MILITARY INSTITUTE OF SCIENCE & TECHNOLOGY

Department of Electrical Electronic and Communication Engineering

EECE-318

PROJECT REPORT

Smart Home Security System with Emergency Response

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Introduction:

In the modern era, technology has crept its way into various applications which has greatly increased the effectiveness and efficiency of such applications. Technology has led to the automation of many processes which is more accurate and versatile than humans. Moreover, this increases human comfort and standard of living. Regardless of this, automation of home security is not yet prevalent in most homes in Bangladesh even though it holds the potential to significantly improve security measures. The benefits of implementing a smart security system includes:

1. Improved surveillance: Smart security systems include CCTV cameras, alarms, motion sensors and biometric locks. The combination of these components makes it extremely difficult for intruders to successfully rob any homes.
2. Instant response: If any unauthorized entry is detected by the system, an instant alert is sent to the homeowner. and in some cases, the police so that they can respond immediately to apprehend the intruder.
3. Deterrent measure: Intruders are less likely to rob homes which have automated security systems as compared to the ones which do not. Thus, a deterrent effect is in place.

In this paper, an automatic home security system will be designed with an alarm system. The theory of finite state machines has been used in order to implement the system in Verilog. A Finite State Machine (FSM) is a conceptual model widely employed by programmers, mathematicians, engineers, and other professionals to represent systems with a limited number of distinct states. It is a computation model that can be implemented with hardware or software and can be used to simulate sequential logic and some computer programs. It serves as a mathematical abstraction that facilitates the analysis and design of systems that exhibit various conditional states. The key components of FSM include:

- A set of potential input events.
- A set of probable output events that correspond to the potential input events.
- A set of expected states the system can exhibit.

Our home security system can be represented by multiple distinct states. Transition between states will require different combinations of inputs and the states themselves will represent certain outputs. These output values will only depend on the current state and not on the previous states. These types of finite state machines are called Moore machines. There are also Mealy machines whose outputs depend on the current state and current inputs.

Methodology:

The system was designed using Verilog hardware description language. Figure 1 shows the state diagram of the system:

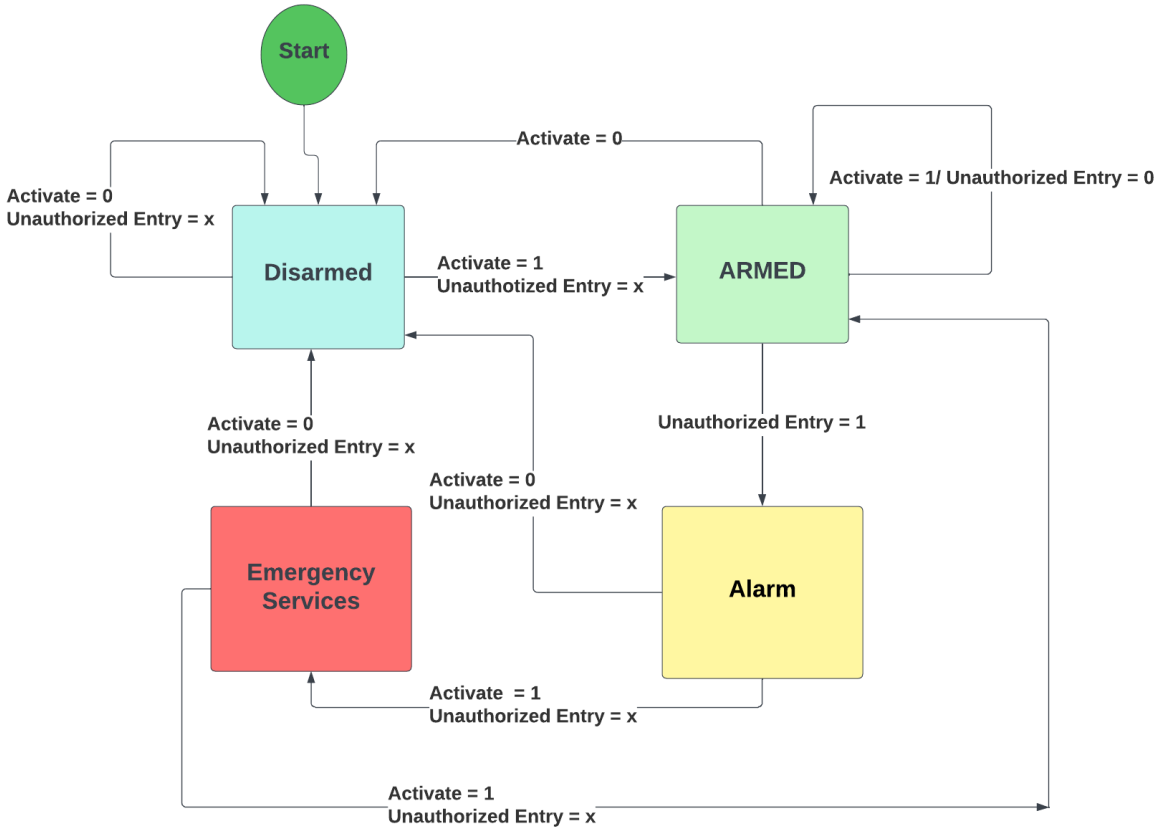

Figure 1: State Diagram of Smart Home Security System

The system includes 2 main inputs:

- Activate: Logic level high enables the security system and logic level low disables the system.
- Unauthorized Entry: Logic level high represents intrusion and turns on alarm while logic level low represents false intrusion and disables the alarm.

There are also two main outputs:

- Alarm: Will be high when activate is high and unauthorized entry is high. This output represents the actual alarm.
- Call: Will be high when activate is high for an additional clock cycle after alarm is high. This output represents the alert being sent to authorities

From the above state diagram, the state table and state assigned table has been created below:

Table 1: State Table

Present State	Next State				Output	
	$\bar{w}\bar{x}$	$\bar{w}x$	$w\bar{x}$	wx	z_1	z_2
Disarmed	Disarmed	Disarmed	Armed	Armed	0	0
Armed	Disarmed	Disarmed	Armed	Alarm	0	0
Alarm	Disarmed	Disarmed	Emergency Services	Emergency Services	1	0
Emergency Services	Disarmed	Disarmed	Armed	Armed	1	1

Here,

w = Activate

x = Unauthorized Entry

z_1 = Alarm output

z_2 = Call output

Table 2: State Assigned Table

Present State	Next State				Output	
	$\bar{w}\bar{x}$	$\bar{w}x$	$w\bar{x}$	wx		
$Y_2\,Y_1$	$Y_2\,Y_1$	$Y_2\,Y_1$	$Y_2\,Y_1$	$Y_2\,Y_1$	Z_1	Z_2
0 0	00	00	01	01	0	0
0 1	00	00	01	10	0	0
1 0	00	00	11	11	1	0
1 1	00	00	01	01	1	1

From the state assigned table, the following equations were derived using K-map method:

$Y_2 = w\bar{x}y_2 + wxy_1\bar{y}_2$

$Y_1 = \bar{w}\bar{x}y_1 + w\bar{x}\bar{y}_2 + \bar{x}y_1y_2$

$Z_1 = y_2$

$Z_2 = y_2y_1$

Y_2 and Y_1 are the inputs of the D flip flops 1 and 2 respectively used in the circuit. y_1 , $\bar{y}_1$ and y_2 , $\bar{y}_2$ are the outputs of the flip flops 1 and 2 respectively. The full circuit diagram is shown below:

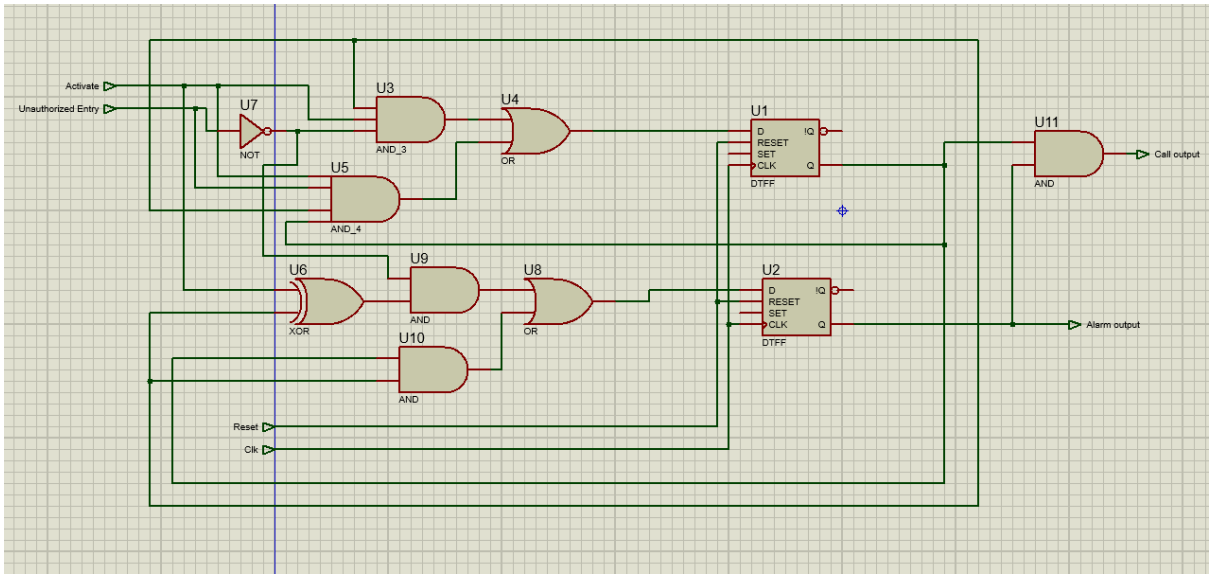

Figure 2: Circuit Diagram of the system

Results:

The circuit was simulated using Icarus Verilog and the results are shown below:

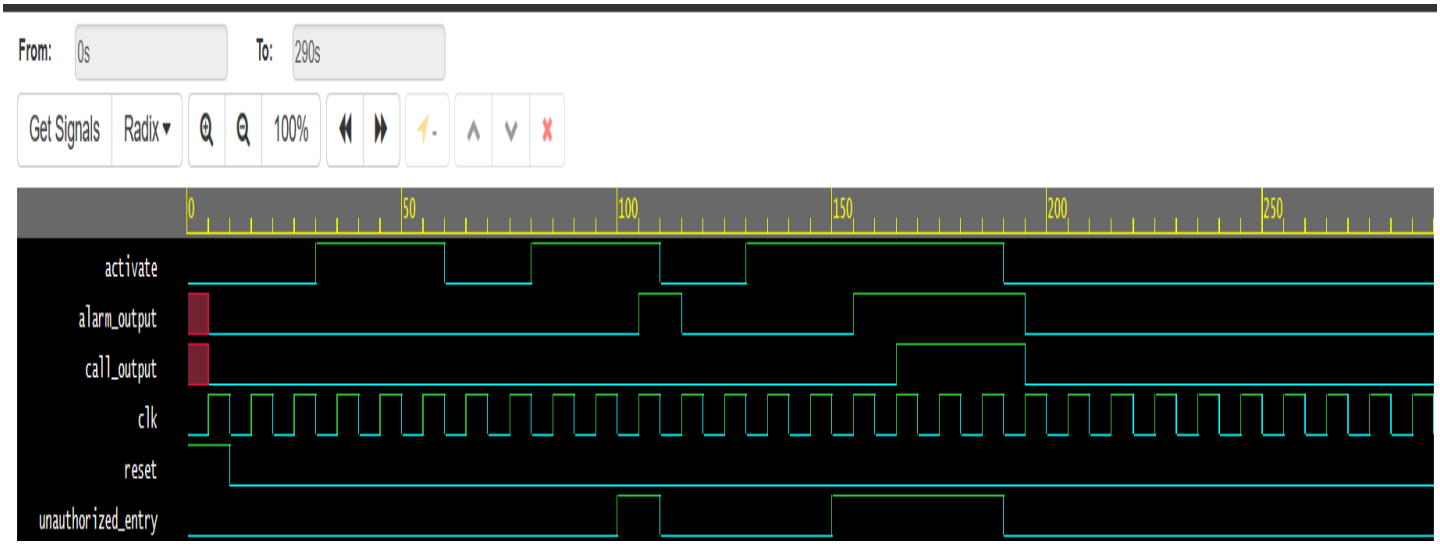

Figure 2: Output Waveform of system

The waveform above shows the relationship of the outputs with respect to the inputs. In this context, two additional inputs, namely "reset" and "clk", have been introduced. The clock

facilitates changes in the state of other parameters, while the reset is integral for implementing the behavior of the D flip-flop.

The two inputs activate and unauthorized entry were applied using testbench code. We can see that the alarm is on during the 11^{th} clock cycle after both inputs were high. However, in the next clock cycle the system was deactivated so the call output was not high. In the 17^{th} clock cycle, the call output is finally high because the alarm was not deactivated.

The behavior of the outputs show that the system performs as intended.

Conclusion:

This project demonstrates the potential of FSMs in designing and implementing efficient and reliable digital circuits for smart home applications. In this system, we have shown intruder detection, alarm trigger and instant response thereby, fully automating the security process. As a result, security has been enhanced, made easy and accurate, offering significant advantages over traditional methods. Future research can explore the expansion of this system to integrate additional features, such as remote monitoring and biometric identification, to further enhance its capabilities and security for smart homes.

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