EKT 221 DIGITAL ELECTRONICS II
MINI PROJECT REPORT

HOME ALARM SYSTEM

GROUP 5

NO	NAME	MATRIC NUMBER	COURSE
1.	Lai Tuck Yeow	191020903	RK 20 - Computer Engineering
2.	Lee Qian Yi	191020906	RK 20 - Computer Engineering
3.	Tan Yi Jie	191020976	RK 20 - Computer Engineering
4.	Quah Xuan Ying	191020968	RK 20 - Computer Engineering
5.	Choong Ting Quan	191020878	RK 20 - Computer Engineering

Lecturer: En. Muslim Mustapa

Introduction

The purpose of this project is to create a safer, more secure living environment in each house. In order to achieve that, we created our own home alarm system which can monitor a house for 24 hours a day, everyday.

The home alarm system detects any suspicious movements and triggers the siren to alarm the owner of the house until the owner inputs the correct password combination to disarm it. The home alarm system consists of PIR sensor which possesses the ability to differentiate between a human and an animal to prevent false alarm, high decibel buzzer, a manual switch for switching the power source on and off, a button to arm or disarm the alarm, LEDs and seven segments which show the trigger status of the home alarm system. The button only works after the user enters the right combination of passwords, means the burglar cannot simply deactivate the alarm.

Literature Review

FPGA is a short for Field-Programmable Gate Array, a type of logic chip that can be programmed. An FPGA is similar to a PLD, but whereas PLDs are generally limited to hundreds of gates, FPGAs support thousands of gates. They are especially popular for prototyping integrated circuit designs. Once the design is set, hardwired chips are produced for faster performance.

Research about automatic fire alarm systems has been conducted by Huide Liu, Suwei Li, Lili Gao, and Tao Wu. Fires continue to occur in modern architecture, the people's lives and property has brought huge losses. In order to reduce the fire in the building automatic fire alarm equipment was placed into a necessity. The system will be collected through the fire alarm detector to the fire, fault and other signals sent to the sub-machine, Submachine re-transmission of such information will be sent to the fire alarm control, and then start from the controller, sound and light alarm display, alarm and other devices, and automatically print a fire information. Fire detectors use a two-wire method to reduce the wall alignment, improve reliability, ease of construction and installation [4].

With the help of advancement in technology today, these undeveloped methods of producing security alarm systems were changed by programmed security alarm systems in the late eighteenth period. These types of electronic security alarm systems usually work without the aid of any human being energy. When the modern security alarm system senses a positive signal which may be a sign of intrusion or breakage, it normally gives a warning of a very high sound or sends an alert to the owner subject to the type of security design [5].

The most significant among these security system technologies is the use of remote signaling thief security alarms. This type of security alarm system was designed in the early 1970s. This administers a fast inventive reaction to alarm calls. However, organizations and industries are based on the supply of security service apparatus that usually come in dissimilar designs to keep burgles and thugs away from the environment that are not built for them. Today, we have an innovative group of electronic security alarm systems with complexity at various levels [6].

With the latest flow in crime rates in the world, it has become very essential to safeguard our buildings and our property with the aid of sophisticated stages of various advanced security alarm devices. The prices of such kinds of security alarm devices depend on the apparatus technology and solicitation desires. These alarm security system devices are characterized by present electronic security alarm systems. Some of nowadays-modern security alarm systems are housebreaker alarms, threat alarms, industrial alarms, speed limit alarms, and anti-theft vehicle alarms [7].

Some of the intruder's security alarms system normally functions delicately on the conception of a magnetic contact and others. For those types of security systems working with the sensors, these devices are usually positioned at any entering of the industries, organizations, and buildings. In this case, the sensor will activate an alarm if the device gets a signal above its set inception [8].

Methodology

Block Diagram

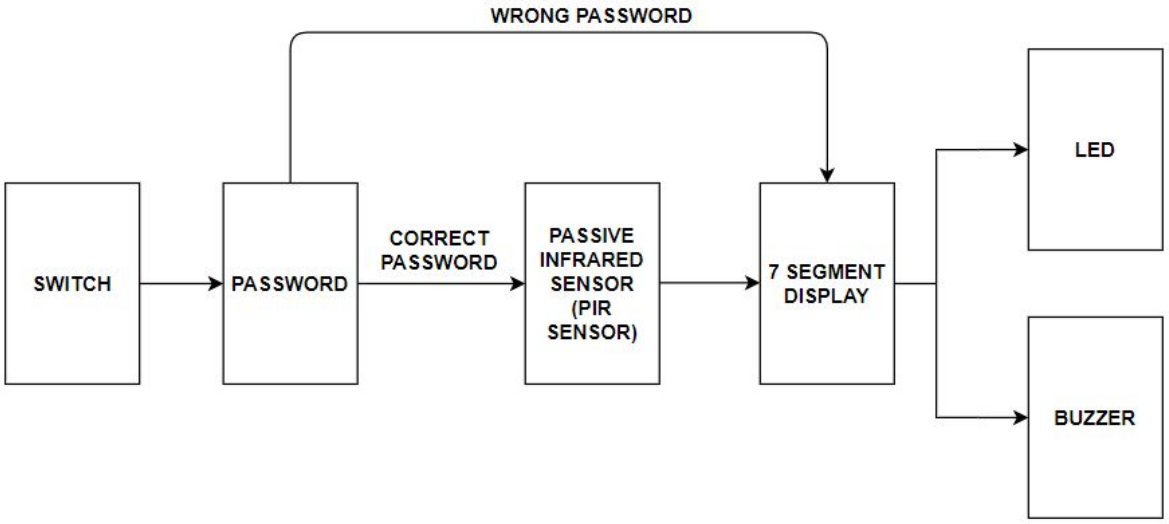

Figure 1: Block diagram of Home Alarm System

Block diagram of the Home Alarm System is shown in Figure 1. The components required for the system include a keypad for password input, a switch, passive infrared sensor (PIR sensor), three seven segment displays, two LEDs and a buzzer. Firstly, the switch will act as an ON/OFF power button in this system. The system runs whenever the switch is ON and the system is shut down when the switch is OFF. The keypad for password input in the alarm system is used to allow the user to enter the correct password right after the switch is on. In this system, the password is set as '1234'. When the password is correct, the PIR sensor will be on. If it does not detect humans, the seven segment displays will display the words 'OFF', the green led will light up in green and the buzzer will not sound.

On the other hand, when the sensor detects humans, three seven segment displays will display the words 'ON'. Thus, the red led will blink and the buzzer will sound to alert the user that someone is trying to enter the house. User will need to input the password again to stop the buzzer. However, if the wrong password is input, the user is not allowed to stop the buzzer, it will continue to sound and the red led will blink until the correct password is input.

Passive Infrared Sensor

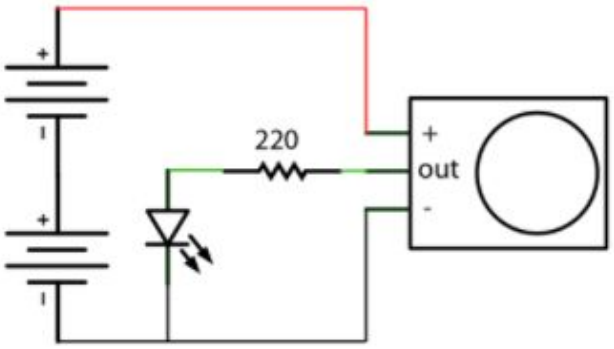

Figure 2: Example of the PIR circuit

Example for PIR circuit is shown in Figure 2. Passive Infrared Sensor (PIR) is applied in most projects that need to detect human or particle movement in a certain range. It is also known as PIR (motion) sensor or IR sensor. PIR sensors are commonly used in security alarms and automatic lighting applications.

The operating principle is all objects with a temperature above absolute zero emit heat energy in the form of electromagnetic radiation. PIR-based motion detectors are used to sense movement of people, animals or other objects. They are commonly used in pet-friendly burglar alarms.

For our project, we use it as sensor alarms. The PIR sensor will trigger the detection when humans move across the sensor's field of view.

Display

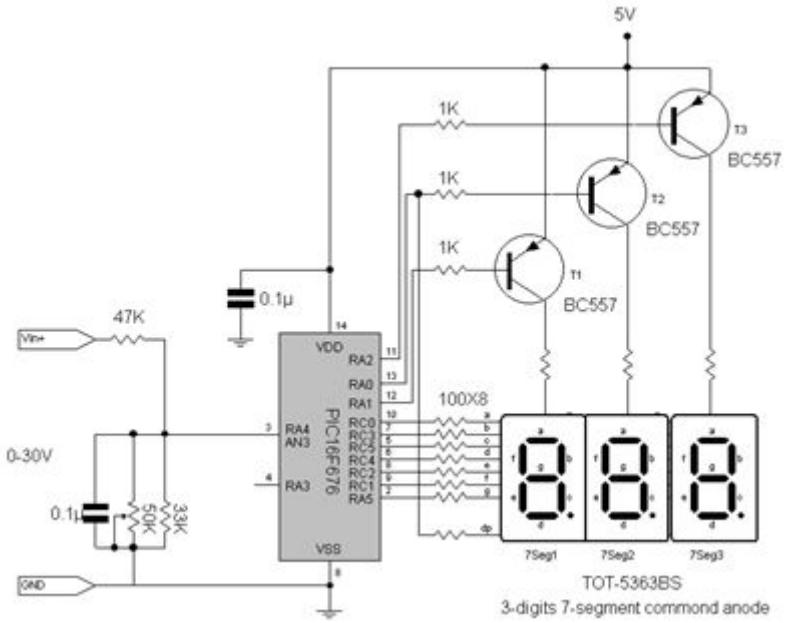

Figure 3: Example of the 3 seven segment display circuit

Example of three seven segment displays circuit is shown in Figure 3. A seven segment display is a form of an electronic display device for displaying decimal numerals that is an alternative to the more complex dot matrix displays. Seven segment displays are widely used in digital clocks, electronic meters, basic calculators, and other electronic devices that display numerical information.

However, for our system, we use this seven segment display to show the alphabet which is ‘OFF’ and ‘ON’. For instance, 7'b0000001 = O , 7'b0001001 = N , 7'b0111000 = F and 7'b1111111 will not show anything on the seven segment display.

Buzzer

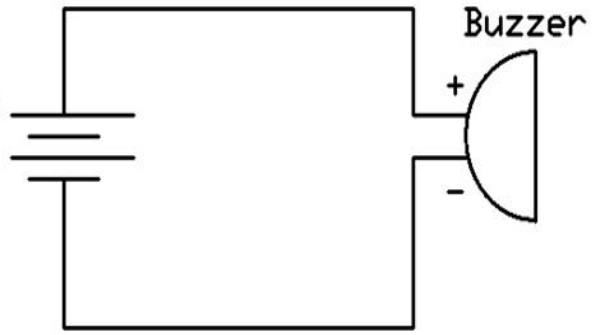

Figure 4: Example of the buzzer circuit

Buzzer is a sounding device that can convert audio signals into sound signals. The example circuit of a buzzer is shown in Figure 4. It is usually powered by DC voltage. It is widely used in alarms, computers, printers and other electronic products as sound devices.

The buzzer is mainly divided into a piezoelectric buzzer and electromagnetic buzzer. According to different designs and uses, the buzzer can emit various sounds such as music, siren, buzzer, alarm, and electric bell. In this project, the buzzer will sound right after the PIR sensor senses any movement in the specific area to alert the user.

Full coding for our system

```
module mix (clk, password0, password1, password2, password3,detect, beam, switch, armedIn,
            disarmedIn, armedState, disarmedState, triggeredState, beamOut,led_green,
            led_red, SSD0, SSD1, SSD2, speaker);
            // label all modules in the port list
// Specify input and output ports
input clk;
input [3:0]password0;
input [3:0]password1;
input [3:0]password2;
input [3:0]password3;
input detect;
input switch;
input beam;
input armedIn;
input disarmedIn;// Both armedIn and disarmIn shares the same button
output reg beamOut;
output reg armedState = 0;
output reg disarmedState = 1;
output reg triggeredState = 0;
output led_green;
output led_red;
output [6:0]SSD0, SSD1, SSD2;
output speaker;

parameter code0 = 1, code1 = 2, code2 = 3, code3 = 4;// Assign parameter values
parameter animal=0, human=1;
assign password=((password0==code0)&&(password1==code1)&&(password2==code2)&&(password3==
code3));// Set the password as 1234

//-----------------------------------------------------------------------------------------
always @(armedIn, disarmedIn, beam, password)
begin
   beamOut <= !beam;          // Beam blocked
   if(switch && password)     // Switch is on and password entered
   begin
      if(armedIn)             // Pressed armed button
         begin
         armedState <= 1;     // Alarm armed
         disarmedState <= 0;
         end

      if(disarmedIn)          // Pressed disarmed button
         begin
         armedState <= 0;
         disarmedState <= 1; // Alarm disarmed
         triggeredState <= 0;
         end
   end
      // Beam is blocked, detected human, pressed armed button and disarmed is low and
switch is on
      if((beam == 0) && (detect == human) && (armedState == 1) && (disarmedState == 0) &&
switch == 1)
         triggeredState <= 1;               // Alarm is triggered


      else if(switch == 1 && password == 0) // Switch is on and password is wrong
         begin
         armedState <= armedState;          // The states remain as it is
         disarmedState <= disarmedState;
         end

      else if(switch == 0)// Switch is off
         begin
         armedState <= 0;// All outputs will be in their off state
         disarmedState <= 0;
         triggeredState <= 0;
```

```
64            beamOut <= 0;
65            end
66    end
67
68    led led1(switch, clk, triggeredState, led_green, led_red);// Declare all instances
69    display display1(switch, armedState, SSD0, SSD1, SSD2);
70    buzzer buzzer1(speaker, clk, triggeredState);
71    endmodule
72
73    //-------------------------------------------------------------------------------------
74    module led (switch, clk, triggeredState, led_green, led_red);// Declare all inputs and
      outputs
75    input clk;
76    input switch;
77    input triggeredState;
78    reg state;
79    reg next_state;
80    output reg led_green;
81    output reg led_red;
82    parameter green=0,red=1;// Let green be 0 and red be 1
83
84    always @(posedge clk)    // Always block at positive edge of clock
85    begin
86
87       // To assign correct input to output based on value of state
88       case (state)
89
90          green : begin     // State for green
91
92             // Switch is on and triggeredState is low
93             if((switch == 1) && (triggeredState == 0))
94                begin
95                next_state = green;  // Next state will be green
96                led_green <= 1;      // Green led will light up
97                led_red <= 0;        // Red led will not blink
98                end
99
100
101            // Switch is on and triggeredState is high
102            else if((switch == 1) && (triggeredState == 1))
103               begin
104               next_state = red;     // Next_state will be red
105               led_green <= 0;       // Green led will not light up
106               led_red <= !led_red; // Red led will blink
107               end
108
109            // Switch is off and triggeredState is low/high
110            else
111               begin
112               led_green <= 0;       // Green and red led will not light up
113               led_red <= 0;
114               end
115            end
116
117         // State for red
118         red : begin
119
120            // Switch is on and triggeredState is low
121            if((switch == 1) && (triggeredState == 0))
122               begin
123               next_state = green;// Next state will be green
124               led_green <= 1;     // Green led will light up
125               led_red <= 0;       // Red led will not blink
126               end
127
128            // Switch is on and triggeredState is high
```

```
129            else if((switch == 1) && (triggeredState == 1))
130               begin
131               next_state = red;    // Next_state will be red
132               led_green <= 0;      // Green led will not light up
133               led_red <= !led_red;// Red led will blink
134               end
135
136            // Switch is off and triggeredState is low/high
137            else
138               begin
139               led_green <= 0;// Green and red led will not light up
140               led_red <= 0;
141               end
142            end
143      endcase
144   end
145   endmodule
146
147   //-------------------------------------------------------------------------------------
148   module buzzer(speaker, clk, triggeredState); // Specify input and output ports
149   input clk;
150   input triggeredState;
151   output speaker;
152
153   reg [23:0] tone;
154   always @(posedge clk)     // Output changes according to the positive edge of clock
155   if (triggeredState == 1) // When triggeredState is 1, the tone will increment by 1
156      tone <= tone+1;        // The buzzer will continue to sound
157
158   // Speaker is assigned to the triggeredState as speaker can change along with the
      triggeredState
159   assign speaker = triggeredState;
160   endmodule
161
162   //-------------------------------------------------------------------------------------
163   module display(switch, armedState, SSD0, SSD1, SSD2);
164   input armedState;
165   input switch;                        // Declare all inputs
166   output reg [6:0]SSD0, SSD1, SSD2; // Declare three 7 bits SSD as reg (output)
167
168   always @(armedState)
169   begin
170      if((armedState == 1) && (switch == 1))
171         begin
172         SSD2 = 7'b0000001; // Display 'O'
173         SSD1 = 7'b0001001; // Display 'N'
174         SSD0 = 7'b1111111; // Display nothing
175         end                // Display 'ON'
176
177      else if((armedState == 0) && (switch == 1))
178         begin
179         SSD2 = 7'b0000001; // Display 'O'
180         SSD1 = 7'b0111000; // Display 'F'
181         SSD0 = 7'b0111000; // Display 'F'
182         end                // Display 'OFF'
183
184      else
185         begin
186         SSD2 = 7'b1111111;
187         SSD1 = 7'b1111111;
188         SSD0 = 7'b1111111; // 3 SSD display nothing
189         end
190   end
191   endmodule
```

Results & Discussion

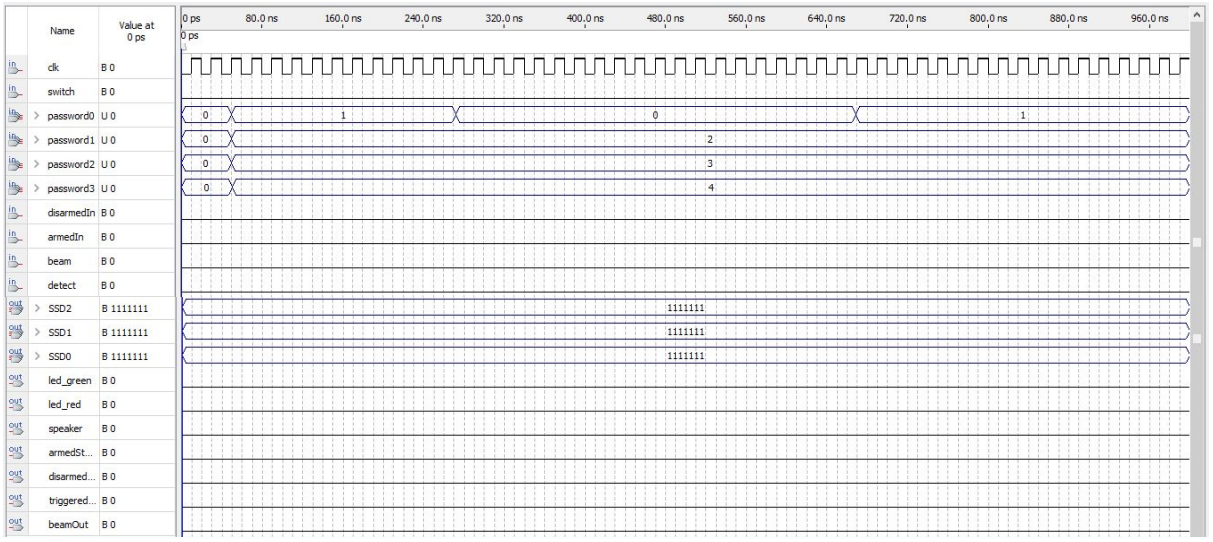

Figure 5 shows the output waveform when the switch is off

When the switch is off (0), the system is shut down. The user is still able to enter the password. All the outputs will be in the off state (0), and nothing will display in the three seven segment displays (7'b1111111).

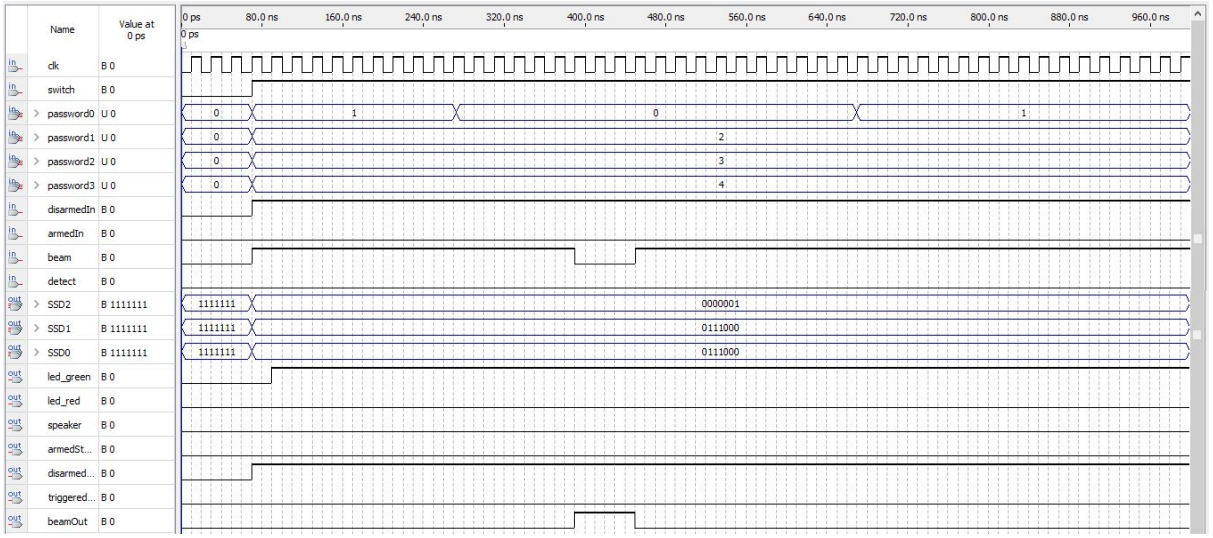

Figure 6 shows the output waveform for the disarmed state

When the switch is on (1) and the user entered the correct password which is set as 1234, the beam (PIR sensor) will be on (1). The beam is Low (0) when something blocks the beam and returns to High (1) after unblocking the beam. The disarmed input is High (1), and the armed input is Low (0). The three seven segment displays will display the word “OFF”, so when the beam is on and detects something (0) and the detector detects an animal (0), the alarm system will not be triggered. The green LED will light up (1), but with one clock cycle delay and the speaker (buzzer) will not have any sound (0), and the red LED will not light up (0). The disarmed state is High (1), and the armed state is Low (0). This indicates to the user that the house is safe. If the user did not press the armed button, the alarm will remain disarmed until the user decides to arm the alarm.

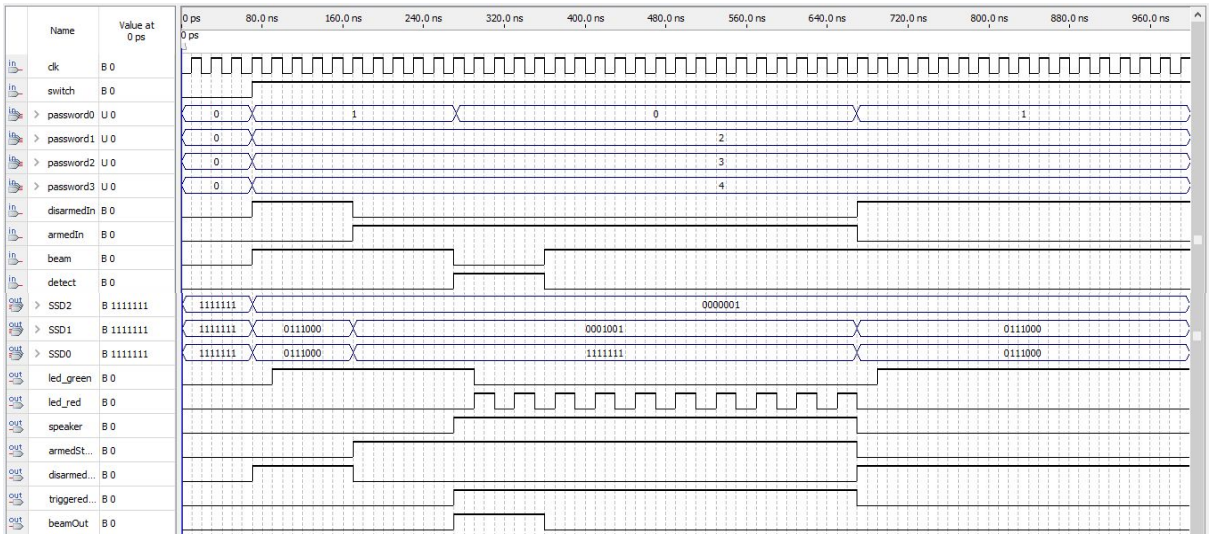

Figure 7 shows the output waveform for the armed state

When the switch is on (1) and the user entered the correct password which is set as 1234, the beam (PIR sensor) will be on (1). Initially, the system is disarmed where the three seven segment displays will display the word “OFF”, the disarmed input is High (1) and the armed input is Low (0). The green LED will light up (1) but with one clock cycle delay and the disarmed state is High (1). The red LED, the speaker (buzzer), the armed state, and the trigger state are Low (0).

After the user pressed the armed button (1), disarmed input is Low (0), the three seven segment displays will display the word “ON” which means the alarm was activated, the armed state will be High (1), and the disarmed state will be Low (0). However, when the beam is Low (0) where the beam of the PIR sensor is blocked and the detector detects a human (1), the alarm will be triggered. When the triggered state is High (1), the speaker (buzzer) for the alarm will sound (1) and the red LED will keep flashing but with one clock cycle delay. This will alert the user that someone is trying to enter the house and the alarm can only be disarmed when the user enters the password again. If the user enters the wrong password, the user is not allowed to disarm the alarm, the alarm will continue to sound and the red LED will keep flashing until the correct password is entered.

After the alarm is disarmed where the disarmed input is High (1) and the armed input is Low (0), the three seven segment displays will display the word “OFF”, the disarmed state goes High (1) and the green LED will light up (1) with a delay of one clock cycle. The armed state will be Low (0), the red LED will not light up (0), the speaker (buzzer) will not sound (0) and the triggered state will be Low (0).

Conclusion

In conclusion, the goal of this project is to provide a safer home alarm system for the resident with efficient and low-cost systems. In this project, Verilog HDL is used to implement the home alarm system. This approach enables us to understand the concept used and make some enhancement until we have obtained our desired output waveform. More research and innovation are needed to further improve our home alarm system so that it is safer to be used.

Recommendation

1. The availability of wireless switch
    - To make the switch accessible in mobile phone, tablet as well as on an application to control the main power of the system.
    - This can make human life easier.

2. The availability of closed-circuit television camera (CCTV)
    - The access of CCTV which enables the user to monitor the situation of the house whenever the laser detects any person.
    - Can safeguard the house whenever children are left in the house alone.

3. Upgrade the PIR sensor to Grid-EYE sensor
    - It is one of the latest technology of sensor products available in the smallest size.
    - Provides the temperature data of a human present at stationary as well as moving position.
    - Grid-EYE will continuously sense the presence of IR radiated energy even if there is a motionless object or no movement direction.

Appendix I – List of group member's contribution

Choong Ting Quan, member contributed in the code for the switches/states, conclusion and reference in the proposal; result & discussion in the report.

Tan Yi Jie, member contributed in the code for the display module, problem statement & objectives in the proposal; conclusion and literature review in the report.

Lee Qian Yi, member contributed in the code for the LED and main module, methodology in the proposal; methodology, result & discussion in the report.

Quah Xuan Ying, member contributed in the code for the buzzer module, methodology in the proposal; methodology, result & discussion in the report.

Lai Tuck Yeow, leader contributed in the main module, combining all member's codes, fixing the errors in the code and simulation of the waveforms, introduction in both proposal and report; appendices in report.

Appendix II – References Used

1.Team Caffiene. (2015-11-30). *FPGA Alarm.* Retrieved from *https://www.instructables.com/FPGA-Alarm-System/*

2.Komol Arafat. Gani, Farzana.(2013-12-20). *A Home Automation System Design Using Hardware Descriptive Tools.* Retrieved from http://psrcentre.org/images/extraimages/9%201213525.pdf

3.Kandepi Madhuri .(2013-7-7). *A Home Automation System Design Using Hardware Descriptive Tools.* Retrieved from https://www.ijert.org/research/a-home-automation-system-design-using-hardware-descriptive-tools-IJERTV2IS70169.pdf.

4. Huide Liu, Suwei Li, Lili Gao, and Tao Wu. About automatic fire alarm systems research. Published in 2010 2nd IEEE International Conference on Information Management and Engineering. https://ieeexplore.ieee.org/document/5477835?reload=true&arnumber=5477835

5. British Security Industry Association (BISA), "Journal on security system section strategy for intruder alarm system", Page 1-3, April 2005. Accessed at https://www.thenbs.com/PublicationIndex/documents ?Pub=BSIA

6. Koenig. J.A, Taylor. L, "Perimeter Security Sensor Technology handbook", Electronic Security Systems Engineering Division, North Charleston, U.S.A, pp. 67-86.

7. Karri. V, Daniel Lim. J. S, 2005, "Method and Device to Communicate via SMS After a Security Intrusion", 1st International Conference on Sensing Technology, Palmerston North, New Zealand, November 21 -23.

8. Mahmud. S.A, Mohammed. G.A, 9, July-Dec 2006, "Development of a Simple Sound Activated Burglar Alarm System" Leonardo Journal of sciences. Issue.

9. Adafruit. (2009, Aug. 24). *PIR Motion Sensor Tutorial.* Retrieved from https://www.instructables.com/PIR-Motion-Sensor-Tutorial/