US008350714B2

(12) **United States Patent**
Trim

(10) **Patent No.: US 8,350,714 B2**
(45) **Date of Patent: Jan. 8, 2013**

(54) **COLLISION ALERT SYSTEM**

(76) Inventor: **Matthew Ian Trim**, Lakewood, CO (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 267 days.

(21) Appl. No.: **12/945,082**

(22) Filed: **Nov. 12, 2010**

(65) **Prior Publication Data**

US 2011/0109469 A1 May 12, 2011

Related U.S. Application Data

(60) Provisional application No. 61/260,404, filed on Nov. 12, 2009.

(51) **Int. Cl.**
G08B 21/00 (2006.01)

(52) **U.S. Cl.** **340/686.6**; 340/545.1; 340/545.6; 318/480; 49/25

(58) **Field of Classification Search** 340/686.6, 340/686.1, 545.1, 545.2, 545.3, 545.6, 545.9, 340/547, 551, 467, 480; 49/25, 27, 31, 334, 49/463; 318/480, 450, 460, 467, 455
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,861,806	A	1/1999	Vories et al.	
5,963,000	A *	10/1999	Tsutsumi et al.	318/480
6,292,100	B1	9/2001	Dowling	
6,304,178	B1 *	10/2001	Hayashida	340/545.1
6,970,085	B2 *	11/2005	Okabe et al.	340/545.6
7,318,298	B2 *	1/2008	Marsden et al.	49/57
2008/0022596	A1	1/2008	Boerger et al.	

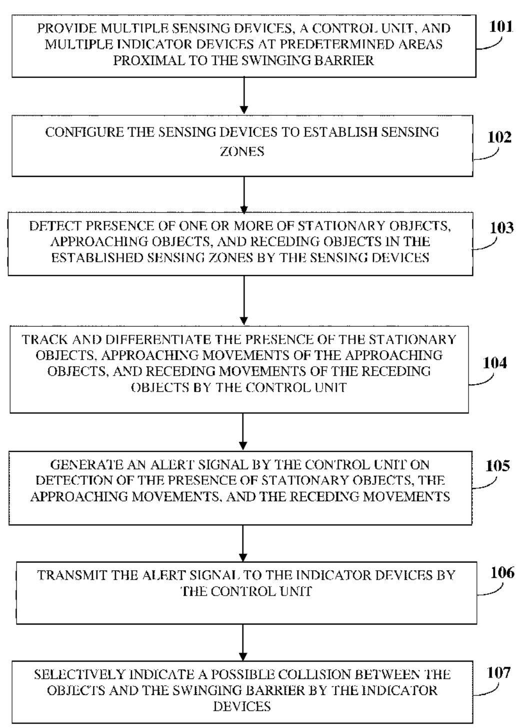
* cited by examiner

Primary Examiner — Anh V La
(74) *Attorney, Agent, or Firm* — Ash Tankha; Lipton, Weinberger & Husick

(57) **ABSTRACT**

A method and system for generating an alert for a possible collision between objects and a swinging barrier is provided. The method and system provides multiple sensing devices, a control unit, and multiple indicator devices at predetermined areas proximal to the swinging barrier. The sensing devices and the control unit electronically communicate with the indicator devices. The sensing devices are configured to establish sensing zones proximal to the swinging barrier. The sensing devices detect presence of one or more of stationary objects, approaching objects, and receding objects in the established sensing zones. The control unit tracks and differentiates the presence of the stationary objects, approaching movements of the approaching objects, and receding movements of the receding objects in the established sensing zones, and generates an alert signal. The indicator devices selectively indicate a possible collision on receiving the alert signal from the control unit.

22 Claims, 41 Drawing Sheets



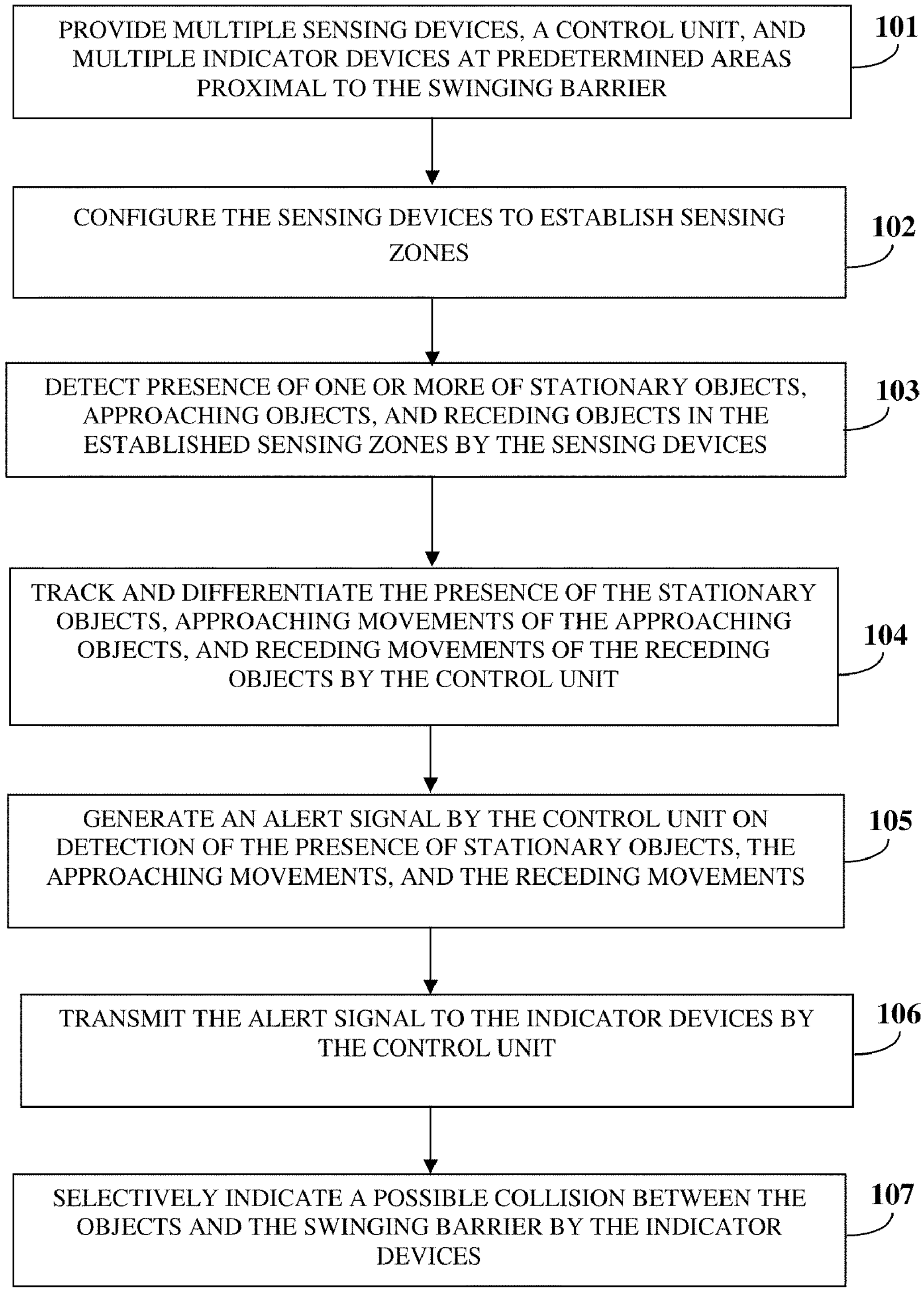

PROVIDE MULTIPLE SENSING DEVICES, A CONTROL UNIT, AND MULTIPLE INDICATOR DEVICES AT PREDETERMINED AREAS PROXIMAL TO THE SWINGING BARRIER
101
CONFIGURE THE SENSING DEVICES TO ESTABLISH SENSING ZONES
102
DETECT PRESENCE OF ONE OR MORE OF STATIONARY OBJECTS, APPROACHING OBJECTS, AND RECEDING OBJECTS IN THE ESTABLISHED SENSING ZONES BY THE SENSING DEVICES
103
TRACK AND DIFFERENTIATE THE PRESENCE OF THE STATIONARY OBJECTS, APPROACHING MOVEMENTS OF THE APPROACHING OBJECTS, AND RECEDING MOVEMENTS OF THE RECEDING OBJECTS BY THE CONTROL UNIT
104
GENERATE AN ALERT SIGNAL BY THE CONTROL UNIT ON DETECTION OF THE PRESENCE OF STATIONARY OBJECTS, THE APPROACHING MOVEMENTS, AND THE RECEDING MOVEMENTS
105
TRANSMIT THE ALERT SIGNAL TO THE INDICATOR DEVICES BY THE CONTROL UNIT
106
SELECTIVELY INDICATE A POSSIBLE COLLISION BETWEEN THE OBJECTS AND THE SWINGING BARRIER BY THE INDICATOR DEVICES
107

FIG. 1

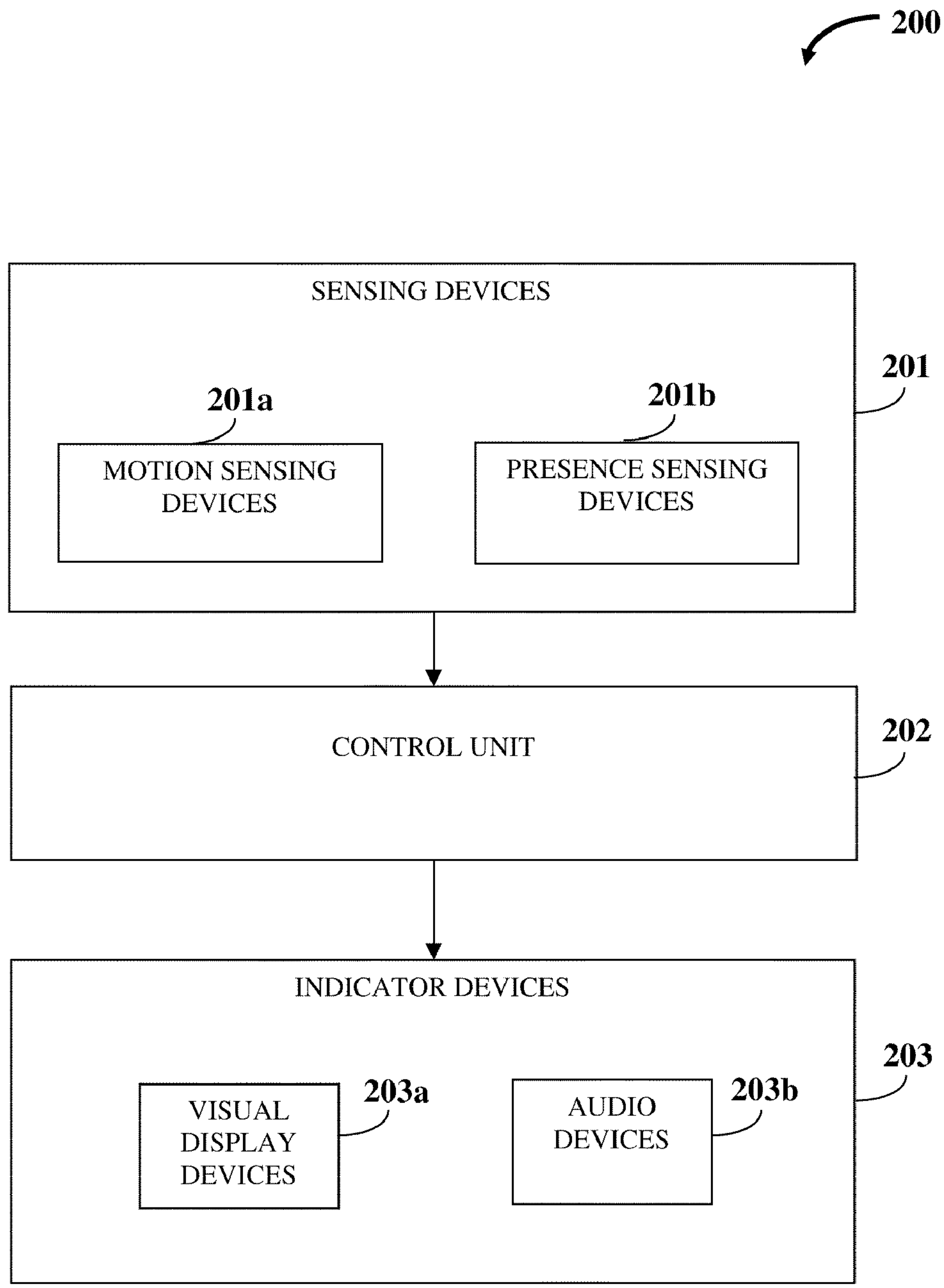

200
SENSING DEVICES
201
201a
201b
MOTION SENSING DEVICES
PRESENCE SENSING DEVICES
CONTROL UNIT
202
INDICATOR DEVICES
203
VISUAL DISPLAY DEVICES
203a
AUDIO DEVICES
203b

FIG. 2

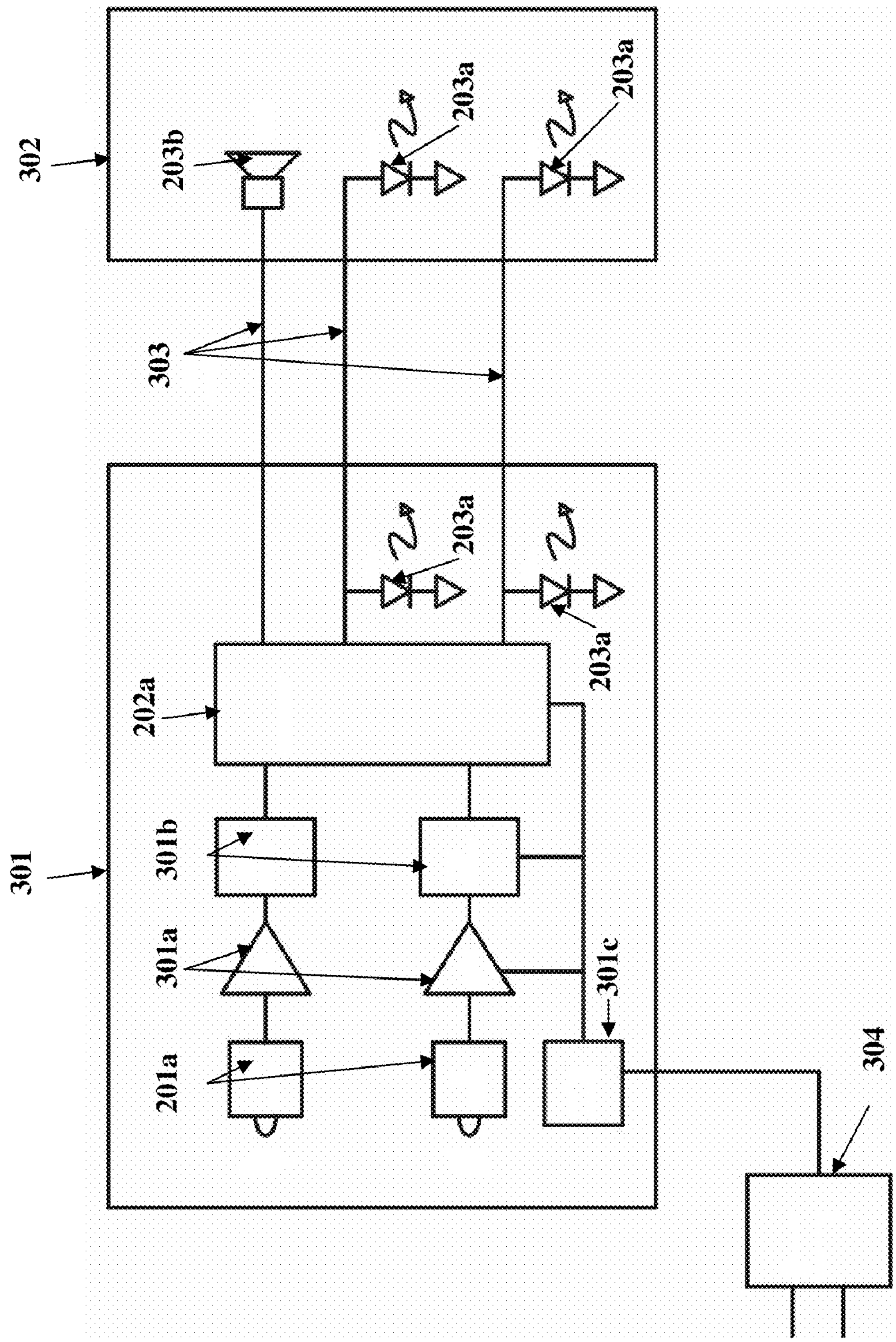

302
203b
203a
203a
303
203a
203a
202a
301
301b
301a
301c
201a
304

FIG. 3

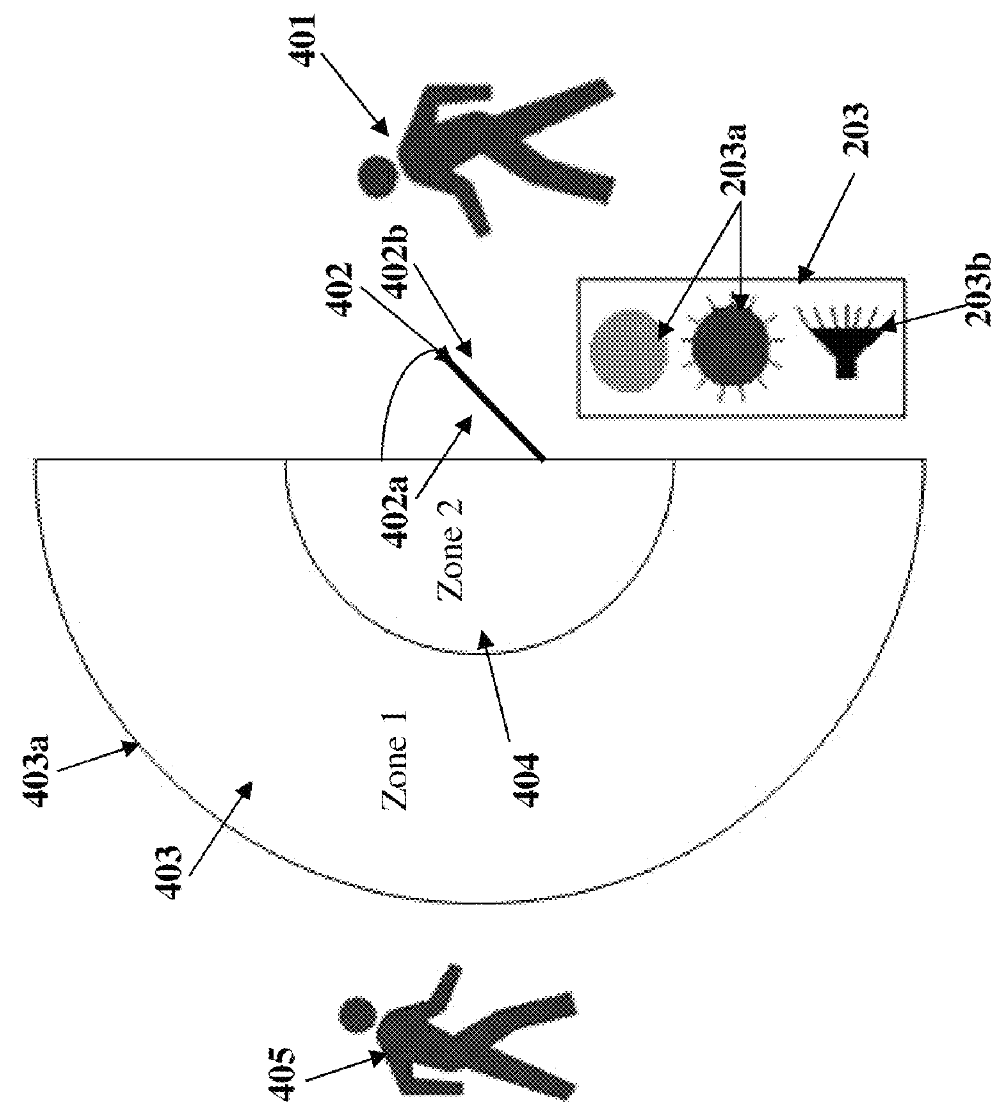


FIG. 4

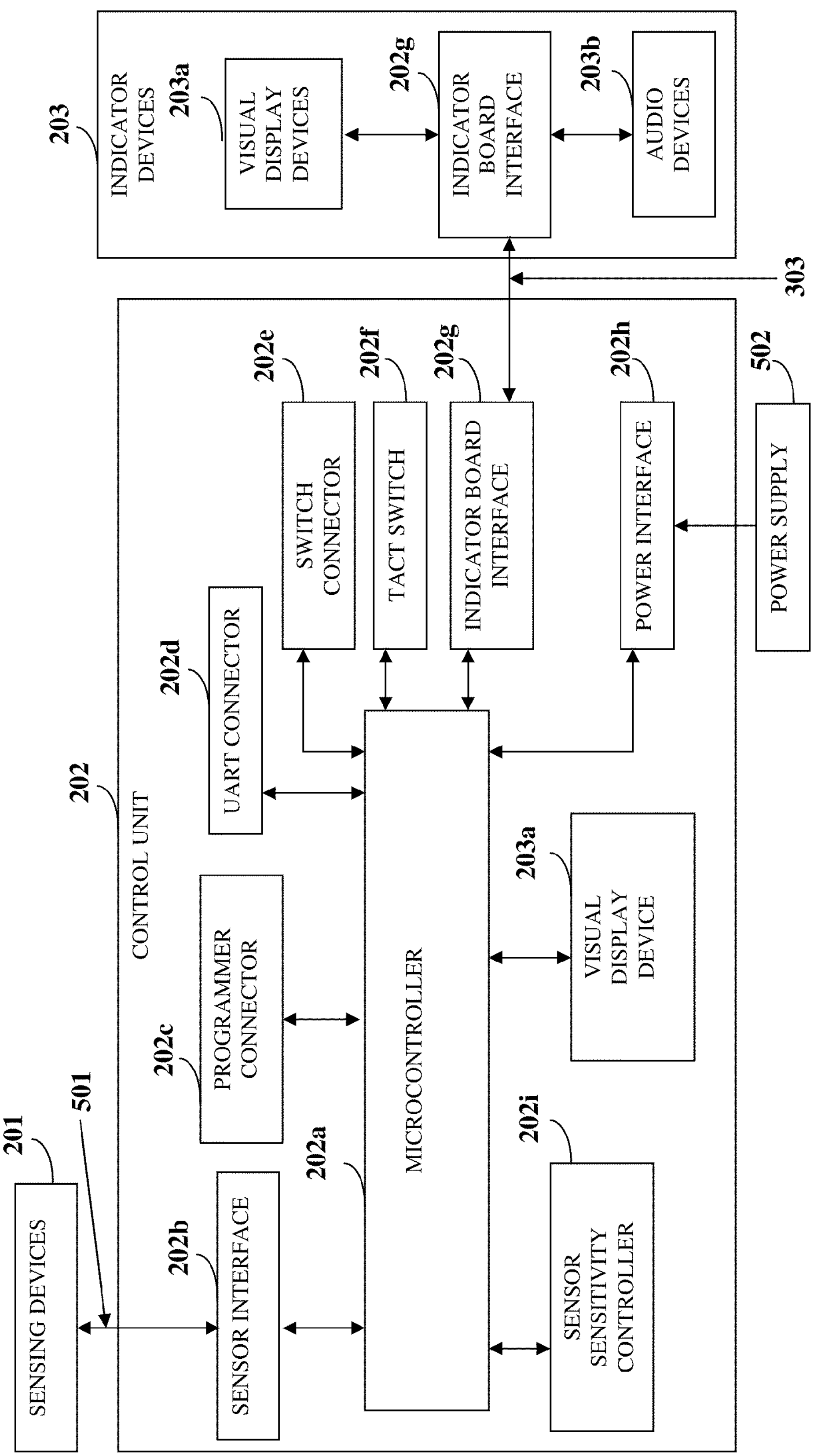

203
INDICATOR DEVICES
203a
VISUAL DISPLAY DEVICES
202g
INDICATOR BOARD INTERFACE
203b
AUDIO DEVICES
303
202
CONTROL UNIT
202e
SWITCH CONNECTOR
202f
TACT SWITCH
202g
INDICATOR BOARD INTERFACE
202h
POWER INTERFACE
502
POWER SUPPLY
202d
UART CONNECTOR
202c
PROGRAMMER CONNECTOR
MICROCONTROLLER
203a
VISUAL DISPLAY DEVICE
201
SENSING DEVICES
501
202b
SENSOR INTERFACE
202a
202i
SENSOR SENSITIVITY CONTROLLER

FIG. 5

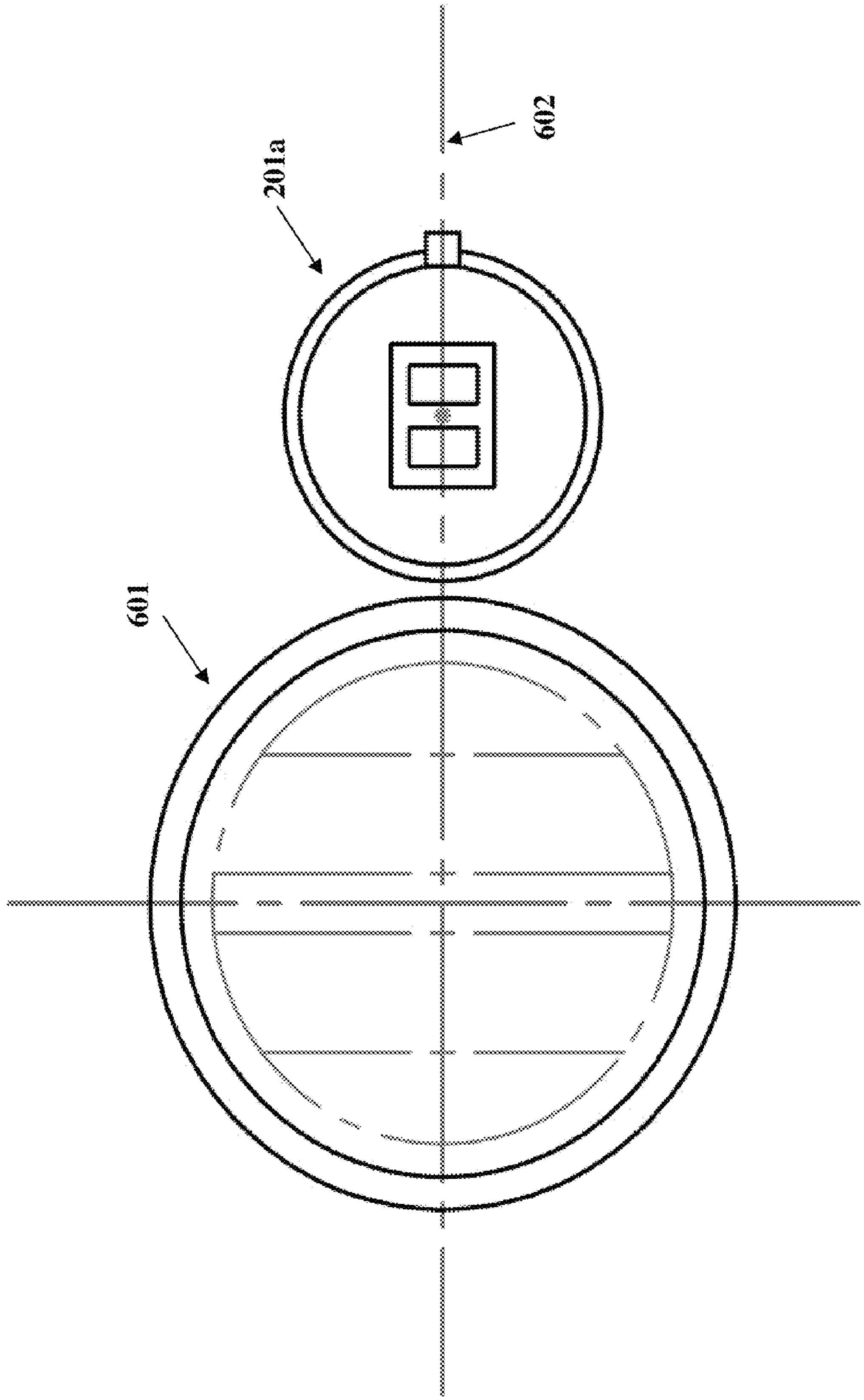


FIG. 6A

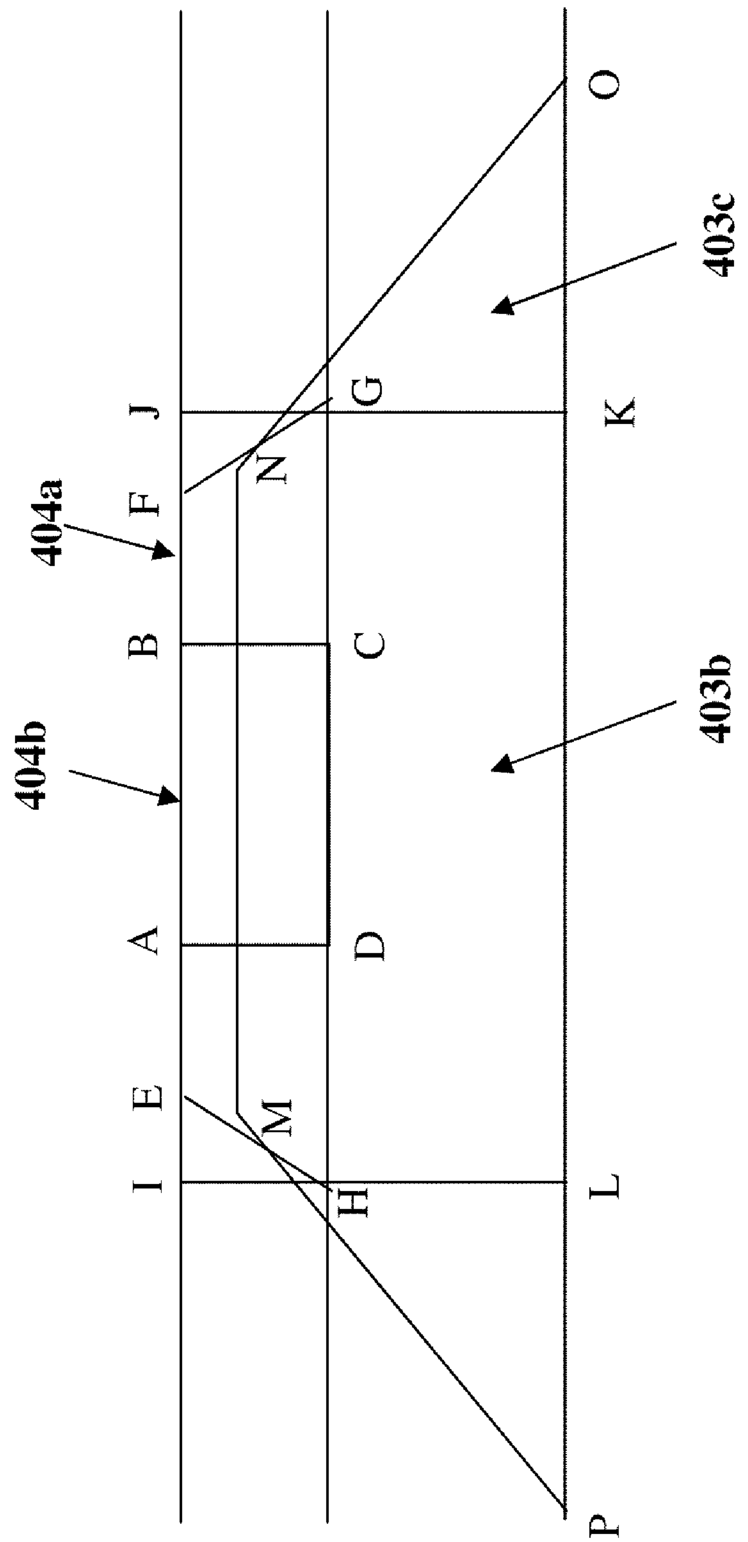


FIG. 6B

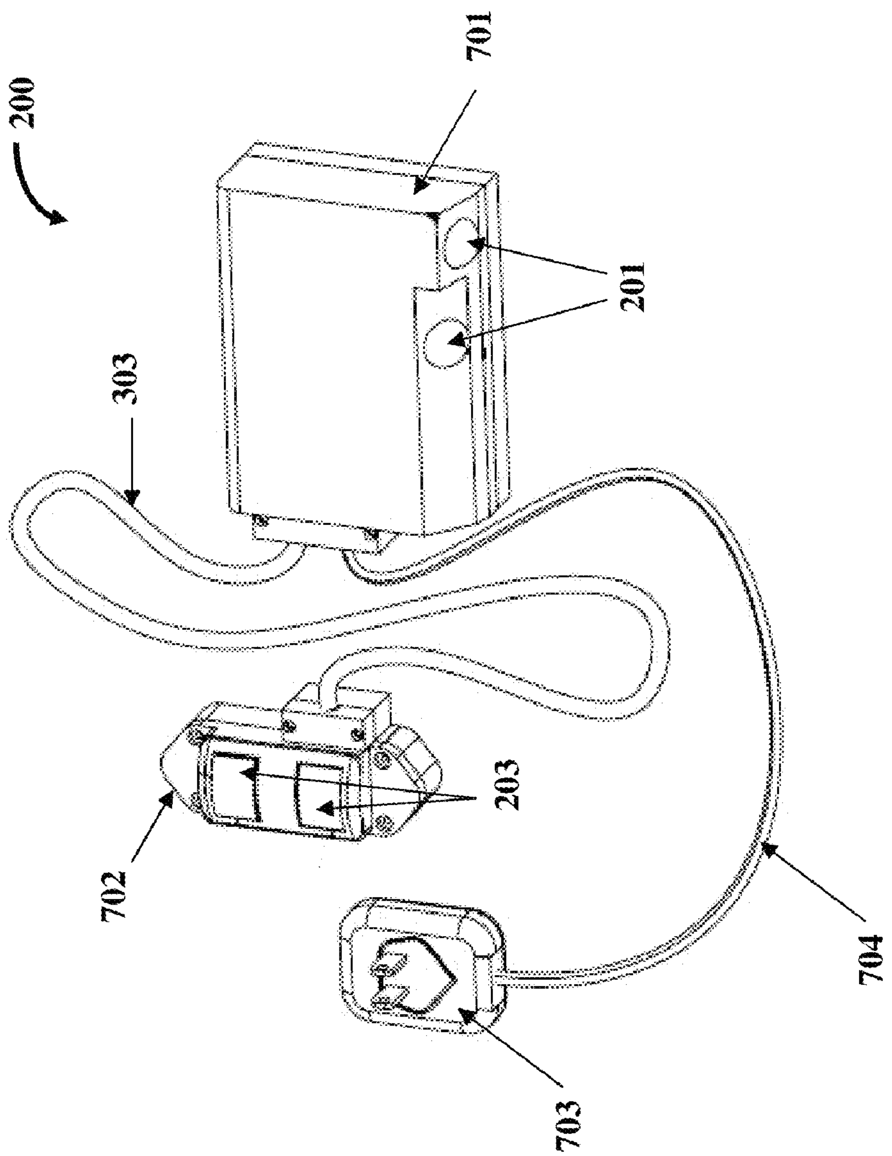


FIG. 7A

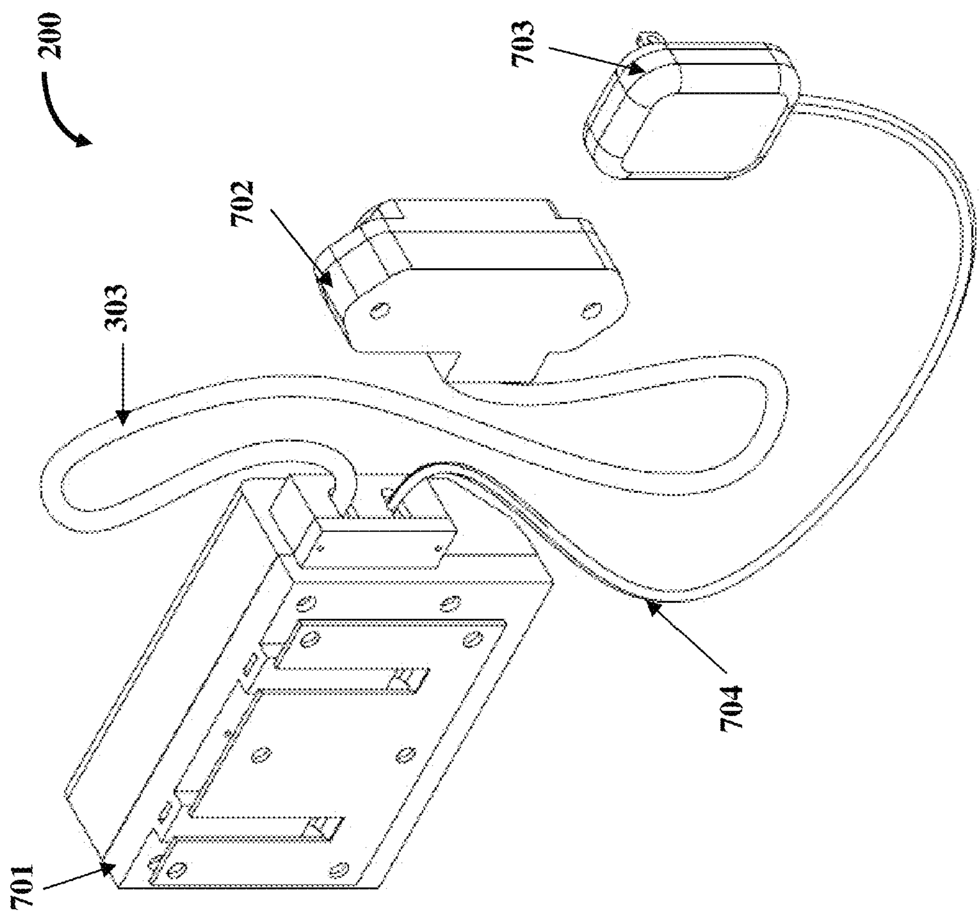


FIG. 7B

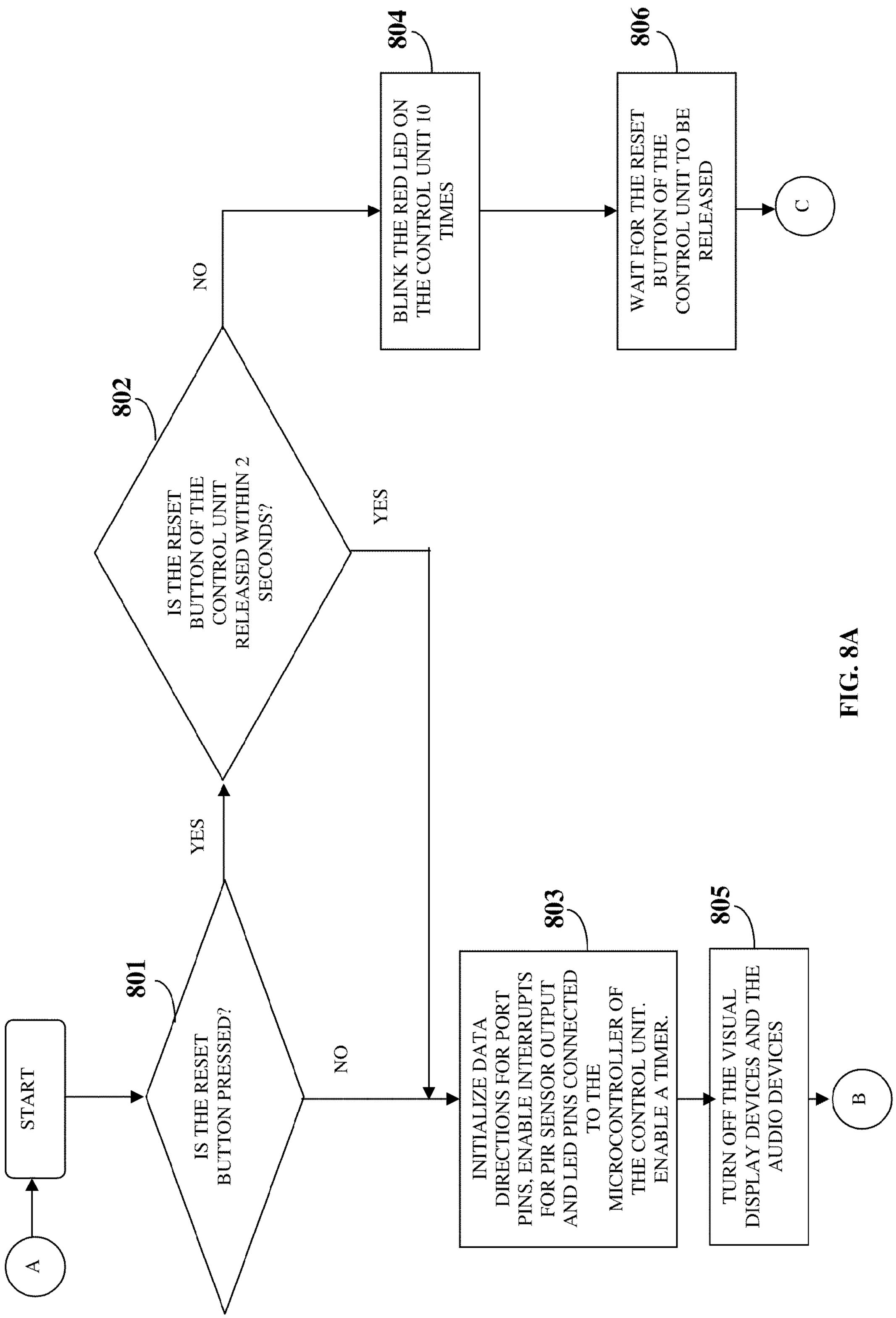

A
START
801
IS THE RESET BUTTON PRESSED?
YES
NO
802
IS THE RESET BUTTON OF THE CONTROL UNIT RELEASED WITHIN 2 SECONDS?
NO
YES
804
BLINK THE RED LED ON THE CONTROL UNIT 10 TIMES
806
WAIT FOR THE RESET BUTTON OF THE CONTROL UNIT TO BE RELEASED
C
803
INITIALIZE DATA DIRECTIONS FOR PORT PINS, ENABLE INTERRUPTS FOR PIR SENSOR OUTPUT AND LED PINS CONNECTED TO THE MICROCONTROLLER OF THE CONTROL UNIT. ENABLE A TIMER.
805
TURN OFF THE VISUAL DISPLAY DEVICES AND THE AUDIO DEVICES
B

FIG. 8A

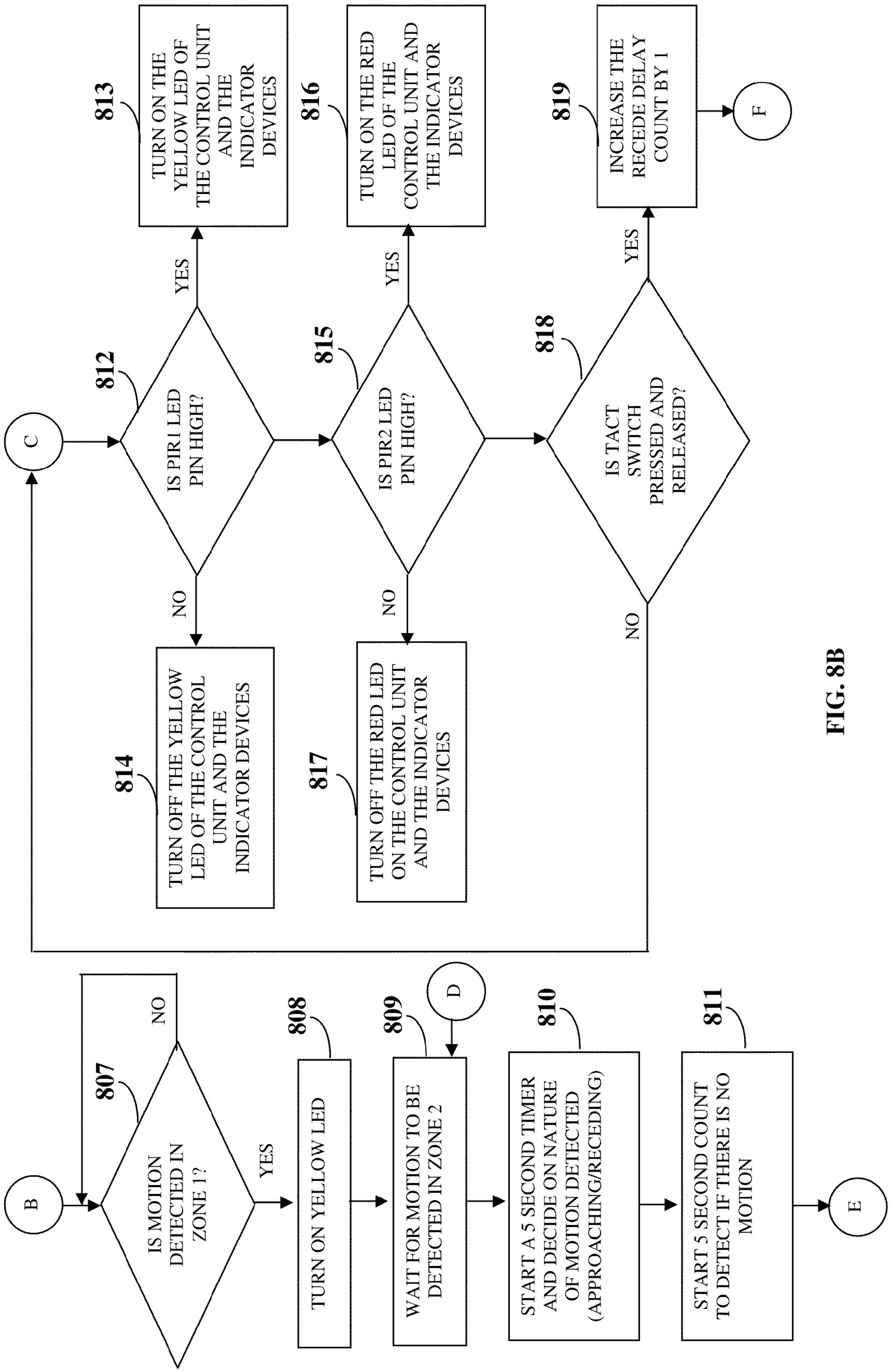

B
807
IS MOTION DETECTED IN ZONE 1?
NO
YES
808
TURN ON YELLOW LED
809
D
WAIT FOR MOTION TO BE DETECTED IN ZONE 2
810
START A 5 SECOND TIMER AND DECIDE ON NATURE OF MOTION DETECTED (APPROACHING/RECEDING)
811
START 5 SECOND COUNT TO DETECT IF THERE IS NO MOTION
E
C
812
IS PIR1 LED PIN HIGH?
YES
813
TURN ON THE YELLOW LED OF THE CONTROL UNIT AND THE INDICATOR DEVICES
NO
814
TURN OFF THE YELLOW LED OF THE CONTROL UNIT AND THE INDICATOR DEVICES
815
IS PIR2 LED PIN HIGH?
YES
816
TURN ON THE RED LED OF THE CONTROL UNIT AND THE INDICATOR DEVICES
NO
817
TURN OFF THE RED LED ON THE CONTROL UNIT AND THE INDICATOR DEVICES
818
IS TACT SWITCH PRESSED AND RELEASED?
YES
819
INCREASE THE RECEDE DELAY COUNT BY 1
F
NO

FIG. 8B

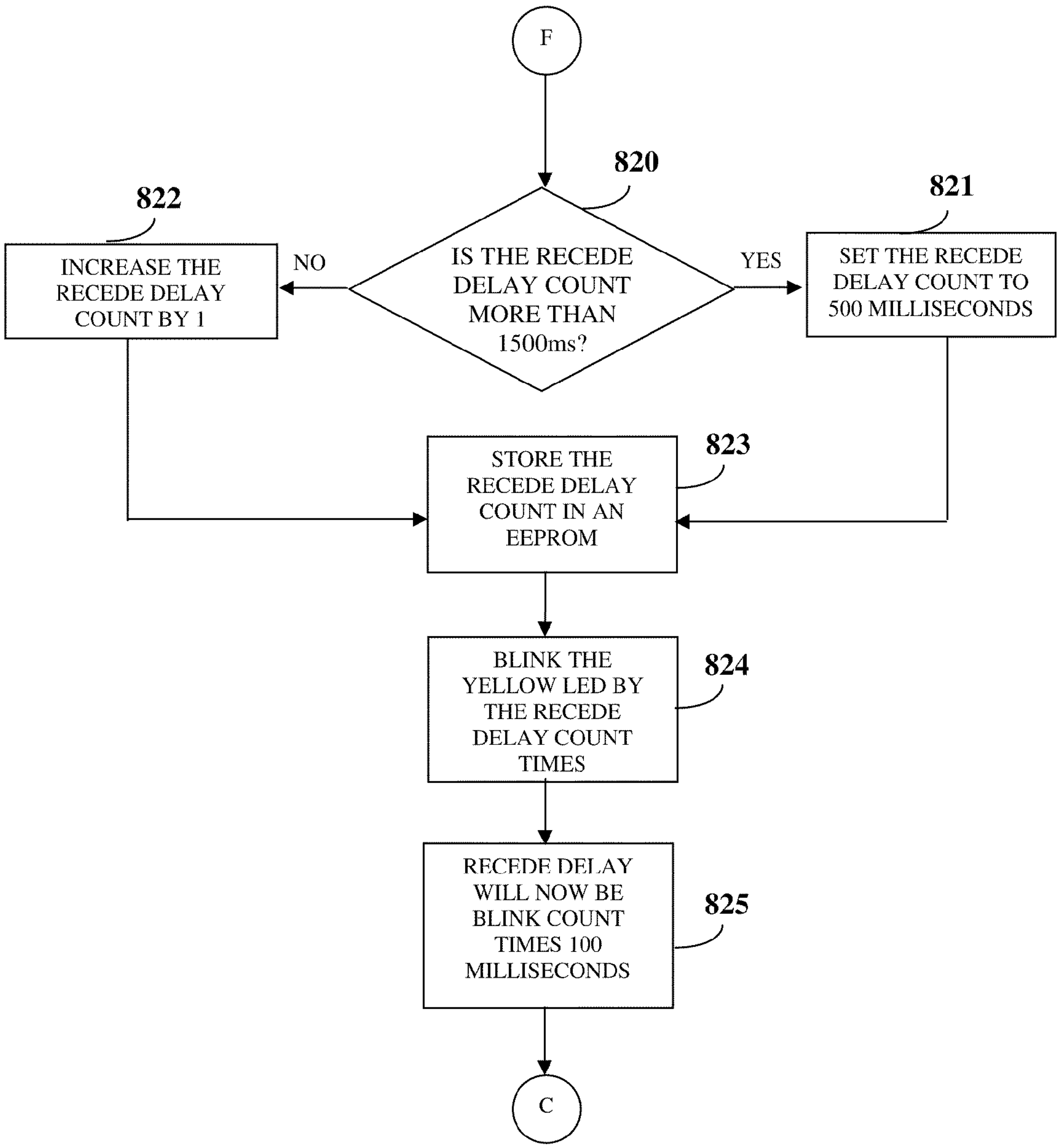

F
820
IS THE RECEDE DELAY COUNT MORE THAN 1500ms?
NO
YES
822
INCREASE THE RECEDE DELAY COUNT BY 1
821
SET THE RECEDE DELAY COUNT TO 500 MILLISECONDS
823
STORE THE RECEDE DELAY COUNT IN AN EEPROM
824
BLINK THE YELLOW LED BY THE RECEDE DELAY COUNT TIMES
825
RECEDE DELAY WILL NOW BE BLINK COUNT TIMES 100 MILLISECONDS
C

FIG. 8C

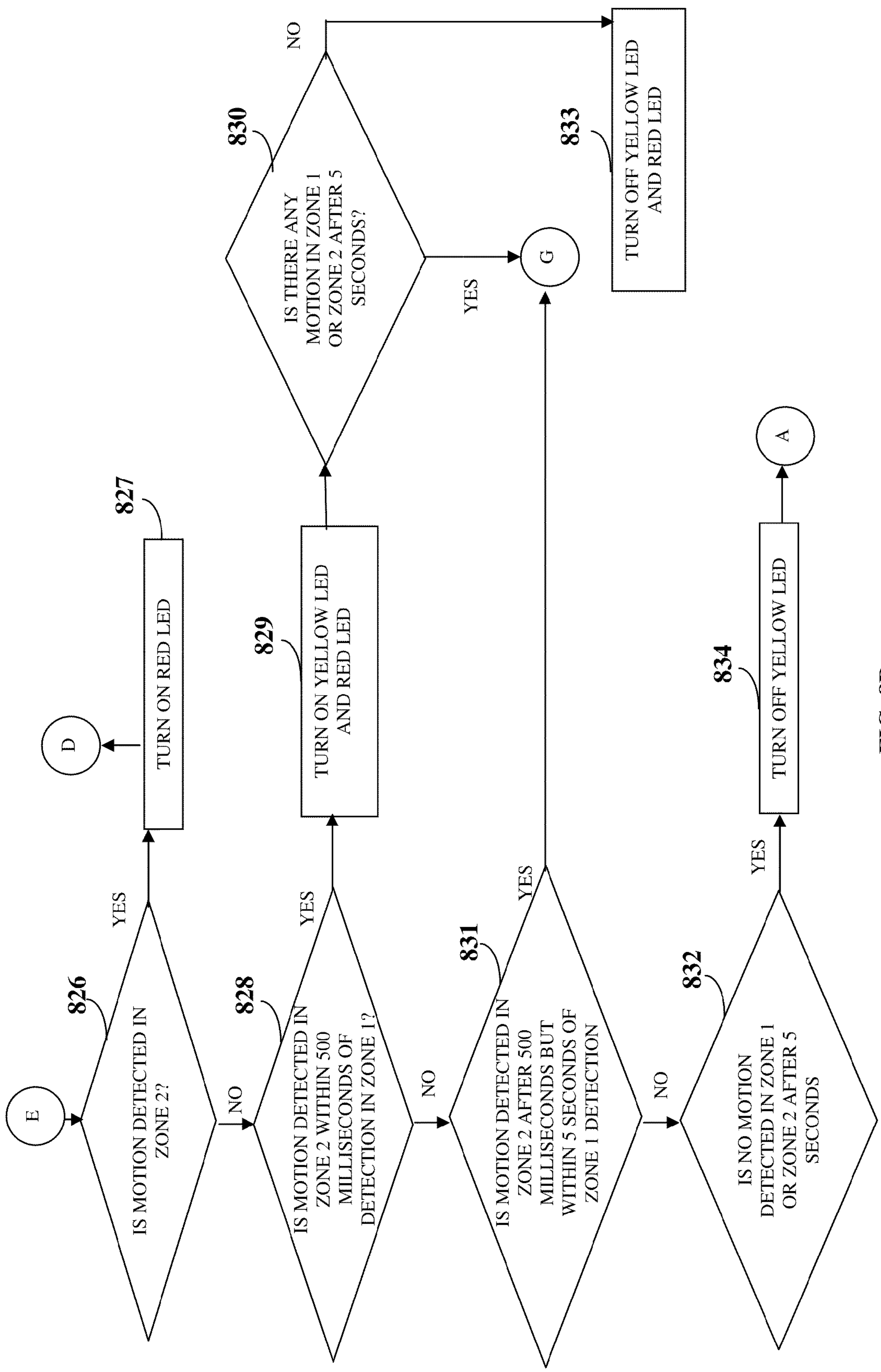

E
826
IS MOTION DETECTED IN ZONE 2?
YES
827
TURN ON RED LED
D
NO
828
IS MOTION DETECTED IN ZONE 2 WITHIN 500 MILLISECONDS OF DETECTION IN ZONE 1?
YES
829
TURN ON YELLOW LED AND RED LED
830
IS THERE ANY MOTION IN ZONE 1 OR ZONE 2 AFTER 5 SECONDS?
YES
G
NO
833
TURN OFF YELLOW LED AND RED LED
NO
831
IS MOTION DETECTED IN ZONE 2 AFTER 500 MILLISECONDS BUT WITHIN 5 SECONDS OF ZONE 1 DETECTION
YES
NO
832
IS NO MOTION DETECTED IN ZONE 1 OR ZONE 2 AFTER 5 SECONDS
YES
834
TURN OFF YELLOW LED
A

FIG. 8D

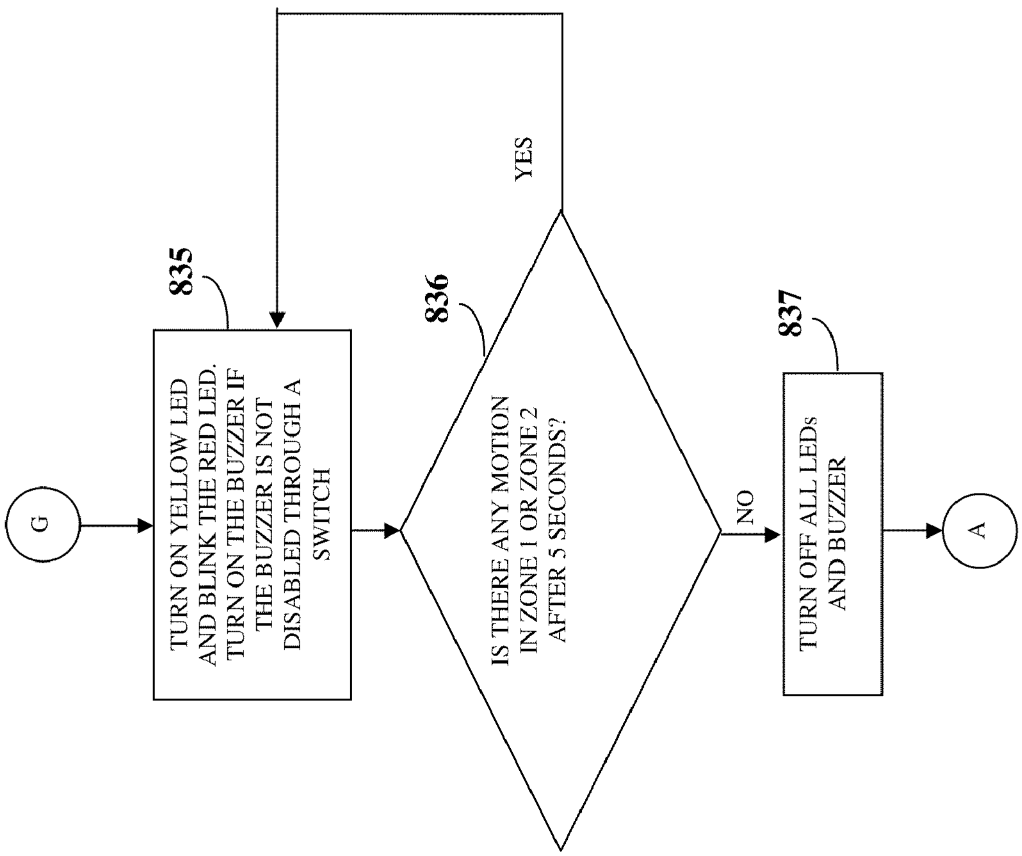
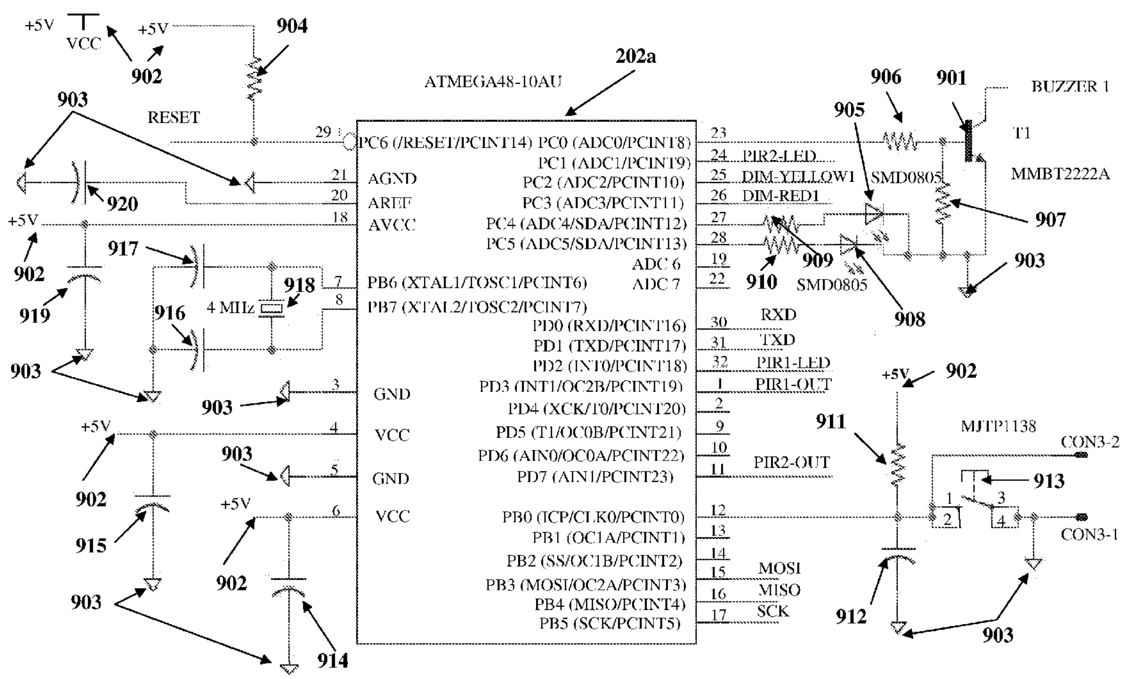

G
TURN ON YELLOW LED AND BLINK THE RED LED. TURN ON THE BUZZER IF THE BUZZER IS NOT DISABLED THROUGH A SWITCH
835
836
IS THERE ANY MOTION IN ZONE 1 OR ZONE 2 AFTER 5 SECONDS?
YES
NO
837
TURN OFF ALL LEDs AND BUZZER
A

FIG. 8E



+5V
VCC
+5V
902
904
ATMEGA48-10AU
202a
903
RESET
920
917
918
4 MHz
916
919
915
914
912
911
913
901
905
906
907
908
909
910
BUZZER 1
T1
MMBT2222A
SMD0805
MJTP1138
CON3-2
CON3-1
PC6 (/RESET/PCINT14)
AGND
AREF
AVCC
PB6 (XTAL1/TOSC1/PCINT6)
PB7 (XTAL2/TOSC2/PCINT7)
GND
VCC
PC0 (ADC0/PCINT8)
PC1 (ADC1/PCINT9)
PC2 (ADC2/PCINT10)
PC3 (ADC3/PCINT11)
PC4 (ADC4/SDA/PCINT12)
PC5 (ADC5/SDA/PCINT13)
ADC 6
ADC 7
PD0 (RXD/PCINT16)
PD1 (TXD/PCINT17)
PD2 (INT0/PCINT18)
PD3 (INT1/OC2B/PCINT19)
PD4 (XCK/T0/PCINT20)
PD5 (T1/OC0B/PCINT21)
PD6 (AIN0/OC0A/PCINT22)
PD7 (AIN1/PCINT23)
PB0 (ICP/CLK0/PCINT0)
PB1 (OC1A/PCINT1)
PB2 (SS/OC1B/PCINT2)
PB3 (MOSI/OC2A/PCINT3)
PB4 (MISO/PCINT4)
PB5 (SCK/PCINT5)
PIR2-LED
DIM-YELLOW1
DIM-RED1
RXD
TXD
PIR1-LED
PIR1-OUT
PIR2-OUT
MOSI
MISO
SCK

FIG. 9

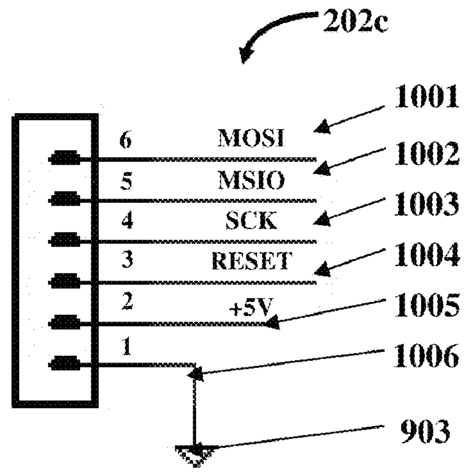


FIG. 10

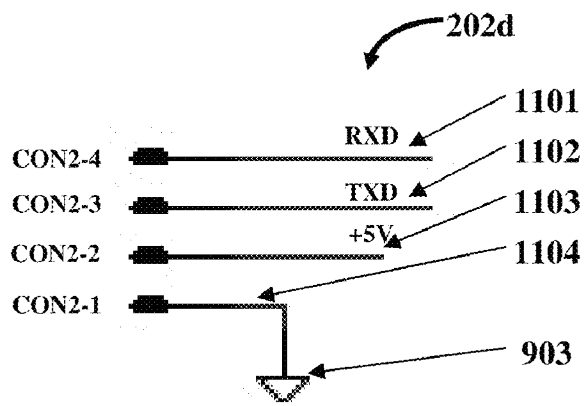


FIG. 11

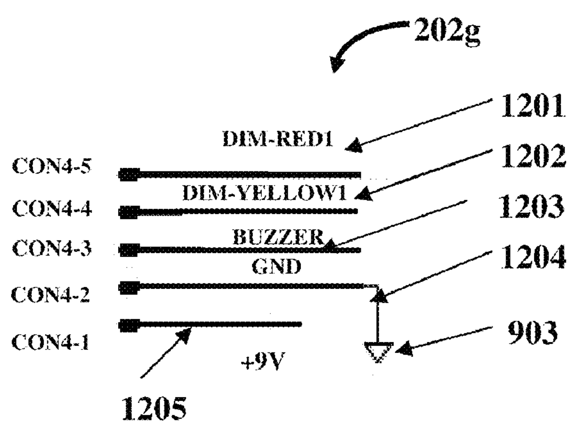


FIG. 12

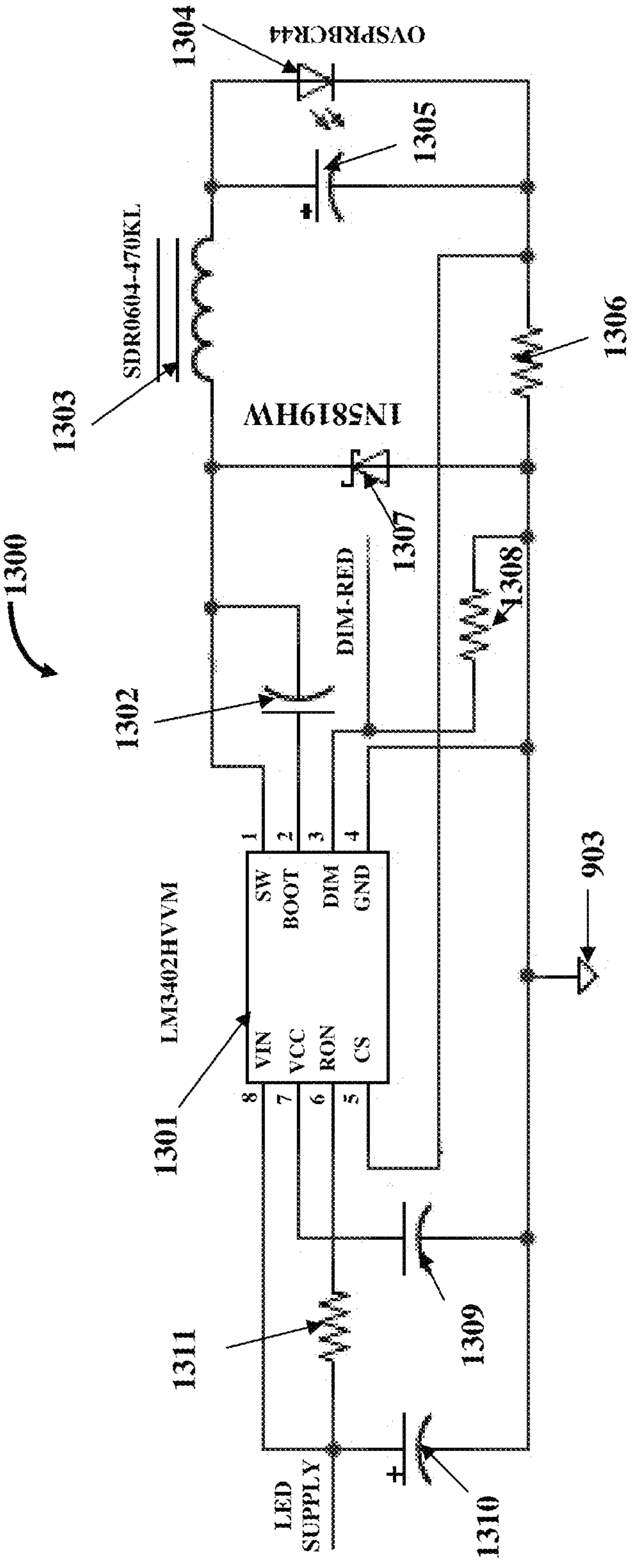

1300
1301
LM3402HVVM
VIN
VCC
RON
CS
SW
BOOT
DIM
GND
1
2
3
4
5
6
7
8
1302
1303
SDR0604-470KL
1304
OVSPRBCR44
1305
1306
1N5819HW
1307
DIM-RED
1308
1309
1310
1311
903
LED SUPPLY

FIG. 13

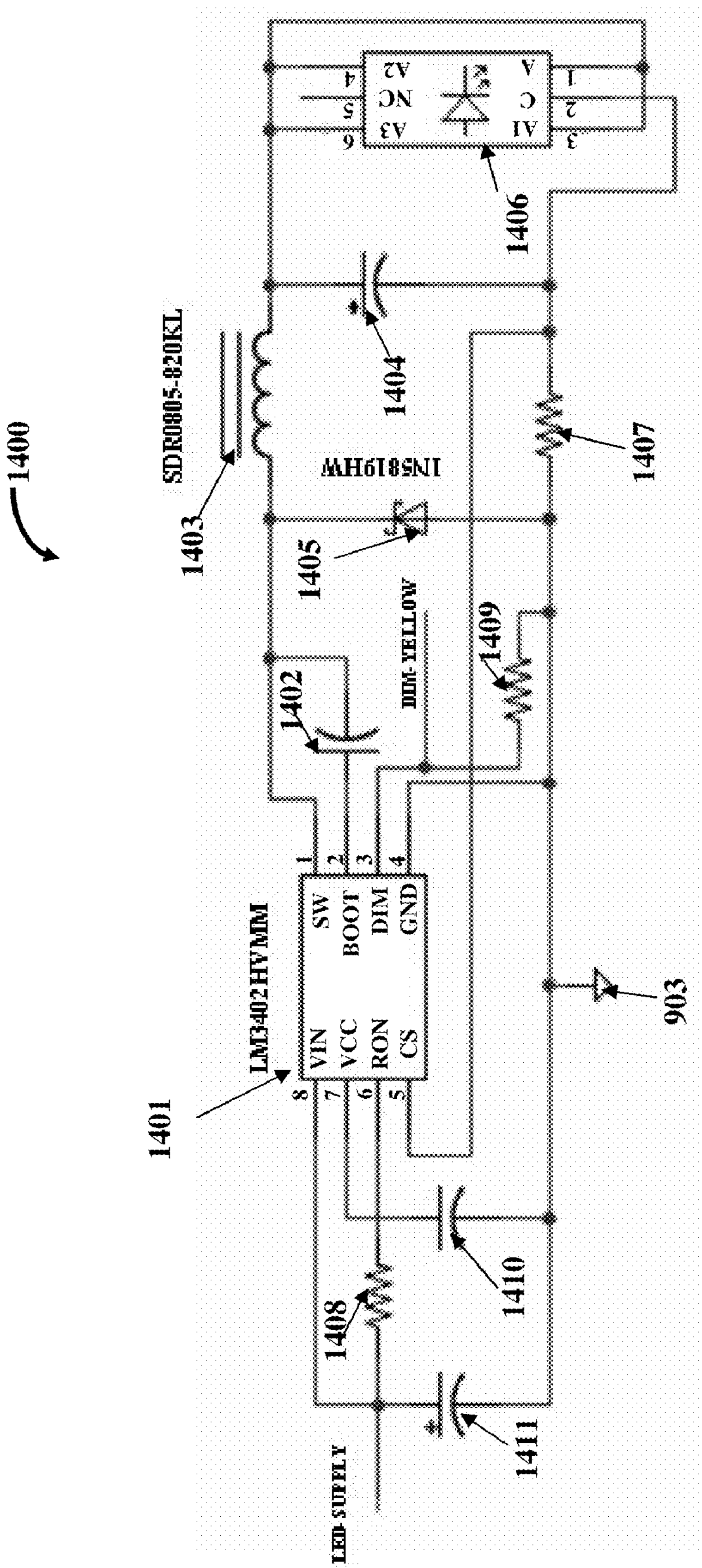

1400
1401
LM3402HVMM
VIN
VCC
RON
CS
SW
BOOT
DIM
GND
1402
1403
SDR0805-820KL
1404
1405
1N5819HW
1406
A2
NC
A3
A
C
A1
1407
1408
1409
DIM-YELLOW
1410
1411
LED-SUPPLY
903

FIG. 14

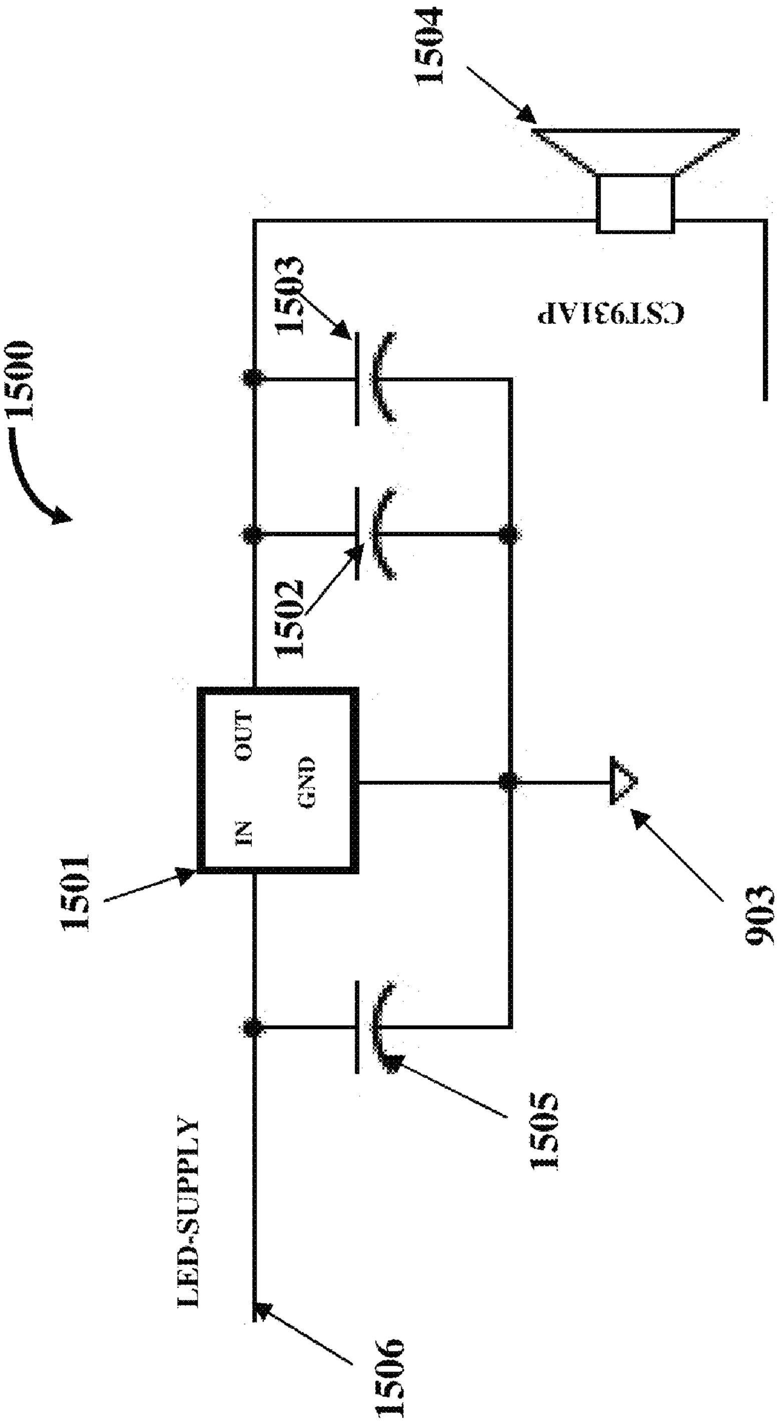

1500
1501
1502
1503
1504
1505
1506
903
IN
OUT
GND
LED-SUPPLY
CST931AP

FIG. 15

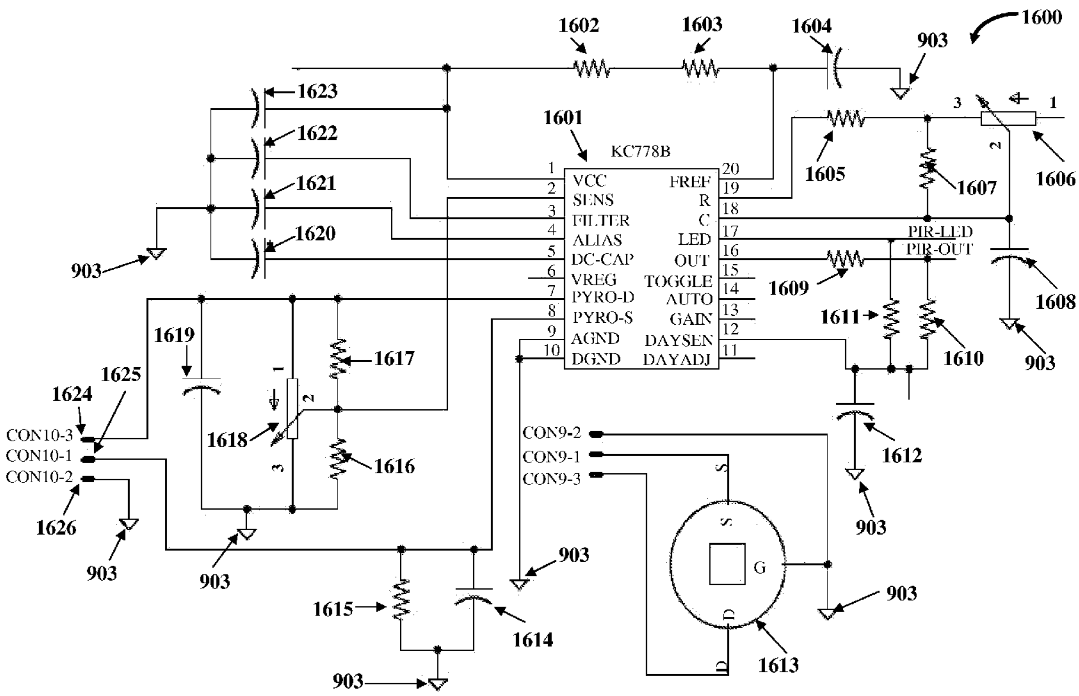

1600
1601
KC778B
1602
1603
1604
1605
1606
1607
1608
1609
1610
1611
1612
1613
1614
1615
1616
1617
1618
1619
1620
1621
1622
1623
1624
1625
1626
903
VCC
SENS
FILTER
ALIAS
DC-CAP
VREG
PYRO-D
PYRO-S
AGND
DGND
FREF
R
C
LED
OUT
TOGGLE
AUTO
GAIN
DAYSEN
DAYADJ
PIR-LED
PIR-OUT
CON10-3
CON10-1
CON10-2
CON9-2
CON9-1
CON9-3
S
G
D

FIG. 16

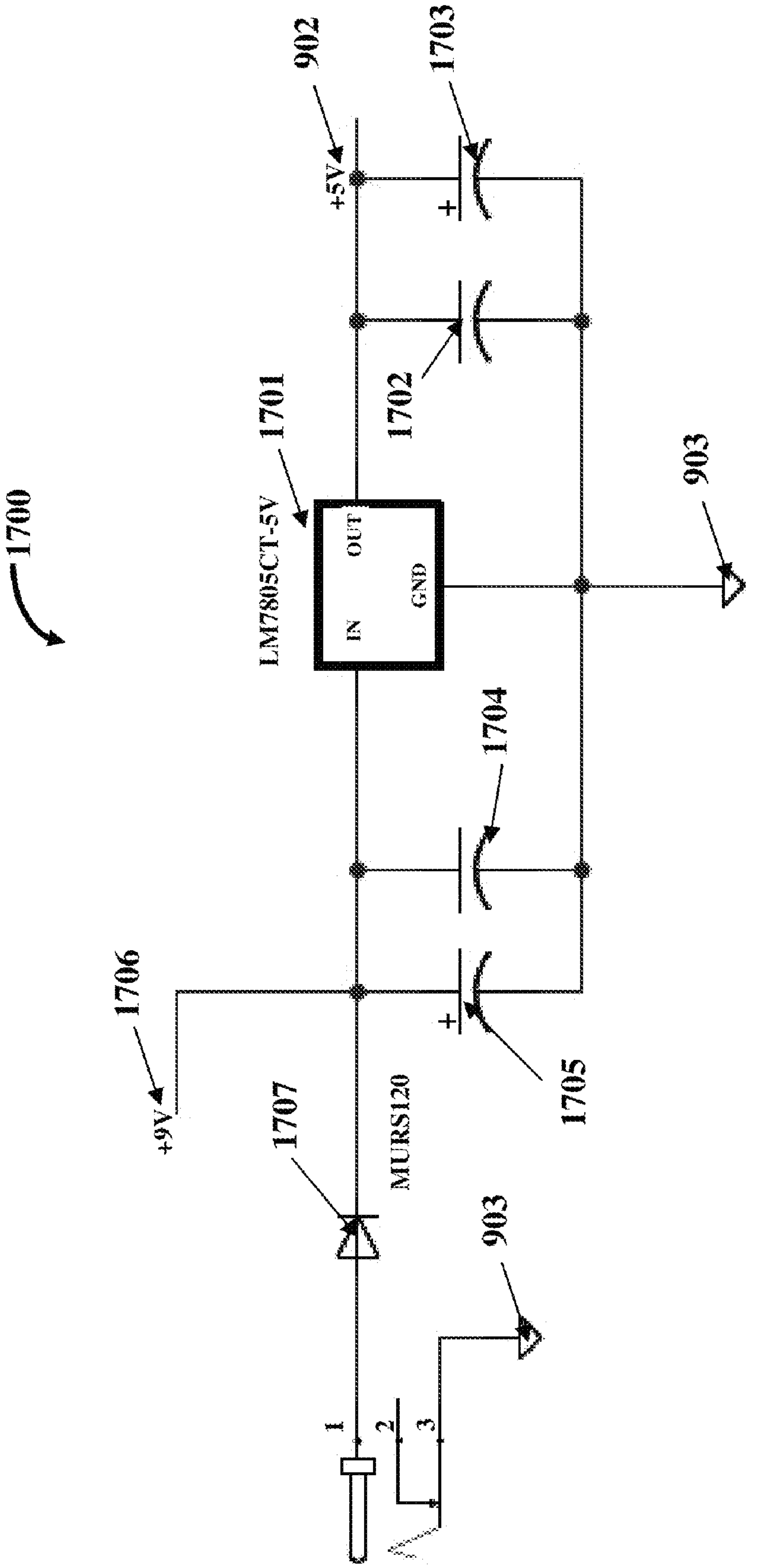

1700
1701
LM7805CT-5V
IN
OUT
GND
902
+5V
1703
1702
903
1704
1705
1706
+9V
1707
MURS120
903
1
2
3

FIG. 17

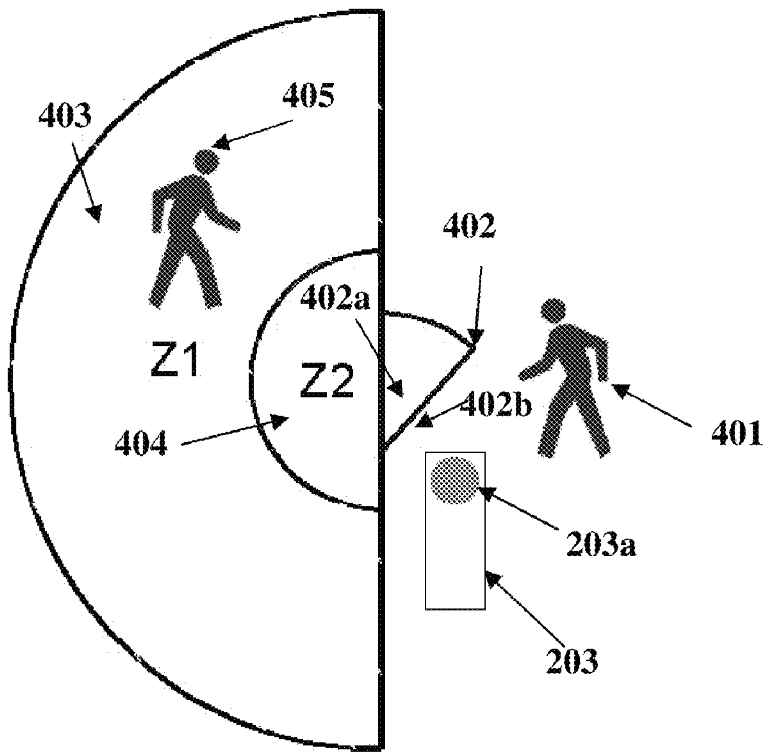


FIG. 18A

Z1	Z2	Y	RED	FLRED	BUZZ
0	0	0	0	0	0
1	0	1	0	0	0
1	1	1	1	0	0
1	1	1	0	1	1

FIG. 18B

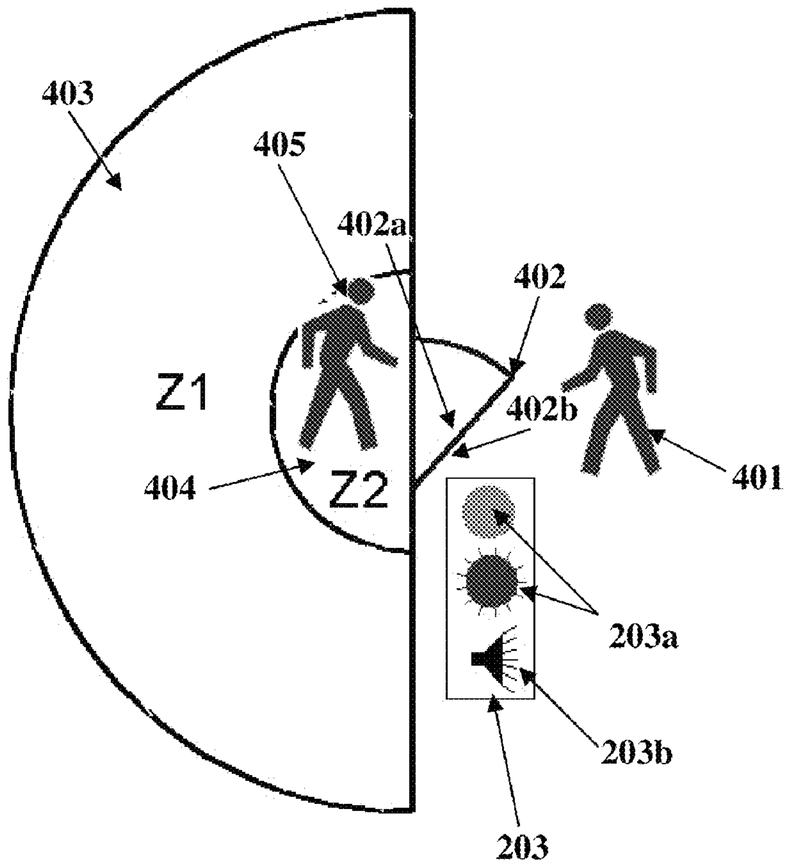


FIG. 19A

Z1	Z2	Y	RED	FLRED	BUZZ
0	0	0	0	0	0
1	0	1	0	0	0
1	1	1	1	0	0
1	1	1	0	1	1

FIG. 19B

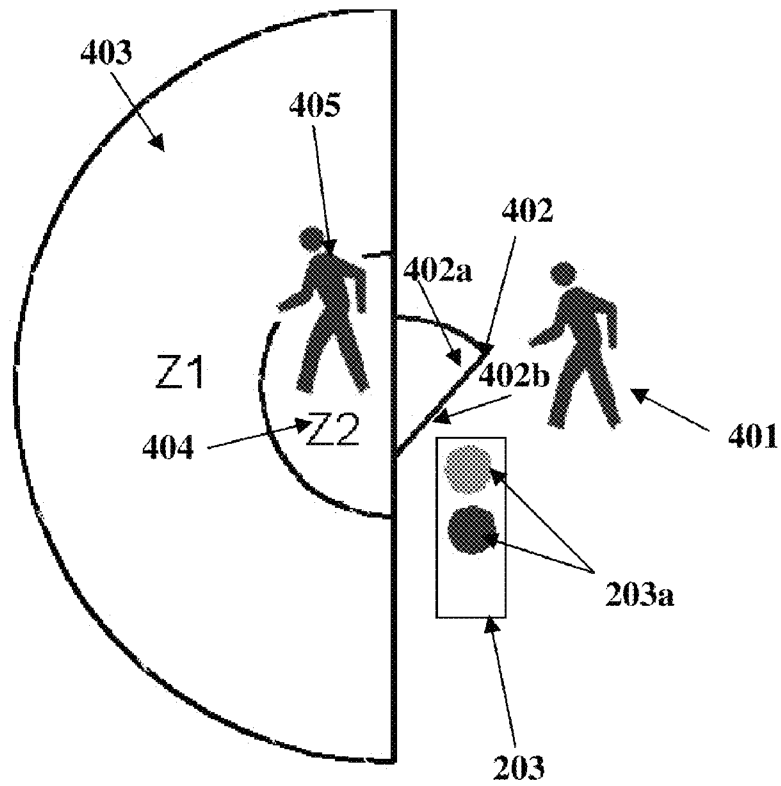


FIG. 20A

Z1	Z2	Y	RED	FLRED	BUZZ
0	0	0	0	0	0
1	0	1	0	0	0
1	1	1	1	0	0
1	1	1	0	1	1

FIG. 20B

```
//#define DEBUGX
#include <mega48.h>
//#include "delay.h"
#include "defines.h"
#include "prototypes.h"

#ifdef DEBUGX
#include "stdio.h"
#endif

unsigned char  eeprom buzzer_state = 0;
volatile unsigned char z1_event = 0, z2_event = 0;
unsigned char transition_event = 0, receding_event = 0, decide_event = 0;
unsigned int no_motion_count = 0, decide_event_count = 0;
unsigned int recede_time = 0, transition_time = 0;
volatile unsigned char MOTION_Z1 = 0;
unsigned char eeprom RECEDING_EVENT_TIME = 5;// 5 * 100 mS

interrupt [TIM1_OVF] void timer1_ovf_isr(void)
{
 static unsigned int d, i = 0, count = 0;
 TCNT1H=0xff;
 TCNT1L=0xeb;// 0xffe8--->0xffff == 183us ( 2.730 kHz for buzzer)

 if( buzzer_state == 0)
  BUZZER_HIGH;

 if( ++count >= 546)
 {
 count = 0;
  #ifdef DEBUGX
     if(!( ++d % 10))
     {
        printf(" -%d", d/10);
        if( receding_event == 1)
           printf("r");
        if( transition_event == 1)
           printf("t");
        printf("%d-", MOTION_Z1);
     }
  #endif
```

FIG. 21A

```
if( MOTION_Z1 == 1 &&( receding_event != 1 &&  transition_event != 1)) // if a
motion is detected in the Zone 1, that is, the outer zone
  {
    // if the motion is not sensed in z1 within 5 s
    if(++no_motion_count >= NO_MOTION_DETECTED_TIME)
    {
      DIM_YELLOW_LED_LOW; // make yellow led low
      MOTION_Z1 = 0;
      decide_event_count = 0;
      decide_event = 0;
      YELLOW_LED_LOW;
      #ifdef DEBUGX
        printf("\r\n no motion");
      #endif
    }
  }
  // if motion is sensed in Zone 1, then wait for the motion to be sensed
  //in the Zone 2 i.e the inner zone
  if( decide_event == 1 &&( receding_event != 1 &&  transition_event != 1))
  {
    ++decide_event_count;// increment the count every 100 mS
    if( MOTION_Z1 == 2)
    {
      if( decide_event_count <= RECEDING_EVENT_TIME)
      {
        if( z1_event == 1) // if a motion sensed in inner zone( Zone2)
        {
            receding_event = 1;
            #ifdef DEBUGX
            printf("\r\n decided - zzreceding");
          #endif
        }
      }
```

FIG. 21B

```
        else
        {
           decide_event_count = 0;// make decide count 0
           decide_event = 0; // make decide event 0
           z2_event = 0; // make z2 event 0
           z1_event = 0;
           recede_time = 0;// make recede count 0
           transition_time = 0; // make transition count 0
           MOTION_Z1 = 0;
           receding_event = 0;
           transition_event = 0;
           RED_LED_LOW;
        }
     }
     if( MOTION_Z1 == 1)
     {
        if( z2_event == 1) // if a motion is sensed in inner zone( Zone2)
        {
          // if it lesser than 500 mS then it is transition event
          if( decide_event_count >= RECEDING_EVENT_TIME)
           {
              transition_event = 1;
              BUZZER_HIGH;        // // MAKE BUZZER HIGH IF IT IS NOT
DISABLED( SEE MACRO)
              #ifdef DEBUGX
                 printf("\r\n decided - transition");
              #endif
           }
           // if it greater than 500 mS then it is receding event
           else
           {
              receding_event = 1;
              #ifdef DEBUGX
                 printf("\r\n decided - receding");
              #endif
           }
```

FIG. 21C

```
            decide_event_count = 0;// make decide count 0
            decide_event = 0; // make decide event 0
            z2_event = 0;     // make z2 event 0
            z1_event = 0;
            recede_time = 0;// make recede count 0
            transition_time = 0; // make transition count 0
            MOTION_Z1 = 0;
          }
       }
       if( decide_event_count >= WAIT_TIME && MOTION_Z1 == 0)// if neither
event takes place in the given time
       {
          z1_event = 0;
          z2_event = 0;
          if( MOTION_Z1 == 0)
          {
             DIM_YELLOW_LED_LOW;
             DIM_RED_LED_LOW;
             decide_event = 0;
          }

          recede_time = 0;
          transition_time = 0;
          decide_event_count = 0;
          //MOTION_Z1 = 0;
          #ifdef DEBUGX
                printf("\r\n z1 2 z2 -waitover");
          #endif
       }
    }
```

FIG. 21D

```
// if it is a receding event
if( receding_event == 1)
{
    if( recede_time <= WAIT_TIME)
    {
        z1_event = 0;
        z2_event = 0;
    }
   if( ++recede_time >= WAIT_TIME + 10 )// if it is in recede state
   // for more than 5 s
   {
      // if z1_event or z2_event has occured during this wait time
      if( z2_event == 1 )
      {
        transition_event = 1;   // go 2 transition state
         #ifdef DEBUGX
            printf("\r\n r 2 t ");
         #endif
         BUZZER_HIGH;    // make buzzer high
      }
      else  // else
      {
         #ifdef DEBUGX
            printf("\r\n recede over");
         #endif

      }
      DIM_RED_LED_LOW; //
      DIM_YELLOW_LED_LOW;
      YELLOW_LED_LOW;
      RED_LED_LOW;
      receding_event = 0;
      recede_time = 0;
      transition_time = 0;
      z1_event = 0;
      z2_event = 0;
      MOTION_Z1 = 0;
      #ifdef DEBUGX
         printf("-rout-");
      #endif
      //delay_ms( 100);

   }
}
```

FIG. 21E

```
  // if it is a transition event, that is, an approaching movement
  if( transition_event == 1)
  {
    if( ++i % 2)
       DIM_RED_LED_BLINK; // blink red led
    if( ++transition_time >= WAIT_TIME )
    {
       // if z1_event or z2_event has occurred during this wait time
       if(  z2_event != 1)      // stop transition
       {
         #ifdef DEBUGX
           printf("\r\n transition over.");
         #endif
         transition_event = 0;
         BUZZER_LOW;
         MOTION_Z1 = 0;
       }
       else      // continue transition
       {
         #ifdef DEBUGX
           printf("\r\n transition cont...");
         #endif
         transition_event = 1;

       }
       z1_event = 0;
       z2_event = 0;

       receding_event = 0;
       decide_event = 0;
       transition_time = 0;
       YELLOW_LED_LOW;
       DIM_YELLOW_LED_LOW; // make yellow led low
       DIM_RED_LED_LOW; // make red led low
       RED_LED_LOW;
       //delay_ms( 100);
    }
   }
 }
}
```

FIG. 21F

```
/*****************************************************************
* Function name:interrupt [PCINT2] void pin_change_isr2(void)        *
* Input parameters: // Pin change 16-23 interrupt service routine    *
* Output parameters: NONE                                            *
* Purpose: I/P FRM PIR2 - O/P PIN( RED)                              *
* Returns: NONE                                                      *
*****************************************************************/

interrupt [PCINT2] void pin_change_isr2(void)
{
  //GREEN_LED_BLINK;
}
/*****************************************************************
* Function name:interrupt [PCINT1] void pin_change_isr1(void)        *
* Input parameters: // Pin change 8-14 interrupt service routine     *
* Output parameters: NONE                                            *
* Purpose: I/P FRM PIR2 - LED PIN( RED)                              *
* Returns: NONE                                                      *
*****************************************************************/

interrupt [PCINT1] void pin_change_isr1(void)
{
  if( MOTION_Z1 == 1)
  {
    if( IS_PIR2_LED_HIGH)
    {
      z2_event = 1;
      #ifdef DEBUGX
        printf("- int z2--");
      #endif
      no_motion_count = 0;
      transition_time = 0;
      RED_LED_HIGH;

      if( transition_event == 1)
      {
        z2_event = 0;
      }
      RED_LED_HIGH;
    }
    else{
      RED_LED_LOW;
    }}
```

FIG. 21G

```
    else if(  MOTION_Z1 == 0  && transition_event != 1 && receding_event != 1)
    {
       if( IS_PIR2_LED_HIGH)
       {
          z2_event = 1;
          z1_event = 0;
          #ifdef DEBUGX
          printf("- int z22--");
          #endif
          MOTION_Z1 = 2;
          decide_event_count = 0;
          decide_event = 1;
          RED_LED_HIGH;
       }
       else
       {
          RED_LED_LOW;
       }
    }
    else if( MOTION_Z1 == 0  && transition_event == 1)
    {
       if( IS_PIR2_LED_HIGH)
       {
          z2_event = 0;
          z1_event = 0;
          #ifdef DEBUGX
             printf("- int z22t--");
          #endif
          transition_time = 0;
          RED_LED_HIGH;
       }
       else
       {
          RED_LED_LOW;
       }
    }
 }
```

FIG. 21H

```
/*****************************************************************
* Function name: interrupt [PCINT0] void pin_change_isr0(void)            *
* Input parameters: I/P FROM SWITCH                                        *
* Output parameters: NONE                                                  *
* Purpose:// Pin change 0-7 interrupt service routine                      *
* Processing: See function                                                 *
* Returns: NONE**************************************************/

interrupt [PCINT0] void pin_change_isr0(void)
{
   if( !IS_SWITCH_HIGH) // IS SWITCH PRESSED?
   {
      delay_ms1( 10);   // DEBOUNCE DELAY
      if( !IS_SWITCH_HIGH)// CONFIRM IT IS NOT A SPIKE
      {
         buzzer_state ^= 0x01;// TOGGLE THE BUZZER STATE

         if( buzzer_state == 0x01)// IF BUZZER STATE IS 1
         {
            BUZZER_LOW;     // SWITCH OFF THE BUZZER
            #ifdef DEBUGX
               printf("- bl--");
            #endif

         }
      }
   }
}
```

FIG. 21I

```
/*****************************************************************
* Function name:interrupt [EXT_INT0] void ext_int0_isr(void)     *
* Input parameters: NONE                                          *
* Output parameters: NONE                                         *
* Purpose:// External Interrupt 0 service routine- I/P FROM PIR1 LED *
* Processing: See function                                        *
* Returns: NONE                                                   *
*****************************************************************/

interrupt [EXT_INT0] void ext_int0_isr(void)
{
   if( IS_PIR1_LED_HIGH)// IS O/P FROM PIR1 IC HIGH
   {
      z1_event = 1;    //IT IS A Z1 EVENT
      #ifdef DEBUGX
         printf("-int z1--");
      #endif
      YELLOW_LED_HIGH;
   }
   else
   {
      YELLOW_LED_LOW;
   }
}
/****************************************************************
* Function name:interrupt [EXT_INT1] void ext_int1_isr(void)    *
* Input parameters: NONE                                         *
* Output parameters: NONE                                        *
* Purpose: // External Interrupt 1 service routine- I/P FROM PIR O/P *
* Processing: See function                                       *
* Returns:NONE                                                   *
****************************************************************

interrupt [EXT_INT1] void ext_int1_isr(void)
{
 // GREEN_LED_BLINK
  ;
}
```

FIG. 21J

```
/**************************************************************
* Function name:void main( void)                              *
* Input parameters: NONE                                      *
* Output parameters: NONE                                     *
* Purpose: MAIN FLOW                                          *
* Processing: See function                                    *
* Returns: NONE                                               *
**************************************************************/

void main( void)
{
  unsigned int i = 0, diagnostic_mode = 0;
  port_init();  // port initialization
  delay_ms1( 20);
  if( !IS_SWITCH_HIGH)// is s1 switch is press n held for 2 s at Power on
  {
    while( ++i <= 40)
    {
      delay_ms1( 50);
      if( IS_SWITCH_HIGH)  // if the switch is released within 2 s
      {
        diagnostic_mode = 0; // go to normal mode
        #ifdef DEBUGX
          printf("-com out-");
        #endif
        break;      //  break
      }
      diagnostic_mode = 1;

    }
    i = 0;
    if( diagnostic_mode == 1)  // diagnostic mode
    {
      for( i = 0; i < 20; i++)  // indication for entering diagnostic mode.
      {
        RED_LED_BLINK;
        delay_ms1( 50);
      }
```

FIG. 21K

```
        while( !IS_SWITCH_HIGH);
        while( 1)
        {

          if( IS_PIR2_LED_HIGH)
          {
            DIM_RED_LED_HIGH1; // for red LEDs on main and LED PCB to
become //high
          }
          else
          {
            DIM_RED_LED_LOW1; // for red LEDs on main and LED PCB to
become //low
          }
          if( IS_PIR1_LED_HIGH)
          {
            DIM_YELLOW_LED_HIGH1; // for Yellow LEDs on main and
LED PCB to become //high
          }
          else
          {
            DIM_YELLOW_LED_LOW1;// for yellow LEDs on main and LED
PCB to become //low
          }
          if( !IS_SWITCH_HIGH)// is s1 switch is press n held for 2 s at Power
on
          {
           delay_ms1( 10);
            if( !IS_SWITCH_HIGH)  // if the switch is released within 2 s
            {
              YELLOW_LED_LOW;// make yellow led low
              RECEDING_EVENT_TIME += 1;// increase the receding event
time by 100 ms
```

FIG. 21L

```
        if( RECEDING_EVENT_TIME > MAX_RECEDING_EVENT_TIME)
                {
                  RECEDING_EVENT_TIME =
MIN_RECEDING_EVENT_TIME;
                }
                while( !IS_SWITCH_HIGH);// wait until switch is released

                delay_ms1( 500);// delay
                for( i = 0; i < ( RECEDING_EVENT_TIME * 2); i++)
                {
                  YELLOW_LED_BLINK;// blink yellow led
                  delay_ms1( 300);
                }
              }
            }
          }
        }
    }
    peripherials_init();  // INITIALIZE THE PERIPHERALS
    //_RED_LED_HIGH;// red led high
    #asm("sei");
    while( 1)
    {

      // IF THERE IS EVENT OR NO MOTION IS SENSED
      if( transition_event != 1 && receding_event != 1  &&  MOTION_Z1 == 0)
      {
        DIM_YELLOW_LED_LOW;  // MAKE YELLOW LED LOW
        DIM_RED_LED_LOW;     // MAKE RED LED LOW
        BUZZER_LOW;

      }
      // IF IT IS TRANSITION EVENT
      if( transition_event == 1)
      {

        DIM_YELLOW_LED_HIGH;  // MAKE YELLOW LED HIGH
        //BUZZER_HIGH;         // // MAKE BUZZER HIGH IF IT IS NOT
DISABLED( SEE MACRO)
      }
```

FIG. 21M

```
    //IF IT IS RECEDING EVENT
    else if( receding_event == 1)
    {
      DIM_YELLOW_LED_HIGH; // MAKE YELLOW LED HIGH
      DIM_RED_LED_HIGH;    // MAKE RED LED HIGH
      BUZZER_LOW;
    }
    // IF THERE IS A Z1 EVENT BUT IT IS NOT IN TRANSITION OR
RECEDING MODE
    if( z1_event == 1 && receding_event != 1 && transition_event != 1 &&
MOTION_Z1 != 2)
    {
      DIM_YELLOW_LED_HIGH; // MAKE YELLOW LED HIGH
      TCNT1H=0xf9;
      TCNT1L=0xe5;// 0xf9e5--->0xffff == 100ms  ( TIMER 1)
      MOTION_Z1 = 1;    // START THE WAIT FOR MOTION DETECTION
      no_motion_count = 0; // INTIALIZE THE COUNT TO 0
      // decide_event_count = 0;
      z1_event = 0;
      transition_event = 0;
      receding_event  = 0;
      decide_event = 1;// START THE WAIT TO DECIDE THE MODE
      #ifdef DEBUGX
        printf("-mz1-");
      #endif
    }
  }
}
/*****************************************************************
* Function name:void delay_ms1( unsigned int delay)                *
* Input parameters: delay needed                                   *
* Output parameters: NONE                                          *
* Purpose:delay in milliseconds                                    *
* Processing: See function                                         *
* Returns: NONE                                                    *
*****************************************************************/
void delay_ms1( unsigned int delay)
{
  unsigned int a, b;
  for( a = 0;  a < 98; a++)
    for( b = 0; b < delay; b++);
}
```

FIG. 21N

```
/****************************************************************
* Function name:void port_init( void)                          *
* Input parameters: NONE                                       *
* Output parameters: NONE                                      *
* Purpose: INITIALIZATION of DATA DIRECTION of PORT PIN        *
* Returns: NONE                                                *
****************************************************************/

void port_init( void)
{
   PIR1_LED_DDR;
  PIR1_OP_DDR;
  PIR2_LED_DDR;
  PIR2_OP_DDR;
  RED_LED_DDR;
  YELLOW_LED_DDR;
  DIM_YELLOW_LED_DDR;
  DIM_RED_LED_DDR;
  BUZZER_DDR;
  SWITCH_DDR;
}
/****************************************************************
* Function name:void interrupt_init( void)                      *
* Input parameters: NONE                                        *
* Output parameters: NONE                                       *
* Purpose: INTERRUPT INITIALIZATION FOR TIMERS AND PIN CHANGE
* Returns: NONE                                                 *
****************************************************************/
void interrupt_init( void)

  // External Interrupt(s) initialization
  // INT0: On
  // INT0 Mode: Any change
  // INT1: On
  // INT1 Mode: Any change
  // Interrupt on any change on pins PCINT0-7: On
  // Interrupt on any change on pins PCINT8-14: On
  // Interrupt on any change on pins PCINT16-23: On
   EICRA=0x05;
  EIMSK=0x03;
  EIFR=0x03;
  PCICR=0x07;
  PCMSK0=0x01;
  PCMSK1=0x02;
  PCMSK2=0x80;
  PCIFR=0x07;
}
```

FIG. 21O

```
/**********************************************************
* Function name:void timer1_init( void)                   *
* Input parameters: NONE                                  *
* Output parameters: NONE                                 *
* Purpose:TIMER 1 INITIALIZATION                          *
* Processing: See function                                *
* Returns: NONE                                           *
**********************************************************
void timer1_init( void)
{
  // Timer/Counter 1 initialization
  // Clock source: System Clock
  // Clock value: 125 kHz
  // Mode: Normal top=FFFFh
  // OC1A output: Discon.
  // OC1B output: Discon.
  // Noise Canceler: Off
  // Input Capture on Falling Edge
  // Timer 1 Overflow Interrupt: On
  // Input Capture Interrupt: Off
  // Compare A Match Interrupt: Off
  // Compare B Match Interrupt: Off
  TCCR1A=0x00;
  TCCR1B=0x02;
  TCNT1H=0xff;
  TCNT1L=0xe8;// 0xffe8--->0xffff == 183us
  ICR1H=0x00;
  ICR1L=0x00;
  OCR1AH=0x00;
  OCR1AL=0x00;
  OCR1BH=0x00;
  OCR1BL=0x00;
  TIMSK1=0x01;
}
```

FIG. 21P

```
/*******************************************************
* Function name:void peripherials_init( void)          *
* Input parameters: NONE                               *
* Output parameters: NONE                              *
* Purpose: PERIPHERALS INITIALIZATION                  *
* Processing: See function                             *
* Returns: NONE                                        *
*******************************************************/

void peripherials_init( void)
{

  interrupt_init();  // INTERRUPT INITIALIZATION
  timer1_init();     // TIMER1 INITIALIZATION
  #ifdef DEBUGX      // USART INITIALIZATION
    // USART initialization
    // Communication Parameters: 8 Data, 1 Stop, No Parity
    // USART Receiver: Off
    // USART Transmitter: On
    // USART0 Mode: Asynchronous
    // USART Baud Rate: 4800
    UCSR0A=0x00;
    UCSR0B=0x18;
    UCSR0C=0x06;
    UBRR0H=0x00;
    UBRR0L=0x0C;
  #endif

}
```

FIG. 21Q

COLLISION ALERT SYSTEM

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of provisional patent application No. 61/260,404 titled "Collision Alert System", filed on Nov. 12, 2009 in the United States Patent and Trademark Office.

The specification of the above referenced patent application is incorporated herein by reference in its entirety.

BACKGROUND

A person moving in a direction towards a swing side of a swinging barrier, for example, a door may not be aware of the presence of a person approaching the door on the opposite side of the door. In such a scenario, there may be a possibility that when the door opens on the swing side, the door may collide with the person moving towards the swing side of the door, thereby potentially resulting in an injury. Conventional alert systems may be able to detect the presence of a person or an object, or motion of a person or an object on the opposite side of the door and alert the person on the swing side of the door. However, these alert systems may trigger an alarm even if a person on the opposite side of the door is receding away from the door, which may preclude a collision. These conventional alert systems lack the ability to clearly distinguish the nature of motion of a person or an object with respect to the door and provide selective alerts accordingly.

Hence, there is a long felt but unresolved need for a method and system that differentiates between the presence of stationary objects, approaching objects, and receding objects with respect to the swinging barrier, and generates selective alerts for indicating a possible collision between the swinging barrier and the objects on the swing side of the swinging barrier, based on the type of motion of the objects on the opposite side of the swinging barrier.

SUMMARY OF THE INVENTION

This summary is provided to introduce a selection of concepts in a simplified form that are further described in the detailed description of the invention. This summary is not intended to identify key or essential inventive concepts of the claimed subject matter, nor is it intended for determining the scope of the claimed subject matter.

The method and system disclosed herein addresses the above stated need for generating an alert for a possible collision between objects and a swinging barrier. The method and system disclosed herein determines the presence of stationary objects as well as approaching objects and receding objects on both sides of the swinging barrier, for example, a door, and generates selective alerts accordingly. As used herein, the term "objects" refers to animate entities, for example, human beings, or inanimate fixtures, for example, forklifts. The method and system disclosed herein generates selective alerts for indicating a possible collision between the swinging barrier and the objects on the swing side of the swinging barrier, based on the type of motion of the objects on the opposite side of the swinging barrier.

In the method disclosed herein, multiple sensing devices, a control unit, and multiple indicator devices are provided. The sensing devices, the control unit, and the indicator devices are strategically positioned at predetermined areas, for example, an entry area and an exit area, proximal to the swinging barrier. The sensing devices and the control unit electronically communicate with the indicator devices. The control unit electronically communicates with the sensing devices and the indicator devices, for example, via a wired mode of communication, a wireless mode of communication, or any combination thereof.

The sensing devices are configured to establish one or more sensing zones proximal to the swinging barrier. The sensing devices establish the sensing zones by scanning a predetermined area corresponding to a swingable distance of the swinging barrier. The sensing devices can be configured by adjusting the range of sensitivity of the sensing devices. The sensing devices detect the presence of one or more of stationary objects, approaching objects, and receding objects in the established sensing zones proximal to the swinging barrier. The sensing devices detect the presence of the stationary objects by detecting immobility of the stationary objects within and between the established sensing zones. Furthermore, the sensing devices detect movements of the objects in a predefined order for enabling the control unit to determine whether the movements are approaching movements or receding movements based on the predefined order of the detection. The sensing devices can be further configured by adjusting delay time for detecting the approaching movements of the approaching objects and the receding movements of the receding objects between the established sensing zones.

The control unit, in electronic communication with the sensing devices, tracks and differentiates the presence of the stationary objects, approaching movements of the approaching objects, and receding movements of the receding objects in the established sensing zones proximal to the swinging barrier. The control unit generates and triggers an alert signal on detection of one or more of the presence of the stationary objects, the approaching movements of the approaching objects, and the receding movements of the receding objects in established sensing zones proximal to the swinging barrier. The control unit transmits the alert signal to the indicator devices.

The indicator devices selectively indicate a possible collision between the objects and the swinging barrier based on the presence of the stationary objects, the approaching movements of the approaching objects, and the receding movements of the receding objects in the established sensing zones, on receiving the alert signal from the control unit. The indicator devices comprise, for example, visual display devices such as light emitting diodes (LEDs), audio devices such as buzzers, etc. The indicator devices indicate a possible collision between the objects and the swinging barrier for a predetermined period of time based on the approaching movements of the approaching objects and the receding movements of the receding objects in the established sensing zones.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing summary, as well as the following detailed description of the invention, is better understood when read in conjunction with the appended drawings. For the purpose of illustrating the invention, exemplary constructions of the invention are shown in the drawings. However, the invention is not limited to the specific methods and components disclosed herein.

FIG. **1** illustrates a method for generating an alert for a possible collision between objects and a swinging barrier.

FIG. **2** illustrates a system for generating an alert for a possible collision between objects and a swinging barrier.

FIG. **3** exemplarily illustrates a collision alert system, showing electronic communication between a front door module and a back door module positioned on opposing sides of a swinging barrier.

FIG. **4** exemplarily illustrates establishment of dual sensing zones by sensing devices on one side of a swinging barrier.

FIG. **5** exemplarily illustrates a block diagram of the collision alert system, showing electronic communication between the sensing devices, a control unit, and indicator devices of the collision alert system.

FIG. **6**A exemplarily illustrates positioning of a Fresnel lens on a sensing device along an X-axis of the sensing device in the collision alert system.

FIG. **6**B exemplarily illustrates sensing zones established by the sensing device with the Fresnel lens.

FIGS. **7**A-**7**B exemplarily illustrate perspective views of the collision alert system.

FIGS. **8**A-**8**E exemplarily illustrate a flow chart comprising the steps for generating an alert for a possible collision between objects and a swinging barrier.

FIG. **9** exemplarily illustrates a circuit diagram of a microcontroller of the control unit that generates an alert for a possible collision between objects and a swinging barrier.

FIGS. **10**-**12** exemplarily illustrate circuit diagrams of components of the control unit.

FIGS. **13**-**15** exemplarily illustrate circuit diagrams of the front door module of the collision alert system.

FIG. **16** exemplarily illustrates a circuit diagram for a sensing device circuit of the collision alert system.

FIG. **17** exemplarily illustrates a circuit diagram for a power regulator circuit of the collision alert system.

FIGS. **18**A-**18**B exemplarily illustrate detection of an approaching object in the sensing zones established by the sensing devices and corresponding generation of an alert for indicating a possible collision between an object and a swinging barrier using a truth table.

FIGS. **19**A-**19**B exemplarily illustrate detection of approaching movements of the approaching object in the sensing zones established by the sensing devices and corresponding generation of an alert for indicating a possible collision between an object and a swinging barrier using a truth table.

FIGS. **20**A-**20**B exemplarily illustrate detection of receding movements of a receding object in the sensing zones established by the sensing devices and corresponding generation of an alert for indicating a possible collision between an object and a swinging barrier using a truth table.

FIGS. **21**A-**21**Q exemplarily illustrate a C programming language implementation of the method for generating an alert for a possible collision between objects and a swinging barrier.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** illustrates a method for generating an alert for a possible collision between objects **401** and a swinging barrier **402** exemplarily illustrated in FIG. **4**. As used herein, the term "swinging barrier" refers to a moveable barrier, for example, a door, having an entry area and an exit area. In the method disclosed herein, multiple sensing devices **201**, a control unit **202**, and multiple indicator devices **203** as exemplarily illustrated in FIG. **2**, are provided **101**. The sensing devices **201**, the control unit **202**, and the indicator devices **203** are strategically positioned at predetermined areas, for example, at the entry area and the exit area proximal to the swinging barrier **402**. In an embodiment, the indicator devices **203** and the sensing devices **201** are provided on both sides **402***a* and **402***b* of the swinging barrier **402** to generate an alert on detection of the presence of stationary objects **405**, approaching objects **405**, and receding objects **405** on both sides **402***a* and **402***b* of the swinging barrier **402**. As used herein, the term "objects" refers to persons, goods, cranes, forklifts, other vehicles, obstacles, moving equipment, etc., on either side **402***a* or **402***b* of the swinging barrier **402**. As used herein, the term "approaching objects" refers to objects **405** that move towards the swinging barrier **402**. Also, as used herein, the term "receding objects" refers to objects **405** that move away from the swinging barrier **402**.

The sensing devices **201** comprise one or more motion sensing devices **201***a* and presence sensing devices **201***b*, for example, passive infrared (PIR) sensors, alarm sensors, triangulation sensors, occupancy sensors, etc. The sensing devices **201** and the control unit **202** electronically communicate with the indicator devices **203**. The sensing devices **201** are configured **102** to establish one or more sensing zones **403** and **404** proximal to the swinging barrier **402**. For example, the sensing devices **201** are configured by adjusting the range of sensitivity of the sensing devices **201**. The sensing devices **201** are mounted proximal to the swinging barrier **402** such that the area of sensitivity is along an X-axis **602** of each of the sensing devices **201** as exemplarily illustrated in FIG. **6**A. The sensing devices **201** are further configured by adjusting a delay time to, for example, about 500 milliseconds, for detecting the approaching movements and the receding movements of an object **405** between the established sensing zones **403** and **404**, with respect to the swinging barrier **402**. The sensing devices **201** establish the sensing zones **403** and **404** by scanning a predetermined area corresponding to a swingable distance of the swinging barrier **402**. The sensing devices **201** establish the initial sensing zones **403** and **404** based on predetermined angles configured in the sensing devices **201**. The sizes of the initial sensing zones **403** and **404** are then fine tuned by adjusting the sensitivity of the sensing devices **201**.

The sensing devices **201** detect **103** the presence of one or more stationary objects **405**, approaching objects **405**, and receding objects **405** in the established sensing zones **403** and **404** proximal to the swinging barrier **402**. The sensing devices **201** detect the presence of the stationary objects **405** by detecting immobility of the stationary objects **405** within and between the established sensing zones **403** and **404**. The sensing devices **201** detect movements of the objects **405** in a predefined order for enabling the control unit **202** to determine whether the movements are approaching movements or receding movements with respect to the swinging barrier **402** based on the predefined order detection.

Consider an example where a sensing device **201** on one side **402***a* of the swinging barrier **402** establishes sensing zones, for example, zone **1** **403** and zone **2** **404** as exemplarily illustrated in FIG. **4**. The control unit **202** determines that an object **405** is an approaching object with respect to the swinging barrier **402** when the sensing device **201** detects movement of the object **405** from zone **1** **403** to zone **2** **404** within a predetermined period of time set during the configuration of the sensing device **201**. The control unit **202** determines that an object **405** is a receding object when the sensing device **201** detects movement of the object **405** from zone **Z2** **404** to zone **Z1** **403** within a predetermined period of time, that is, the delay time, set during configuration of the sensing device **201**. The predetermined period of time is, for example, based on the environment in which the sensing devices **201**, the control unit **202**, and the indicator devices **203** defining a collision alert system **200** is located.

The control unit **202**, in electronic communication with the sensing devices **201**, tracks and differentiates **104** the presence of the stationary objects **405**, approaching movements of the approaching objects **405**, and receding movements of the receding objects **405** in the established sensing zones **403** and **404** proximal to the swinging barrier **402**. The control unit **202** generates **105** and triggers an alert signal on detection of one or more of the presence of the stationary objects **405**, the approaching movements of the approaching objects **405**, and the receding movements of the receding objects **405** in the established sensing zones **403** and **404** proximal to the swinging barrier **402**. The control unit **202** transmits **106** the alert signal to the indicator devices **203**.

The indicator devices **203** selectively indicate **107** a possible collision between the objects **401** and the swinging barrier **402** based on the presence of the stationary objects **405**, the approaching movements of the approaching objects **405**, and the receding movements of the receding objects **405** in the established sensing zones **403** and **404**, on receiving the alert signal from the control unit **202**. The indicator devices **203** comprise, for example, visual display devices **203***a* such as light emitting diodes (LEDs) and audio devices **203***b* such as buzzers for selectively indicating a possible collision between the objects **401** and the swinging barrier **402**. The indicator devices **203** indicate a possible collision between the objects **401** and the swinging barrier **402** for a predetermined period of time based on the approaching movements of the approaching objects **405** and the receding movements of the receding objects **405** in the established sensing zones **403** and **404**. For example, the indicator devices **203** selectively indicate the potential for collision as follows: The control unit **202** triggers an alert signal to invoke a yellow LED only for a stationary object **405** or a passerby passing by an outer limit **403***a* of zone **1 403**, which defines a low potential for collision. The control unit **202** triggers an alert signal to invoke a red LED and a yellow LED on detecting a receding movement of a receding object **405**, which defines a medium potential for collision. The control unit **202** triggers an alert signal to invoke a flashing red LED, a yellow LED, and a buzzer on detecting an approaching movement of an approaching object **405**, which defines a high potential for collision.

FIG. **2** illustrates a system **200** for generating an alert for a possible collision between objects **401** and a swinging barrier **402**. The system **200** for generating an alert for a possible collision between the objects **401** and the swinging barrier **402** is herein referred to as a "collision alert system". The collision alert system **200** disclosed herein comprises multiple sensing devices **201** strategically positioned at predetermined areas, for example, the entry area and the exit area proximal to the swinging barrier **402**. The sensing devices **201** are configured to establish sensing zones **403** and **404** proximal to the swinging barrier **402**. The sensing devices **201** detect the presence of one or more stationary objects **405**, approaching objects **405**, and receding objects **405** in the established sensing zones **403** and **404** proximal to the swinging barrier **402** as disclosed in the detailed description of FIG. **1**. The sensing devices **201** comprise, for example, one or more motion sensing devices **201***a* and presence sensing devices **201***b*. The presence sensing devices **201***b* detect the presence of the stationary objects **405**. The motion sensing devices **201***a* detect objects **405** in motion, namely, the approaching objects **405** and the receding objects **405** in the established sensing zones **403** and **404**. The approaching objects **405** are in motion in the direction of the swinging barrier **402**, while the receding objects **405** are in motion in a direction opposite to or away from the swinging barrier **402**. The motion sensing devices **201***a* are, for example, passive infrared (PR) sensors and are herein referenced by the numeral **201***a*. For purposes of illustration, the detailed description refers to PIR sensors **201***a* for detecting presence or movement of an object **405**. However, the scope of the method and the collision alert system **200** disclosed herein is not limited to PIR sensors **201***a* but may be extended to include alarm sensors, triangulation sensors, occupancy sensors, etc., and other functionally equivalent sensing devices.

The PIR sensors **201***a* work on a principle of heat change sensing which is based on emission of black body radiation by the objects **405**. The PIR sensors **201***a* detect infrared (IR) radiation, which is invisible to a human eye. The PIR sensors **201***a* do not produce infrared radiation, but passively accept the incoming infrared radiation. The PIR sensors **201***a* measure the infrared radiation emitted by the objects **405** in their field of view. The PIR sensors **201***a* detect motion of the object **405** when the object **405**, for example, a human emitting infrared radiation, at a certain temperature passes in front of an infrared source, for example, the swinging barrier **402**, at another temperature.

The collision alert system **200** disclosed herein further comprises a control unit **202** in electronic communication with the sensing devices **201** and the indicator devices **203** for processing, controlling, and monitoring the sensing devices **201** and the indicator devices **203**. The control unit **202** electronically communicates with the sensing devices **201** and the indicator devices **203**, for example, via a wired mode of communication through electrical cables **501** and **303** respectively as exemplarily illustrated in FIG. **5** and FIG. **3**, a wireless mode of communication through a Bluetooth™ communication protocol, a WiFi communication protocol, or other wireless communication protocols, and any combination thereof. The control unit **202** tracks and differentiates the presence of the stationary objects **405**, approaching movements of the approaching objects **405**, and receding movements of the receding objects **405** in the established sensing zones **403** and **404** proximal to the swinging barrier **402**. The control unit **202** generates and triggers an alert signal on detection of the presence of the stationary objects **405**, the approaching movements of the approaching objects **405**, and the receding movements of the receding objects **405** in the established sensing zones **403** and **404** proximal to the swinging barrier **402**.

The collision alert system **200** disclosed herein further comprises indicator devices **203** in electronic communication with the control unit **202**. The indicator devices **203** comprise one or more visual display devices **203***a*, for example, light emitting diodes (LEDs) that emit light of different colors such as yellow, red, flashing red, etc. The visual display devices **203***a* provide a visual indication for indicating a possible collision between the objects **401** and the swinging barrier **402** on receiving the generated alert signal from the control unit **202**. The indicator devices **203** further comprise one or more audio devices **203***b*, for example, alerting beacons, buzzers, beepers, etc. The audio devices **203***b* provide an audio indication for indicating a possible collision between the objects **401** and the swinging barrier **402** on receiving the generated alert signal from the control unit **202**. In an embodiment, the sensing devices **201**, the indicator devices **203**, and the control unit **202** are powered, for example, by different power sources.

The indicator devices **203** selectively indicate a possible collision between the objects **401** and the swinging barrier **402** based on the presence of the stationary objects **405**, the approaching movements of the approaching objects **405**, and the receding movements of the receding objects **405** in the established sensing zones **403** and **404**, on receiving the generated alert signal from the control unit **202**. For example, on detection of a stationary object **405** on one side **402***a* of the swinging barrier **402**, the control unit **202** generates an alert signal to light up a yellow LED on the other side **402***b*, that is, the swing side **402***b* of the swinging barrier **402** to alert a second object **401** on the swing side **402***b* of the presence of the stationary object **405**. The control unit **202** also generates an alert signal to light up a yellow LED on the swing side **402***b* of the swinging barrrier **402** to alert a second object **401**, if the first object **405** is passing by the outer limit **403***a* of the established sensing zone **1 403** as exemplarily illustrated in FIG. **4**. On detection of an approaching object **405** on one side **402***a* of the swinging barrier **402**, the control unit **202** generates an alert signal to activate a flashing red LED, a yellow LED, and a buzzer on the swing side **402***b* of the swinging barrier **402** to alert the second object **401** on the swing side **402***b* of the swinging barrier **402** of a possible collision within the swinging radius. On detection of a receding object **405** on one side **402***a* of the swinging barrier **402**, the collision alert system **200** lights up a yellow LED and a red LED to alert the second object **401** on the swing side **402***b* of the swinging barrier **402** of the receding object **405**.

The collision alert system **200** further comprises a power supply **502**, as exemplarily illustrated in FIG. **5**, provided in a housing (not shown) proximal to the swinging barrier **402** for powering the sensing devices **201**, the control unit **202**, and the indicator devices **203**. The power supply **502** is, for example, a source of alternating current (AC) or a direct current (DC). In an embodiment, the sensing devices **201**, the control unit **202**, and the indicator devices **203** can be powered separately.

FIG. **3** exemplarily illustrates a collision alert system **200**, showing electronic communication between a front door module **301** and a back door module **302** positioned on opposing sides **402***a* and **402***b* of a swinging barrier **402**. The collision alert system **200** disclosed herein comprises the front door module **301** and the back door module **302** that electronically communicate with each other, for example, via a wired mode of communication, a wireless mode of communication, or any combination thereof. In an embodiment, the front door module **301** comprising the sensing devices **201** and the control unit **202** of the collision alert system **200** is positioned on a side **402***a* opposite to the swing side **402***b* of the swinging barrier **402**, and the back door module **302** comprising the indicator devices **203** are positioned on the swing side **402***b* of the swinging barrier **402** as exemplarily illustrated in FIG. **4**. The control unit **202** and the indicator devices **203** electronically communicate with each other, for example, via electrical cables **303**. In an embodiment, the control unit **202** electronically communicates with the indicator devices **203**, for example, via a Bluetooth™ communication protocol, a ZigBee® wireless communication protocol, a WiFi communication protocol, etc. Furthermore, in an embodiment, the control unit **202** electronically communicates the sensing devices **201**, for example, via electrical cables **501** or a Bluetooth™ communication protocol, ZigBee® wireless communication protocol, etc.

The front door module **301** comprises a pair of sensing devices **201**, for example, passive infrared (PIR) sensors **201***a*, a pair of amplifiers **301***a*, and "signal on delay" units **301***b* connected to a microcontroller **202***a* of the control unit **202**. In an embodiment, the "signal on delay" unit **301***b* sets timers for enabling the control unit **202** to distinguish between approaching movements of the approaching objects **405** and receding movements of the receding objects **405**. The back door module **302** comprises the indicator devices **203**. The microcontroller **202***a* controls a first set of indicator devices **203** in the front door module **301** and a second set of indicator devices **203** in the back door module **302** connected via the electrical cables **303**. The first set of indicator devices **203** comprise visual display devices **203***a*, for example, a yellow light emitting diode (LED) and a red light emitting diode (LED). The second set of indicator devices **203** comprise visual display devices **203***a*, for example, a yellow light emitting diodes (LED), a red light emitting diode (LED), etc., and an audio device **203***b*, for example, a buzzer. The visual display devices **203***a* and the audio devices **203***b* are disposed in a housing **702**, as exemplarily illustrated in FIG. **7**, and positioned on the swing side **402***b* of the swinging barrier **402** to form the back door module **302**. A wall mount transformer **304** provides electric power to the front door module **301** via a power regulator **301***c*.

The sensing devices **201** are configured to define and establish sensing zones **403** and **404**, for example, in a long area range or a short area range. The sensing devices **201**, for example, passive infrared (PIR) sensors **201***a* detect the presence of stationary objects **405**, approaching objects **405**, and receding objects **405**, within the long area range or the short area range. The PIR sensors **201***a* are contained within a housing **701**, as exemplarily illustrated in FIG. **7**, strategically positioned at the entry area and/or the exit area defined by the swinging barrier **402**. The PIR sensors **201***a* along with the control unit **202** of the collision alert system **200** monitor the areas around the swinging barrier **402**. The PIR sensors **201***a* measure infrared energy radiated from the objects **405** in their range or field of view. The PIR sensors **201***a* detect infrared energy radiated from stationary objects **405**, approaching objects **405**, and receding objects **405** in the sensing zones **403** and **404**. The PIR sensors **201***a* establish a serial array of sensing zones **403** and **404** proximate to the entry area and the exit area of the swinging barrier **402**. The PIR sensors **201***a* also detect motion of an object **405**, for example, when a human with one temperature passes in front of the swinging barrier **402** with another temperature. When the PIR sensors **201***a* detect the presence of objects **405**, for example, stationary objects **405**, and approaching movements of the approaching objects **405** in the sensing zones **403** and **404**, the microcontroller **202***a* generates and triggers an alert signal that selectively activates the visual display devices **203***a* and the audio device **203***b* on the back door module **302**. The collision alert system **200** sounds the alarm of the audio device **203***b*, thereby alerting an object **401** facing the swing side **402***b* of the swinging barrier **402** of a possible collision.

FIG. **4** exemplarily illustrates establishment of dual sensing zones **403** and **404** by the sensing devices **201** on one side **402***a* of a swinging barrier **402**. Consider an example where two sensing devices **201**, for example, passive infrared (PIR) sensors **201***a*, are positioned on one side **402***a* of the swinging barrier **402**. Each of the PR sensors **201***a* establish a sensing zone, for example, zone **1 403** and zone **2 404** respectively. The control unit **202** is also positioned on the side **402***a* opposing the swing side **402***b* of the swinging barrier **402**. The indicator devices **203** comprising the visual display devices **203***a* such as a yellow LED and a red LED and the audio devices **203***b* such as a buzzer are positioned on the swing side **402***b* of the swinging barrier **402**. In an embodiment, indicator devices **203**, for example, a yellow LED and a red LED are also provided in the control unit **202**. The sensing devices **201** and the control unit **202** positioned on one side **402***a* of the swinging barrier **402** electronically communicate with the indicator devices **203** on the swing side **402***b* of the swinging barrier **402**.

The indicator devices **203** provided in the control unit **202** are activated as follows: When there is any motion in zone **1**

403, the control unit **202** generates and transmits an alert signal to turn on one of the indicator devices **203**, for example, a yellow LED of the control unit **202**. When there is any motion in zone 2 **404**, the control unit **202** generates and transmits an alert signal to turn on one of the indicator devices **203**, for example, a red LED of the control unit **202**. The indicator devices **203** of the control unit **202** communicate with the indicator devices **203** on the swing side **402***b* of the swinging barrier **402**.

When one of the PIR sensors **201***a* detects an approaching object **405** facing one side **402***a* of the swinging barrier **402**, with approaching movements in the direction of the swinging barrier **402** in zone 1 **403**, the control unit **202** generates and transmits an alert signal to turn on one of the indicator devices **203**, for example, a yellow LED on the swing side **402***b* of the swinging barrier **402**. The PIR sensors **201***a* continue to monitor and detect motion of an object **405** between zone 1 **403** and zone 2 **404**. The yellow LED continues to stay on as long as there is motion detected in zone 1 **403**. If one of the PIR sensors **201***a* does not detect any motion in zone 1 **403**, the yellow LED stays on for a predetermined period of time, for example, five seconds, before turning off.

If the object **405** moves from zone 1 **403** to zone 2 **404**, the yellow LED on the swing side **402***b* of the swinging barrier **402** continues to stay on. When the other PIR sensor **201***a* detects motion in zone 2 **404**, the control unit **202** generates and transmits an alert signal to another one of the indicator devices **203**, for example, a red LED on the swing side **402***b* of the swinging barrier **402**. The red LED starts blinking as long as there is motion detected in zone 2 **404**. The control unit **202** also generates and transmits an alert signal to activate the audio device **203***b* on the swing side **402***b* of the swinging barrier **402**, when there is continued motion detected in zone 2 **404**. If there is no motion detected in zone 2 **404**, the control unit **202** waits for about five seconds before turning off the audio device **203***b*. The control unit **202** also turns off the red LED and the yellow LED on the swing side **402***b* of the swinging barrier **402**.

If the object **405** moves from zone 2 **404** to zone 1 **403**, both the PIR sensors **201***a* detect the receding movement of the receding object **405** away from the side **402***a* of the swinging barrier **402** with a delay known as a recede delay. If the PIR sensors **201***a* detect motion with a delay exceeding the recede delay, the control unit **202** considers the movement of the object **405** as an approaching movement in a direction towards the swinging barrier **402** and sends an alert signal to the indicator devices **203** accordingly. The recede delay can be reconfigured from, for example, about 500 milliseconds (ms) to about 1500 ms. When motion is detected by both the PIR sensors **201***a* within the recede delay, the control unit **202** activates both the red LED and the yellow LED on the swing side **402***b* of the swinging barrier **402**.

If the object **405** in motion does not leave both the zone 1 **403** and zone 2 **404** within a predetermined period of time, for example, 5 seconds, the control unit **202** considers the movement as an approaching movement and activates the red LED, while the yellow LED continues to remain turned on. If the object **405** in motion has crossed zone 2 **404** within a predetermined period of time, for example, 5 seconds, but continues moving in zone 1 **403**, then the control unit **202** turns the red LED off, while the yellow LED continues to be turned on until one of the PIR sensors **201***a* does not detect any motion in zone 1 **403**. The control unit **202** turns off the yellow LED after a predetermined period of time, for example, 5 seconds. In an embodiment, the indicator devices **203** can be disabled or turned off through a tact switch **202***f* provided in the control unit **202**, or through an external switch (not shown) connected to a switch connector **202***e* on the control unit **202** as exemplarily illustrated in FIG. **5**.

FIG. **5** exemplarily illustrates a block diagram of the collision alert system **200**, showing electronic communication between the sensing devices **201**, the control unit **202**, and the indicator devices **203** of the collision alert system **200**. The control unit **202** is implemented on a printed circuit board. The control unit **202** comprises a sensor interface **202***b*, a programmer connector **202***c*, a universal asynchronous receiver/transmitter (UART) connector **202***d*, a switch connector **202***e*, a tact switch **202***f*, an indicator board interface **202***g*, a power interface **202***h*, a sensor sensitivity controller **202***i*, and a visual display device **203***a* mechanically supported and electrically connected on the printed circuit board of the control unit **202**. The control unit **202** electronically communicates with the sensing devices **201** via the sensor interface **202***b*. The sensing devices **201** are also implemented on individual or combined printed circuit boards. The programmer connector **202***c* provides an interface for controlling programmable aspects of the microcontroller **202***a*. The microcontroller **202***a* is programmed using program codes written, for example, in a C computer programming language as exemplarily illustrated in FIGS. **21**A-**21**Q.

The universal asynchronous receiver/transmitter (UART) connector **202***d* connects to a UART, which is a programmed microchip that controls interfacing of the control unit **202** with the sensing devices **201** and the indicator devices **203**. The UART exchanges data between the sensing devices **201** and the indicator devices **203**. The data exchange between the sensing devices **201** and the control unit **202** occurs via the sensor interface **202***b*. The data exchange between the indicator devices **203** and the control unit **202** occurs via the indicator board interface **202***g*. The switch connector **202***e* enables connection of the control unit **202** to an external switch used for enabling or disabling the indicator devices **203**, for example, the visual display device **203***a* on the printed circuit board. The tact switch **202***f* can be used to configure the collision alert system **200** in a diagnostic mode of operation. The tact switch **202***f* is also used to disable the indicator devices **203**. The indicator devices **203** are also implemented on individual or combined printed circuit boards.

The control unit **202** electronically communicates with the indicator devices **203**, for example, the visual display devices **203***a* and the audio devices **203***b* via the indicator board interface **202***g* of each of the control unit **202** and the indicator devices **203**. The control unit **202** is powered up through the power interface **202***h* using, for example, a 9 volts, 600 milliamperes (mA) alternating current (AC)/direct current (DC) adapter. The sensing devices **201** are powered, for example, using the 9 Volts, 600 mA alternating current (AC)/direct current (DC) adapter through the power interface **202***h*, or through the sensor interface **202***b* depending on whether the sensing devices **201** are connected via a wired connection using the electrical cables **501** or a wireless connection. The indicator devices **203** are powered, for example, using the 9 Volts, 600 mA alternating current (AC)/direct current (DC) adapter through the power interface **202***h*, or through the indicator board interface **202***g* depending on whether the indicator devices **203** are connected via a wired connection or a wireless connection. The indicator devices **203** are connected to the control unit **202**, for example, through the electrical cables **303** via the indicator board interfaces **202***g*.

In this embodiment, the sensing devices **201**, for example, a pair of PIR sensors **201***a* is connected to the control unit **202** via the sensor interface **202***b*, for example, using the electrical cables **501**. The sensor sensitivity controller **202***i* is used for configuring or calibrating the PIR sensors **201***a* for adjusting their sensitivity of sensing or motion detection. For example, the sensor sensitivity controller **202***i* calibrates one PIR sensor **201***a* to detect motion in zone **1 403** and another PIR sensor **201***a* to detect motion in zone **2 404** as exemplarily illustrated in FIG. **4**.

In the diagnostic mode of operation, the configuration and calibration of each of the PIR sensors **201***a* comprises positioning the PIR sensors **201***a* such that the area where the motion is detected by the PIR sensors **201***a* comes along an X-axis **602** of each of the PIR sensors **201***a* as exemplarily illustrated in FIG. **6**A, adjusting the sensitivity of the PIR sensors **201***a*, and adjusting the recede delay. Consider an example of adjusting the sensitivity of the PIR sensors **201***a*. A user turns off the power supply **502** to the control unit **202** via the power interface **202***h*. The user presses and holds down the tact switch **202***f* on the control unit **202** and then turns on the power supply **502** to the control unit **202** via the power interface **202***h*. After the control unit **202** is powered by the power supply **502**, the user presses and holds down the tact switch **202***f* for a predetermined period of time, for example, about two seconds to about three seconds, until a visual display device **203***a*, for example, a red LED starts to blink and continues to blink, for example, about ten times. The blinking of the red LED indicates entry of the control unit **202** in the diagnostic mode. If the red LED does not blink about ten times in three seconds, the control unit **202** is in the normal mode of operation and needs to enter the diagnostic mode of operation.

Other visual display devices **203***a*, for example, yellow LEDs are provided on the control unit **202** in the front door module **301** and on the printed circuit board housing the indicator devices **203** in the back door module **302**. The yellow LED on the control unit **202** and the yellow LED of the indicator device board blink when there is motion detected by one of the PIR sensors **201***a* in zone **1 403**. The user can vary the sensitivity by adjusting the sensor sensitivity controller **202***i* which comprises, for example, a variable resistor. The user can increase the sensitivity of the PIR sensor **201***a* by rotating a knob of the sensor sensitivity controller **202***i*, for example, in an anti-clockwise direction. The user can decrease the sensitivity of the PIR sensor **201***a* by rotating the knob of the sensor sensitivity controller **202***i*, for example, in a clockwise direction. The red LEDs on the control unit **202** and the indicator device board blink when there is motion detected in zone **2 404** by the other PIR sensor **201***a*. The user can vary the sensitivity of the other PIR sensor **201***a* by adjusting the sensor sensitivity controller **202***i*. The user can increase the sensitivity of the other PIR sensor **201***a* by rotating the knob of the sensor sensitivity controller **202***i*, for example, in an anti-clockwise direction. The user can decrease the sensitivity of the other PIR sensor **201***a* by rotating the knob of the sensor sensitivity controller **202***i*, for example, in a clockwise direction. To enter the normal mode from the diagnostic mode, the user can turn off the power supply **502** which powers the control unit **202** and the PIR sensors **201***a* and then turn the power supply **502** back on to enter the normal mode of operation.

Consider an example for adjusting the recede delay. The recede delay is defined as the time elapsed between motion detected in zone **1 403** and zone **2 404**, which aids the control unit **202** in distinguishing between an approaching movement and a receding movement. A typical value for the recede delay is, for example, 500 milliseconds, which can be adjusted by the user in the diagnostic mode of operation. To adjust the recede delay, the user first turns off the power supply **502** to the control unit **202** via the power interface **202***h* and disconnects each of the PIR sensors **201***a* connected to the control unit **202** via the sensor interface **202***b*. The user presses and holds down the tact switch **202***f* on the control unit **202** and then turns on the power supply **502** to the control unit **202** via the power interface **202***h*. After the control unit **202** is powered by the power supply **502**, the user presses and holds down the tact switch **202***f* for a predetermined period of time, for example, about two seconds to about three seconds, until a visual display device **203***a*, for example, a red LED starts to blink and continues to blink, for example, about ten times.

When the tact switch **202***f* on the control unit **202** or the external switch connected to the switch connector **202***e* is pressed, the recede delay is increased, for example, by 100 milliseconds (ms). The user can vary the recede delay from 500 ms to 1500 ms. The yellow LED on the control unit **202** blinks a few times to indicate the recede delay. The number of blinks multiplied by 100 ms indicates the recede delay. The user can further increase the recede delay by repeatedly pressing the tact switch **202***f* or the external switch. When the recede delay reaches 1500 ms and the user presses the tact switch **202***f* or the external switch again, the recede delay is reset to the initial value of 500 ms. To exit from the diagnostic mode of operation after adjusting the recede delay, the user turns off the power supply **502**, reconnects the PIR sensors **201***a*, and turns on the power supply **502** to enter the normal mode of operation.

FIG. **6**A exemplarily illustrates positioning of a Fresnel lens **601** on a sensing device **201** along an X-axis **602** of the sensing device **201** in the collision alert system **200**. The sensing device **201**, for example, the PIR sensor **201***a* is mounted proximal to the swinging barrier **402** so that the area where the motion is to be detected comes along an X-axis **602** of the PIR sensor **201***a*. In an embodiment, a Fresnel lens **601** is mounted on the PIR sensor **201***a* so that the X-axis **602** of the Fresnel lens **601** is parallel to the X-axis **602** of the PIR sensor **201***a*. The Fresnel lens **601** is made of a high density polyethylene material. The Fresnel lens **601** filters infrared radiation to the PIR sensor **201***a* by focusing infrared radiation into the center of the PIR sensor **201***a* by usage of concentric circles. This allows for the widest range x, y, and z axes of detection, and therefore establishment of different wider sensing zones **403** and **404**.

The Fresnel lens **601** is mounted on the PIR sensor **201***a* so that the X-axis **602** of the Fresnel lens **601** is parallel to the X-axis **602** of the PIR sensor **201***a* to enable adjustment of the sizes of the sensing zones **403** and **404** established by the PIR sensor **201***a*. The sizes of the initial sensing zones **403** and **404** are fine tuned by adjusting the sensitivity of the sensing devices **201** using the sensor sensitivity controller **202***i*. The Fresnel lens **601** has sensing patterns that are aligned with respect to the sensing zones **403** and **404** established by the sensing devices **201**. Sensing areas of the Fresnel lens **601** are adjusted to correct angles to establish ideal sensing zones as disclosed in the detailed description of FIG. **6**B.

FIG. **6**B exemplarily illustrates sensing zones **403***b*, **403***c*, **404***a*, and **404***b* established by the sensing device **201**, for example, a PIR sensor **201***a*, with the Fresnel lens **601**. The Fresnel lens **601** is mounted on the PIR sensor **201***a* so that the X-axis **602** of the Fresnel lens **601** is parallel to the X-axis **602** of the PIR sensor **201***a*. As exemplarily illustrated in FIG. **6**B, the PIR sensor **201***a* with the Fresnel lens **601** establishes an outer sensing zone **403***c* defined by the trapezoid MNOP, where the length of the side MN is, for example, about 285 inches, the length of the side OP is, for example, about 674 inches, and the height of the trapezoid MNOP is, for example, about 156.6 inches. By adjusting the sensor sensitivity controller **202***i* of the control unit **202** exemplarily illustrated in FIG. **5**, the sensitivity of the PIR sensor **201***a* is adjusted to establish an ideal outer sensing zone **1 403***b* defined by the rectangle IJKL. The rectangle IJKL has, for example, a length of about 360 inches and a width of about 180 inches. The PIR sensor **201***a* with the Fresnel lens **601** establishes an inner sensing zone **404***a* defined by the trapezoid EFGH, where the length of the side EF is, for example, about 293 inches, the length of side GH is, for example, about 360 inches, and the height of the trapezoid EFGH is, for example, about 70 inches. By adjusting the sensor sensitivity controller **202***i* of the control unit **202** exemplarily illustrated in FIG. **5**, the sensitivity of the PIR sensor **201***a* is adjusted to establish an ideal inner sensing zone **1 404***b* defined by the rectangle ABCD. The rectangle ABCD has, for example, a length of about 140.75 inches and a width of about 70 inches. To establish the desired sensing zones **403***b* and **404***b*, the sensing devices **201** are set in predetermined positions on a housing **701** of the control unit **202** as exemplarily illustrated in FIG. **7**A.

FIGS. **7**A-**7**B exemplarily illustrate perspective views of the collision alert system **200**. The components **201**, **202**, and **203** of the collision alert system **200** are incorporated in one or more individual and combined housings **701** and **702** that can be detachably attached at the entry area and the exit area of the swinging barrier **402**. The control unit **202** of the collision alert system **200** is incorporated in a housing **701** and attached to, for example, the side **402***a* of the swinging barrier **402**. The sensing devices **201** of the collision alert system **200** are incorporated in the housing **701** of the control unit **202** and communicate with the microcontroller **202***a* of the control unit **202** via the sensor interface **202***b* through the electrical cable **501** as exemplarily illustrated in FIG. **5**. The sensing devices **201** are positioned at predetermined positions in the housing **701** of the control unit **202** to establish the desired sensing zones **403** and **404**.

The indicator devices **203**, for example, the visual display devices **203***a* such as the red LED and the yellow LED are housed within another housing **702** and connected to the control unit **202** via the electrical cable **303**. The indicator devices **203** communicate with the microcontroller **202***a* of the control unit **202** via the indicator board interface **202***g* as exemplarily illustrated in FIG. **5**. The indicator devices **203** receive the on/off alert signal from the control unit **202** via the indicator board interface **202***g*. A power adaptor **703**, for example, an alternating current (AC) or a direct current (DC) power adaptor is connected to the control unit **202** via an electrical cable **704**. The power adaptor **703** is connected to the power supply **502**, which is used to power up the sensing devices **201**, the control unit **202**, and the indicator devices **203** of the collision alert system **200**. The power adaptor **703** powers the indicator devices **203** via the indicator board interface **202***g*.

FIGS. **8**A-**8**E exemplarily illustrate a flow chart comprising the steps for generating an alert for a possible collision between objects **401** and a swinging barrier **402**. The collision alert system **200** comprises the sensing devices **201**, the control unit **202**, and the indicator devices **203** as disclosed in the detailed description of FIG. **1**. In the collision alert system **200** disclosed herein, the sensing devices **201** comprise, for example, a pair of passive infrared (PIR) sensors **201***a* namely PIR **1** and PIR **2**. A user adjusts the sensitivity of PIR **1** and PIR **2** such that PIR **1** is sensitive to motion in zone **1 403** and PIR **2** is sensitive to motion in zone **2 404** as disclosed in the detailed description of FIG. **5**. The user mounts PIR **1** and PIR **2** proximal to the swinging barrier **402** such that their area of sensitivity is along the X-axis **602** of PIR **1** and PIR **2** respectively to detect presence of stationary objects **405**, approaching movements of approaching objects **405**, and receding movements of receding objects **405** in zone **1 403** and zone **2 404** respectively as exemplarily illustrated in FIG. **6**. The user also adjusts the recede delay to about 500 milliseconds as disclosed in the detailed description of FIG. **5**. The indicator devices **203** comprise visual display devices **203***a* such as yellow LEDs and red LEDs on the control unit **202** and the back door module **302**, and audio devices **203***b* such as a buzzer in the back door module **302**.

The user resets the control unit **202** by pressing a reset button on the control unit **202**. The collision alert system **200** checks **801** whether the user pressed the reset button. If the user pressed the reset button, the collision alert system **200** checks **802** whether the user releases the reset button within two seconds. If the user does not release the reset button within two seconds, the red LED on the control unit **202** blinks **804** ten times. The collision alert system **200** then waits **806** for the user to release the reset button of the control unit **202**. The control unit **202** then checks **812** whether the PIR **1** LED pin of the microcontroller **202***a* is high. If the PIR **1** LED pin of the microcontroller **202***a* is high, the control unit **202** generates and transmits an alert signal to the yellow LEDs to turn on **813** the yellow LEDs. If the PIR **1** LED pin of the microcontroller **202***a* is not high, the control unit **202** generates and transmits an alert signal to the yellow LEDs to turn off **814** the yellow LEDs. The control unit **202** then checks **815** whether the PIR **2** LED pin of the microcontroller **202***a* is high. If the PIR **2** LED pin of the microcontroller **202***a* is high, the control unit **202** generates and transmits an alert signal to the red LEDs to turn on **816** the red LEDs. If the PIR **2** LED pin of the microcontroller **202***a* is not high, the control unit **202** generates and transmits an alert signal to the red LEDs to turn off **817** the red LEDs. The control unit **202** then checks **818** whether the user has pressed and released the tact switch **202***f*. If the user has not pressed and released the tact switch **202***f*, the process returns to step **812**. If the user has pressed and released the tact switch **202***f*, the control unit **202** increases **819** the recede delay count by one.

The control unit **202** then checks **820** whether the recede delay count is more than 1500 milliseconds. If the recede delay count is more than 1500 ms, the control unit **202** sets **821** the recede delay count to 500 milliseconds. If the recede delay count is not more than 1500 ms, the control unit **202** increases **822** the recede delay count by one. The control unit **202** stores 823 the recede delay count in a memory unit, for example, an electrically erasable programmable read only memory (EEPROM) of the control unit **202**. The control unit **202** generates and transmits an alert signal to the yellow LED to cause the yellow LED to start blinking **824** a few times to indicate the recede delay count. The recede delay is the number of blinks multiplied **825** by 100 milliseconds. The process then returns to step **812**.

If the user does not release the reset button in two seconds, the collision alert system **200** initializes **803** data directions for port pins of the microcontroller **202***a*, enable interrupts for the PIR sensor output and the LED pins connected to the microcontroller **202***a* of the control unit **202**. The collision alert system **200** enables **803** a timer for measuring the delay of motion detection in zone **1 403** and zone **2 404**. The collision alert system **200** turns off **805** all the visual display devices **203***a* and the audio devices **203***b*.

The control unit **202** of the collision alert system **200** determines **807** whether motion of an object **405** is detected in zone **1 403** by PIR **1**. If motion is not detected in zone **1 403**, the control unit **202** continues to monitor and check whether motion of the object **405** is detected in zone **1 403** by PIR **1**.

If motion is detected in zone **1 403** by PIR **1**, the control unit **202** generates and transmits an alert signal to the yellow LED to turn on **808** the yellow LED. The control unit **202** then waits **809** for motion to be detected in zone **2 404** by PIR **2**. The control unit **202** starts **810** a 5 second timer to decide on the nature of the motion detected, that is, to determine whether the motion detected is an approaching movement or a receding movement. The control unit **202** then starts **811** a 5 second count to detect if there is any motion in zone **1 403** or zone **2 404**.

The control unit **202** checks **826** whether motion is detected in zone **2 404** by PIR **2**. If there is motion in zone **2 404**, the control unit **202** generates and transmits an alert signal to the red LED to turn on **827** the red LED and the process returns to step **809**. If there is no motion is zone **2 404**, the control unit **202** checks **828** whether motion is detected in zone **2 404** by PIR **2** within 500 milliseconds of detection of motion in zone **1 403**. If there is motion detected in zone **2 404** within 500 milliseconds of detection of motion in zone **1 403**, the control unit **202** generates and transmits an alert signal to the yellow LED and the red LED to turn them on **829**. The control unit **202** then checks **830** whether there is any motion detected in zone **1 403** or zone **2 404** after 5 seconds. If there is no motion detected in zone **1 403** or zone **2 404** after 5 seconds, the control unit **202** turns off **833** the yellow LED and the red LED. If there is motion detected in zone **1 403** or zone **2 404** after 5 seconds, the process then continues to step **835**.

If there is no motion detected in zone **2 404** within 500 milliseconds of detection of motion in zone **1 403**, the control unit **202** checks **831** whether motion is detected in zone **2 404** after 500 milliseconds but within 5 seconds of detection of motion in zone **1 403**. If there is motion detected in zone **2 404** after 500 milliseconds but within 5 seconds of detection of motion in zone **1 403**, the control unit **202** generates and transmits an alert signal to the yellow LED, the red LED, and the buzzer to turn on **835** the yellow LED, blink **835** the red LED, and turn on **835** the buzzer if the buzzer is not disabled through the tact switch **202*f*** or an external switch. The control unit **202** then checks **836** whether there is any motion detected in zone **1 403** or zone **2 404** after 5 seconds. If there is no motion detected in zone **1 403** or zone **2 404** after 5 seconds, the control unit **202** turns off **837** all the LEDs and the buzzer and the process repeats from step **801**. If there is motion detected in zone **1 403** or zone **2 404** after 5 seconds, the yellow LED remains on **835**, the red LED continues to blink **835**, and the buzzer continues to remain on **835**. If there is no motion detected in zone **2 404** after 500 milliseconds but within 5 seconds of detection of motion in zone **1 403**, the control unit **202** checks **832** whether there is any motion detected in zone **1 403** or zone **2 404** after 5 seconds. If there is no motion in zone **1 403** or zone **2 404** after 5 seconds, the control unit **202** turns off **834** the yellow LED and the process repeats from step **801**.

FIG. **9** exemplarily illustrates a circuit diagram of a microcontroller **202*a*** of the control unit **202** that generates an alert for a possible collision between objects **401** and a swinging barrier **402**. The microcontroller **202*a*** of the control unit **202** is, for example, a microcontroller with Atmel model number ATMEGA48-10AU of Atmel® Corporation. The microcontroller **202*a*** can be programmed to control different functions of the control unit **202**. The microcontroller **202*a*** can be powered up using low voltages for conserving power. For example, a 5-volt (5V) power supply **902** is applied to the VCC and AVCC pins, for example, pins **4**, **6** and, **18** of the microcontroller **202*a***. In order to prevent noise and fluctuations in the power supply voltage from affecting the operation of the microcontroller **202*a***, the power supply voltage of 5V to the microcontroller **202*a*** is filtered by multiple bypass capacitors **914**, **915**, **919**, and **920**. The 5-volt power supply **902** is also used to disable unused inputs as well as to pull various control pins high for proper operation. For example, the 5-volt power supply **902** is applied to the active low pin **29**, that is, the PC6(/RESET/PCINT14) pin, of the microcontroller **202*a*** by way of a pull-up resistor **904**. The microcontroller **202*a*** is adapted to operate at 4 megahertz (MHz) at 5-volt power supply **902**. A clock generator **918** provides a 4 MHz clock signal to clock input pins **7** and **8**, that is, the PB6 (XTAL1/TOSC1/PCINT6) pin and the PB7(XTAL2/TOSC2/PCINT7) pin respectively of the microcontroller **202*a*** by way of a pair of capacitors **916** and **917**.

The microcontroller **202*a*** is interfaced to a general purpose NPN amplifier **901**, for example, MMBT2222A of Fairchild Semiconductor™ Incorporated that connects to an audio device **203*b***, for example, a buzzer. The NPN amplifier **901** is connected to the pins **23**, **27**, and **28**, that is, the PC0(ADC0/PCINT8) pin, the PC4(ADC4/SDA/PCINT12) pin, and the PC5(ADC5/SDA/PCINT13) pin, respectively of the microcontroller **202*a***. The NPN amplifier **901** comprises an emitter terminal, a collector terminal, and a base terminal. The base terminal is connected to pin **23** of the microcontroller **202*a*** through a resistor **906**. The base terminal is also connected to pin **28** of the microcontroller **202*a*** through a resistor **907**. The emitter terminal is connected to the pin **28** of the microcontroller **202*a*** through a resistor **910** and a surface mount LED **908**, for example, SMD0805. Another surface mount LED **905** is connected to the pin **27** of the microcontroller **202*a*** through a resistor **909**.

The microcontroller **202*a*** is further interfaced to an electronic component, for example, a switch **913**. The switch **913** is a tact switch **202*f***, for example, MJTP1138 **913** of APEM. The switch **913** is used to calibrate the sensing devices **201** in the diagnostic mode as disclosed in the detailed description of FIG. **5**. The switch **913** is connected to a 5-volt power supply **902** by way of a pull-up resistor **911** and a capacitor **912** that prevents noise and fluctuations in the power supply voltage from affecting the operation of the switch **913**. The switch **913** is connected to the pin **12**, that is, the PB0(ICP/CLK0/PCINT0) pin of the microcontroller **202*a***. The sensing devices **201**, for example, the PIR sensors **201*a*** are connected to the pins **32**, **1**, **24**, and **11**, that is, the PD2(INT0/PCINT18) pin, the PD3(INT1/OC2B/PCINT19) pin, the PC1(ADC1/PCINT9) pin, and the PD7(AIN1/PCINT23) pin respectively. The microcontroller **202*a*** takes in inputs from the PIR sensors **201*a*** and the switch **913**. The programmer connector **202*c*** of the control unit **202** is connected to the pins **15**, **16**, and **17**, that is, the PB3(MOSI/OC2A/PCINT3) pin, the PB4 (MISO/PCINT4) pin, and the PB5(SCK/PCINT5) pin respectively of the microcontroller **202*a***. The UART connector **202*d*** of the control unit **202** is connected to the pins **30** and **31**, that is, the PD0(RXD/PCINT16) pin and the PD1(TXD/PCINT17) pin respectively of the microcontroller **202*a***.

The indicator devices **203**, for example, the yellow LED and the red LED are connected to the pins **25** and **26**, that is, the PC2(ADC2/PCINT10) pin and the PC3(ADC3/PCINT11) pin respectively of the microcontroller **202*a*** via the indicator board interface **202*g***. The indicator devices **203** selectively indicate **107** a possible collision between the objects **401** and the swinging barrier **402** based on the presence of the stationary objects **405**, the approaching movements of the approaching objects **405**, and the receding movements of the receding objects **405** in the established sensing zones **403** and **404**, on receiving the alert signal from the microcontroller **202*a***. For example, if the pin **32** of the microcontroller **202***a* is high, the microcontroller **202***a* generates and transmits an alert signal to the yellow LED to turn on the yellow LED. If the pin **32** of the microcontroller **202***a* is not high, the microcontroller **202***a* generates and transmits an alert signal to the yellow LED to turn off the yellow LED. If the pin **24** of the microcontroller **202***a* is high, the control unit **202** generates and transmits an alert signal to the red LEDs to turn on the red LED. If the pin **24** of the microcontroller **202***a* is not high, the microcontroller **202***a* generates and transmits an alert signal to the red LED to turn off **817** the red LED. The microcontroller **202***a* executes the program and outputs the alert signal to the indicator devices **203**, for example, the LEDs and the buzzer. The alert signal conveys, for example, whether to turn on the LEDs, when to flash the red LED, etc.

FIGS. **10-12** exemplarily illustrate circuit diagrams of components of the control unit **202**. The components of the control unit **202** comprise, for example, the programmer connector **202***c*, the universal asynchronous receiver/transmitter (UART) connector **202***d*, the indicator board interface **202***g*, etc.

As exemplarily illustrated in FIG. **10**, the pin **6 1001** of the programmer connector **202***c* is connected to the pin **15**, that is, the PB3(MOSI/OC2A/PCINT3) pin of the microcontroller **202***a*, the pin **5 1002** of the programmer connector **202***c* is connected to the pin **16**, that is, the PB4(MISO/PCINT4) pin of the microcontroller **202***a*, and the pin **4 1003** of the programmer connector **202***c* is connected to the pin **17**, that is, the PB5(SCK/PCINT5) pin of the microcontroller **202***a*. The pin **3 1004** of the programmer connector **202***c* is connected to the pin **29**, that is, the PC6(/RESET/PCINT14) pin of the microcontroller **202***a*, the pin **2 1005** of the programmer connector **202***c* is connected to the 5-volt power supply **902** at the VCC pin **4** or **6** of the microcontroller **202***a*, and the pin **1 1006** is connected to an electrical ground **903**. The programmer connector **202***c* circuit connects the microcontroller **202***a* to, for example, a computer system (not shown) through a serial port which allows data transfer from the computer system to the microcontroller **202***a* via the pins, for example, the data input pin MOSI, the data output pin MISO, the clock input pin SCK, and the RESET pin of the microcontroller **202***a*. The RESET pin of the microcontroller **202***a* is used to activate serial programming of the microcontroller **202***a*.

As exemplarily illustrated in FIG. **11**, the CON2-4 pin **1101** of the UART connector **202***d* is connected to the pin **30**, that is, the PD0(RXD/PCINT16) pin of the microcontroller **202***a*, the CON2-3 pin **1102** of the UART connector **202***d* is connected to pin **31**, that is, the PD1(TXD/PCINT17) pin of the microcontroller **202***a*, the CON2-2 pin **1103** of the UART connector **202***d* is connected to the 5-volt power supply **902** at the VCC pin **4** or **6** of the microcontroller **202***a*, and the CON2-1 pin **1104** of the UART connector **202***d* is connected to the electrical ground **903**. The circuit connections as exemplarily illustrated in FIG. **11** can be used for a serial data transfer with the computer system.

As exemplarily illustrated in FIG. **12**, the CON4-5 pin **1201** of the indicator board interface **202***g* is connected to the pin **26**, that is, the PC3(ADC3/PCINT11) pin of the microcontroller **202***a*, the CON4-4 pin **1202** of the indicator board interface **202***g* is connected to the pin **25**, that is, the PC2 (ADC2/PCINT10) pin of the microcontroller **202***a*, the CON4-3 pin **1203** is connected to a buzzer, the CON4-2 pin **1204** of the indicator board interface **202***g* is connected to the electrical ground **903**, and the CON4-1 pin **1205** of the indicator board interface **202***g* is connected to a 9-volt power supply. The indicator board interface **202***g* comprises power in conjunction with signal outputs to the indicator devices **203**, for example, the yellow LED, the red LED, the buzzer, etc. The alert signal, along with the power is sent to the indicator devices **203** through the indicator board interface **202***g* to convey to each of the indicators **203** when to turn on and off.

FIGS. **13-15** exemplarily illustrate circuit diagrams of the front door module **301** of the collision alert system **200**. The front door module **301** comprises, for example, a red LED driver circuit **1300** that drives the red LED **1304**, a yellow LED driver circuit **1400** that drives the yellow LED **1406**, and a buzzer circuit **1500** that drives the buzzer **1504**.

As exemplarily illustrated in FIG. **13**, the red LED driver circuit **1300** comprises, for example, a 0.5 A constant current buck regulator **1301** such as LM3402HVMM of National Semiconductor, resistors **1306**, **1308**, and **1311**, capacitors **1302**, **1305**, **1309**, and **1310**, a schottky diode **1307** such as 1N5819HW of Diodes Incorporated®, an inductor **1303**, a red LED **1304** such as OVSPRBCR44 of Optek Technology. The regulator **1301** LM3402HVMM is driven by the power supply. The red LED driver circuit **1300** receives the alert signal and power from the printed circuit board of the control unit **202** via the indicator board interface **202***g*. In the red LED driver circuit **1300**, the alert signal is filtered and cleaned to provide a constant voltage and current at a correct power to the high output red LED **1304**, which ensures the consistency of intensities of the red LED **1304**.

As exemplarily illustrated in FIG. **14**, the yellow LED driver circuit **1400** comprises, for example, a 0.5 A constant current buck regulator **1401** such as LM3402HVMM of National Semiconductor, driven by a power supply, resistors **1407**, **1408**, and **1409**, capacitors **1402**, **1404**, **1410**, and **1411**, the schottky diode **1405** such as 1N5819HW of Diodes Incorporated®, an inductor **1403**, a yellow LED **1406** such as LY-G6SP-BBDB-36-1 of OSRAM Opto Semiconductors Inc. The yellow LED driver circuit **1400** receives the alert signal and power from the printed circuit board of the control unit **202** via the indicator board interface **202***g*. In the yellow LED driver circuit **1400**, the alert signal is filtered and cleaned to provide a constant voltage and current at the correct power to the high output yellow LED **1406**, which ensures the consistency of the intensities of the yellow LED **1406**.

The buzzer circuit **1500** that drives the buzzer **1504** is exemplarily illustrated in FIG. **15**. The buzzer circuit **1500** comprises, for example, an adjustable micro power voltage regulator **1501** such as LP2950ACZ Of National Semiconductor and a magnetic buzzer **1504** such as CST931AP of CUI, Inc. In order to prevent noise and fluctuations in the buzzer circuit **1500** driven by the LED supply **1506** voltage from affecting the operation the buzzer circuit **1500**, the LED supply **1506** voltage of the buzzer circuit **1500** is filtered by multiple bypass capacitors **1502**, **1503**, and **1505** that in turn connect to the magnetic buzzer **1504**. The buzzer circuit **1500** receives the alert signal and power from the printed circuit board of the control unit **202** via the indicator board interface **202***g*.

FIG. **16** exemplarily illustrates a circuit diagram for a sensing device circuit **1600**, of the collision alert system **200**. The sensing device circuit **1600** comprises a master PIR controller **1601** and a sensing device **201**, for example, a PIR sensor **201***a*. A master PIR controller **1601**, for example, KC778B of COMedia Ltd. controls the PIR sensor **201***a*. As exemplarily illustrated in FIG. **16**, the pin **1**, that is, the VCC pin of the master PIR controller **1601** is connected to a regulated power supply of 5V. The pin **1** is also connected the electrical ground **903** via a bypass capacitor **1623**. The pin **2** of the master PIR controller **1601** is a sensitivity adjust pin that is used to adjust the sensitivity threshold of motion comparators. The pin **2** is connected to a variable resistor **1618** whose resistance can be varied. When the voltage on the pin **2** is equal to the pyro drain reference voltage on the pin **7** of the master PIR controller **1601**, the sensitivity of the PIR sensor **201***a* is minimum. When the voltage on the pin **2** of the master PIR controller **1601** is at the electrical ground **903**, the sensitivity of the PIR sensor **201***a* is maximum. Intermediate voltages on the pin **2** provide the PIR sensor **201***a* with intermediate sensitivities. The pin **3** of the master PIR controller **1601**, that is, an offset filter is connected to a capacitor **1622** that holds an average value of switched capacitor bandpass filter output. The PIR sensor **201***a* detects motion when the difference between the average value and the actual filter output is greater than the sensitivity setting. The pin **4** of the master PIR controller **1601** is an anti-alias filter, which is connected to a capacitor **1621** that provides low pass filtering of the PIR sensor input signal, thereby blocking input signals at and above the switching frequency of the switched capacitor bandpass filter. The pin **5** of the master PIR controller **1601** is a DC CAP that is connected to a capacitor **1620** that holds the average pyro source voltage. The average pyro source voltage value is compared with the actual detected value of the pyro source voltage and is amplified and coupled to the switched capacitor bandpass filter. The typical value of the capacitors **1622**, **1621**, and **1620** connected to pins **3**, **4**, and, **5** respectively of the master PIR controller **1601** is, for example, 10 micro farads. The capacitor **1620** connected to the pin **5** of the master PIR controller **1601** is a low leakage capacitor, for example, a tantalum capacitor.

The pin **6** is a voltage regulator output pin. The voltage regulator output pin outputs a voltage that can be used to directly drive an external NPN or PNP voltage regulator, or the gate of an external depletion mode JFET voltage regulator pass element. The pin **7** of the master PIR controller **1601** outputs a pyro drain reference voltage. The arrangement of the capacitor **1619** and the resistors **1616** and **1617** connected to the pin **7** serve to cancel noise and improve performance and reliability of the sensor interface **202***b*. The pyro drain reference voltage can also be divided down by an external potentiometer **1618** to supply the sensitivity adjust voltage to the pin **2**.

The pin **8** of the master PIR controller **1601** is the pyro source input pin that receives a PIR input signal. The pins **9** and **10** of the master PIR controller **1601** are connected to the electrical ground **903**. The pin **11** is the daylight adjustment and cadmium sulfide (CdS) input pin. The pin **12** of the master PIR controller **1601** is the input to a daylight sense amplifier and has a connection to the electrical ground **903** via the capacitor **1612**. The pin **13** is the gain select tri-state input pin used to select the gain of the PIR sensor **201***a*. The pin **14** is the mode select tri-state input pin used to determine the operation of the PIR sensor **201***a*. The pin **15** is the mode select toggle input pin also used to determine the operation of the PIR sensor **201***a*. The pin **16** of the master PIR controller **1601** is an output pin used to turn the external load on or off and also drive small pulse relay through a capacitor. The pin **16** of the master PIR controller **1601** is connected to the pin **11** of the microcontroller **201***a* via a resistor **1609**. The pin **16** of the master PIR controller **1601** is connected to the pin **12** of the master PIR controller **1601** via the resistor **1610**. The pin **17** is the LED pin, which is driven by the output from the motion comparator through a current limiting resistor, thereby enabling the pin **17** to directly drive the LED motion indicator. The pin **17** of the master PIR controller **1601** is connected to the pin **24** of the microcontroller **201***a*. The pin **17** of the master PIR controller **1601** connects to the pin **12** of the master PIR controller **1601** via the resistor **1611**. The pins **18** and **19** are input to and output of an off timer oscillator respectively. The pins **18** and **19** are connected to a pair of resistors **1605** and **1607** respectively, a variable resistor **1606**, and a capacitor **1608**. The pin **20** is the frequency reference oscillator input pin and is connected to VCC through the resistors **1602** and **1603** and a capacitor **1604** of predetermined values. This ensures that the oscillator frequency is fixed to a predetermined value. This oscillator frequency drives the switched capacitor bandpass filter and other internal timing delays. The output of the PIR sensor **201***a* are stored and averaged. When the average of the outputs of the PIR sensors **201***a* is outside of a threshold, the average of the outputs of the PIR sensors **201***a* is outputted back to the printed circuit board of the control unit **202** through the sensor interface **202***b*, showing that the output is massaged and verified.

CON10-31624 is connected to the pin **7** of the master PIR controller **1601**. CON10-1 **1625** is connected to the pin **8** via a parallel connection of a resistor **1615** and a capacitor **1614**. CON10-2 **1626** is connected to the electrical ground **903**. The PIR sensor **201***a* is, for example, a pyroelectric infrared sensor **1613** such as RE200B-P.

FIG. **17** exemplarily illustrates a circuit diagram for a power regulator circuit **1700** of the collision alert system **200**. The power regulator circuit **1700** comprises a 3 terminal 1 A positive voltage regulator **1701** such as LM7805 CT of National Semiconductor, a rectifier **1707** such as MURS120 of International Rectifier, etc. The power regulator circuit **1700** takes in the power for the collision alert system **200**, cleans the power for consistent 9V power **1706** and outputs 5V **902** to the necessary components within the control unit **202** that require 5V. Bypass capacitors **1702**, **1703**, **1704**, and **1705** are provided in the power regulator circuit **1700** to prevent noise and fluctuations in the power supply voltage from affecting the operation of the power regulator circuit **1700**.

FIGS. **18**A-**18**B exemplarily illustrate detection of an approaching object **405** in the sensing zones **403** and **404** established by the sensing devices **201** and corresponding generation of an alert for indicating a possible collision between an object **401** and a swinging barrier **402** using a truth table. The sensing devices **201**, for example, the PIR sensors **201***a*, namely, PIR **1** and PIR **2**, for detecting presence of stationary objects **405**, approaching objects **405**, and receding objects **405** are positioned on one side **402***a* of the swinging barrier **402** in order to alert a second object **401** on the swing side **402***b* of the swinging barrier **402** of a possible collision. The indicator devices **203** comprise visual display devices **203***a*, for example, a red LED and a yellow LED and audio devices **203***b*, for example, a buzzer. The truth tables represent the activation of the indicator devices **203** based on detection of movement of the object **405** in the sensing zones **403** and **404**. The audio devices **203***b* may be disabled depending on where the collision alert system **200** is used. The red LED may be turned on or may flash based on detection of movements of the object **405**, for example, approaching movements and receding movements of the object **405** as disclosed in the detailed description of FIG. **4**.

As exemplarily illustrated in FIG. **18**A, when an object **405** enters the outer sensing zone, that is, zone **1 403** represented by Z1, PIR **1** recognizes the movement of the object **405** within Z1. The control unit **202**, in communication with PIR **1**, generates and transmits an alert signal to the yellow LED to light up the yellow LED on the swing side **402***b* of the swinging barrier **402**. The yellow LED indicates that an object **405** has entered zone **1 403** and may be approaching the swinging barrier **402**. As exemplarily illustrated in the truth table in FIG. **18**B, row number **2** illustrates the above process where the activation of Z1 turns on the yellow LED. The yellow LED alerts the second object **401** on the swing side **402***b* of the swinging barrier **402** to be cautious.

FIGS. **19**A-**19**B exemplarily illustrate detection of approaching movements of the approaching object **405** in the sensing zones **403** and **404** established by the sensing devices **201** and corresponding generation of an alert for indicating a possible collision between the object **401** and a swinging barrier **402** using a truth table. As exemplarily illustrated in FIG. **19**A, when an object **405** moves from zone **1 403** to zone **2 404**, PIR **1** and PIR **2** detect the motion from zone **1 403** to zone **2 404** respectively. The control unit **202**, in communication with PIR **1** and PIR **2**, recognizes the transition to zone **2 404** and generates and transmits an alert signal to the yellow LED, the red LED, and the buzzer, thereby lighting up the yellow LED, flashing the red LED, and activating an alarm of the buzzer to alert a second object **401** on the swing side **402***b* of the swinging barrier **402** of a possible collision within the swinging radius. As exemplarily illustrated in the truth table in FIG. **19**B, row number **4** illustrates the above process where the activation of Z1 and Z2 turns on the yellow LED, the flashing red LED, and sounds the alarm of the buzzer. The transition from zone **1 403** to zone **2 404** changes the state of the collision alert system **200** from row number **2** to row number **4** of the truth table as exemplarily illustrated in FIG. **19**B.

FIGS. **20**A-**20**B exemplarily illustrate detection of receding movements of a receding object **405** in the sensing zones **403** and **404** established by the sensing devices **201** and corresponding generation of an alert for indicating a possible collision between an object **401** and a swinging barrier **402** using a truth table. As exemplarily illustrated in FIG. **20**A, when an object **405** recedes from the swinging barrier **402**, PIR **2** and PIR **1** detect the motion from zone **2 404** to zone **1 403** respectively. The control unit **202**, in communication with PIR **1** and PIR **2**, recognizes the movement of the object **405** based on when Z1 and Z2 are activated in the truth table. When both Z1 and Z2 are activated, the control unit **202** detects the receding event and generates and transmits an alert signal to the yellow LED and the red LED to light up the yellow LED and the red LED respectively on the swing side **402***b* of the swinging barrier **402**. The collision alert system **200** enters the state represented by row number **3** of the truth table illustrated in FIG. **20**B. A timer is preset to detect this state. If the object **405** does not move out of both zone **1 403** and zone **2 404** within the predetermined time measured by the timer, the collision alert system **200** goes back to the state represented by row number **4** of the truth table. This indicates that the object **405** may have changed directions and did not continue on the path that the object **405** was heading, which may therefore lead to a possible collision. If the object **405** exits from zone **2 404** within the predetermined time, the collision alert system **200** enters the state represented by row number **2** of the truth table. If movement of the object **405** is detected in both zone **1 403** and zone **2 404**, both the red LED and the yellow LED light up. The flashing red LED is activated to indicate the difference between an approaching movement and receding movement of the object **405**.

FIGS. **21**A-**21**Q exemplarily illustrate a C programming language implementation of the method for generating an alert for a possible collision between objects **401** and a swinging barrier **402**. The clock frequency for the microcontroller **202***a* is set to, for example, 4 MHz and the data stack size is, for example, about 128. A function is defined for determining an overflow interrupt routine. FIG. **21**A exemplarily illustrates initialization of variables and configuration of a recede delay time for determining a receding event or movement and an approaching event or movement. The approaching event is herein referred to as a "transition event". FIGS. **21**B-**21**N exemplarily illustrate codes used for differentiating the presence of a stationary object **405**, a transition event of an approaching object **405**, and a receding event of a receding object **405** in the established sensing zones Z1 **403** and Z2 **404**, and selectively activating the yellow LED, the red LED, a green LED, and a buzzer accordingly. FIG. **21**O exemplarily illustrates codes for initialization of data direction of port pins and interrupt initialization for timers and pin change. FIG. **21**P exemplarily illustrates a code listing for timer initialization. FIG. **21**Q exemplarily illustrates codes for initializing peripherals of the computer system used for programming the microcontroller **202***a*.

The foregoing examples have been provided merely for the purpose of explanation and are in no way to be construed as limiting of the present invention disclosed herein. While the invention has been described with reference to various embodiments, it is understood that the words, which have been used herein, are words of description and illustration, rather than words of limitation. Further, although the invention has been described herein with reference to particular means, materials and embodiments, the invention is not intended to be limited to the particulars disclosed herein; rather, the invention extends to all functionally equivalent structures, methods and uses, such as are within the scope of the appended claims. Those skilled in the art, having the benefit of the teachings of this specification, may effect numerous modifications thereto and changes may be made without departing from the scope and spirit of the invention in its aspects.

I claim:

1. A method for generating an alert for a possible collision between objects and a swinging barrier, comprising:

providing a plurality of sensing devices, a control unit, and a plurality of indicator devices at predetermined areas proximal to said swinging barrier, wherein said sensing devices and said control unit electronically communicate with said indicator devices;

configuring said sensing devices to establish sensing zones proximal to said swinging barrier;

detecting presence of one or more of stationary objects, approaching objects, and receding objects in said established sensing zones proximal to said swinging barrier by said sensing devices;

tracking and differentiating said presence of said stationary objects, approaching movements of said approaching objects, and receding movements of said receding objects in said established sensing zones proximal to said swinging barrier by said control unit in electronic communication with said sensing devices;

generating an alert signal by said control unit on detection of one or more of said presence of said stationary objects, said approaching movements of said approaching objects, and said receding movements of said receding objects in said established sensing zones proximal to said swinging barrier, wherein said control unit transmits said alert signal to said indicator devices; and

selectively indicating said possible collision between said objects and said swinging barrier by said indicator devices based on said presence of said stationary objects, said approaching movements of said approaching objects, and said receding movements of said receding objects in said established sensing zones, on receiving said alert signal from said control unit.

2. The method of claim **1**, wherein said predetermined areas for positioning said sensing devices and said indicator devices comprise an entry area and an exit area of said swinging barrier.

3. The method of claim **1**, wherein said configuring of said sensing devices comprises adjusting range of sensitivity of said sensing devices.

4. The method of claim **1**, wherein said configuring of said sensing devices comprises adjusting delay time for detecting said approaching movements of said approaching objects and said receding movements of said receding objects between said established sensing zones.

5. The method of claim **1**, wherein said sensing devices detect said presence of said stationary objects by detecting immobility of said stationary objects within and between said established sensing zones.

6. The method of claim **1**, wherein said sensing devices detect movements of objects in a predefined order for enabling said control unit to determine whether said movements are one of said approaching movements and said receding movements with respect to said swinging barrier based on said predefined order of said detection.

7. The method of claim **1**, wherein said indicator devices comprise one or more visual display devices and audio devices for selectively indicating said possible collision between said objects and said swinging barrier.

8. The method of claim **1**, wherein said indicator devices indicate said possible collision between said objects and said swinging barrier for a predetermined period of time based on said approaching movements of said approaching objects and said receding movements of said receding objects in said established sensing zones.

9. The method of claim **1**, wherein said sensing devices establish said sensing zones by scanning a predetermined area corresponding to a swingable distance of said swinging barrier.

10. A system for generating an alert for a possible collision between objects and a swinging barrier, comprising:

a plurality of sensing devices strategically positioned at predetermined areas proximal to said swinging barrier, wherein said sensing devices are configured to establish sensing zones proximal to said swinging barrier, wherein said sensing devices detect presence of one or more of stationary objects, approaching objects, and receding objects in said established sensing zones proximal to said swinging barrier;

a control unit in electronic communication with said sensing devices and a plurality of indicator devices for processing, controlling, and monitoring said sensing devices and said indicator devices, wherein said control unit tracks and differentiates said presence of said stationary objects, approaching movements of said approaching objects, and receding movements of said receding objects in said established sensing zones proximal to said swinging barrier, wherein said control unit generates an alert signal on detection of one or more of said presence of said stationary objects, said approaching movements of said approaching objects, and said receding movements of said receding objects in said established sensing zones proximal to said swinging barrier; and

said indicator devices in electronic communication with said control unit, wherein said indicator devices selectively indicate said possible collision between said objects and said swinging barrier based on said presence of said stationary objects, said approaching movements of said approaching objects, and said receding movements of said receding objects in said established sensing zones, on receiving said generated alert signal from said control unit.

11. The system of claim **10**, wherein said sensing devices comprise one or more of motion sensing devices and presence sensing devices.

12. The system of claim **11**, wherein said motion sensing devices are passive infrared sensors.

13. The system of claim **10**, wherein said sensing devices are configured by adjusting range of sensitivity of said sensing devices.

14. The system of claim **10**, wherein said sensing devices are configured by adjusting delay time for detecting said approaching movements of said approaching objects and said receding movements of said receding objects between said established sensing zones.

15. The system of claim **10**, wherein said sensing devices detect said presence of said stationary objects by detecting immobility of said stationary objects within and between said established sensing zones.

16. The system of claim **10**, wherein said sensing devices detect movements of objects in a predefined order for enabling said control unit to determine whether said movements are one of said approaching movements and said receding movements with respect to said swinging barrier based on said predefined order of said detection.

17. The system of claim **10**, wherein said indicator devices comprise one or more visual display devices, wherein said visual display devices provide a visual indication for indicating said possible collision between said objects and said swinging barrier on receiving said generated alert signal from said control unit.

18. The system of claim **10**, wherein said indicator devices comprise one or more audio devices, wherein said audio devices provide an audio indication for indicating said possible collision between said objects and said swinging barrier on receiving said generated alert signal from said control unit.

19. The system of claim **18**, wherein said audio devices comprise one or more alerting beacons, buzzers, and beepers.

20. The system of claim **10**, further comprising a power supply provided in a housing proximal to said swinging barrier for powering said sensing devices, said control unit, and said indicator devices.

21. The system of claim **10**, wherein said sensing devices establish said sensing zones by scanning a predetermined area corresponding to a swingable distance of said swinging barrier.

22. The system of claim **10**, wherein said control unit electronically communicates with said sensing devices and said indicator devices via one of a wired mode of communication, a wireless mode of communication, and any combination thereof.

* * * * *