Security Alarm System

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Abstract - Security alarm systems are necessary in every household to maximize security. This design project creates an affordable home alarm system with a password . With the use of a Xilinx FPGA board, Vivado program, a sound impact sensor and wide angle passive IR sensor, a code is developed to set an alarm to detect intruders. The alarm is disabled by using a series of switches as a password which can be reset. The method of logic behind the alarm scenarios are depicted by two Algorithmic State Machines. The sensors may be faulty, therefore, the code is written to be successful in maximizing security by reading and writing a password.

I. INTRODUCTION

An estimated 3.7 million household burglaries occur each year [1]. For our project, we designed an inexpensive home alarm system that will detect intruders. Since it is affordable, more people will have access to an alarm system. All homes should have alarm systems, homes without a security system are 300% more likely to be burglarized [2]. The security alarm system create makes for less burgalaries considering 60% of burglars claim that they would change their mind about breaking into a home if an alarm system is active [3]. With the use of a Xilinx board, Vivado program, Parallax Wide Angle Passive IR sensor and a Parallax Sound Impact Sensor, the alarm system has maximum security. The coding and attachment of the sensors as well as the alarm sound generated is new material for all group members. Both sensors play a vital role to the alarm system: the sound impact sensor will detect abrupt sounds and the wide angle sensor detects motion. The sensors enable the alarm when detected that cannot be turned off unless the proper password is inserted. Once the correct password has been prompted, the password has the ability to change.

II. METHODOLOGY

A. Functionality

In order to determine the proper outputs, two algorithmic state machine diagrams, as displayed in Figures 1 and 2, are created to portray the sequential operations of the digital system. Figure 1 displays the state diagram for the password reset. The password changing relies on the read and write switches (rd_wr) that will either read the password input or write a new one. If the read or write is not enabled, the alarm system cannot write a new password, let alone interpret the password input. If the read is enabled and the correct password (pwc) is prompted, the new password can be written and stored by using the the switch inputs (sw_input). If the password is inserted to disable the alarm, the read must be enabled and the password can be written to turn the LED off. If the incorrect password is prompted, then the LED will not turn off.

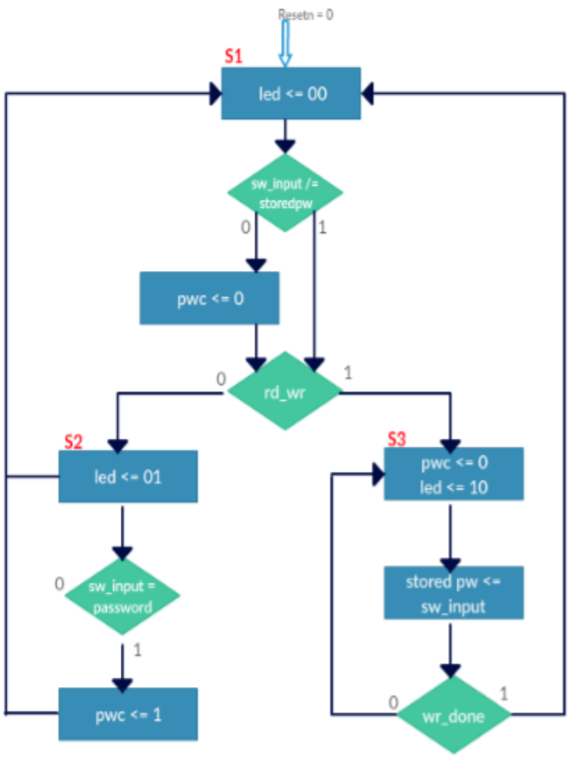

Figure 1. Algorithmic State Diagram for Password

Moving along to Figure 2, the functionality of the alarm, sensors and password is portrayed on the state diagram. The alarm is enabled when it detects an intruder with the sound and motion sensors. Since the password (pw) is enabled at an active high, it is dependent on the triggers (T2, T1) set by the sensors. The sensors create a high or low signal, determining whether they have been enabled or not. If the proper switches are prompted, the correct password will stop the alarm. From this point, if the password needs to be reset, Figure 1 is used again.

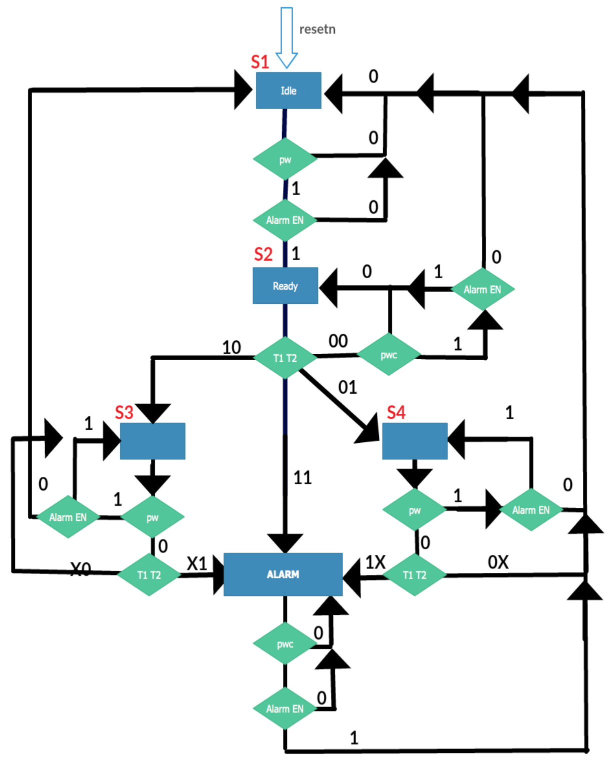

Figure 2. Algorithmic State Diagram for Alarm with Password

B. Implementing the Process

For the code, we have created multiple sources in order to execute the generate a reliable alarm system. We begin with the top level, state machine for password functionality, state machine for alarm functionality and testbench. The top level maps out the inputs and outputs of the system, which in this case, the led and password correct are outputs and all other signals are inputs. The password state machine provides determines the functionality of the password along with its store and reset. It does so by going through all three states with if and when statements. The alarm state machine goes through all scenarios of enabling the alarm with the triggers. The alarm state machine also determines the outcome with if and when statements but for five states. Both state machines follow the same logic determined in Figures 1 and 2 to maintain accuracy. Lastly, the test bench incorporates all elements of the system, including the sensors. The indications are port mapped in order to declare each signal. The clock is also enabled to trigger the signals high or low depending on the rising or falling edge of the clock.

C. Assembling the Hardware

The sensors attached to the Nexys Board are enabled with either high or low signals. In order to read the input signals from the sensors, the each sensor is attached to the Pmod modules of the board. In Figure 3, the assembly of the sensors is portrayed. In order to prevent the board from being damaged, a breadboard is used. Ground and 3.3V from each Pmod ports are powered from the board to create a vertical bus strips on the breadboard. The voltage and ground pins from each sensor are connected to the breadboard for power. The wide angle sensor output pin and the sound impact sensor signal pin are both connected directly to separate Pmod ports. The constraints for the pins are set so that the first pin of each Pmod is declared. The two Pmod headers used in Figure 3 are JA and JB. The overall circuit is simple, therefore, the code must be executed properly to guarantee accuracy of the sensors.

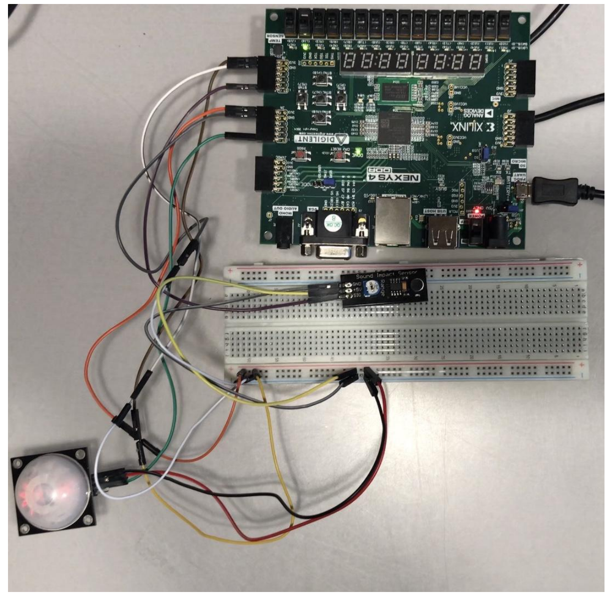

Figure 3. Assembly of the Sensors

III. EXPERIMENTAL SETUP

In order to generate ideas about creating a simple alarm system, research on other alarms was conducted. An older, portable, simple alarm system's patent was referenced to ensure all aspects of an alarm system are being created [5]. In order to properly attach the sensors to the Nexys4 DDR FPGA Board, the manuals for the board and sensors were utilized. The board's reference manual illustrated the Pmod ports mapping of the twelve pins with the functionality and constraints [4]. The board uses a 3.3V and ground pin to provide power to the attached sensors.

The wide angle sensor specifications from the maker's website were also used to configure the sensor correctly [6]. The sensor has four pins: ground, voltage, output and enable. For the purpose of this project, the enable was not used. The specifications provided examples of other projects that include the wide angle sensor; the other projects helped give a better perspective of the sensor's functionality. The last equipment used is the sound impact sensor - to determine ultimate accuracy with the sensor, its manual were also utilized [7]. The sound impact sensor possesses three pins: voltage, ground and signal. All pins were utilized to enable the sensor. The manual also provided further information, including features and key specifications.

IV. RESULTS

The two state diagrams used to construct the code are both dependent on the password entry. In Figure 4 and Figure 5, the password behavioral and timing simulations are portrayed. In Figure 4, the correct password can be entered once the writing is enabled. In the timing simulation, Figure 5, depicts writing the new password (wr_done) remains high since it is stored.

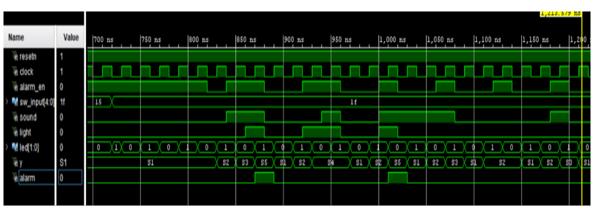

Figure 4. Password Reset and Store Behavioral Simulation

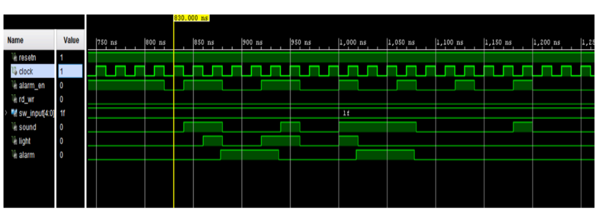

Figure 5. Password Reset and Store Implementation Timing

For the alarm state machine, the behavioral and post implementation timing diagram is also generated, as displayed in Figure 6 and Figure 7. For the behavioral simulation, the 'y' signal represents the different states. Each state is dependent on the sound and light sensor signals. The led is enabled only when it is at a logic high, 1. In Figure 7, the timing diagram illustrates a better representation of the alarm enabling when the sensors are enabled.

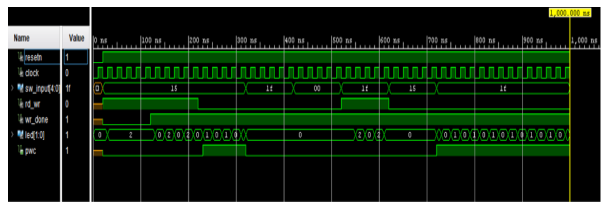

Figure 6. Alarm Behavioral Timing

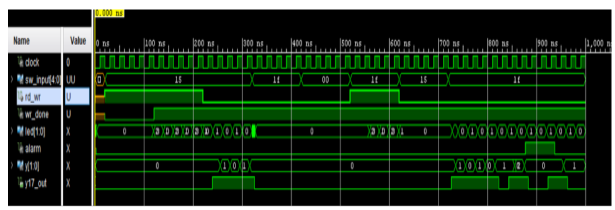

Figure 7. Alarm Post Implementation Timing

The overall alarm system is dependent on the the intruder in which the sensor detects. The following link provides a demonstration of resetting the password if it needs to be changed: https://streamable.com/vj0m2. From this point, the new password can be used to set the alarm on. A tutorial on how to set the alarm off with the sensors and turn it off is provided in the following link: https://streamable.com/h0k7t. These videos provide the outcome of the hardware and code implementation. Also, with these tutorials, the user can utilize the alarm system

V. CONCLUSION

Due to the alarm system being affordable, the sensors attached may be faulty. Therefore, it is utmost important to generate the proper code in order to have a secure system with a password. As a group, we learned to implement hardware to the Nexys Board, for it was a new procedure for us all. We learned to implement the sensors' signals into the code, enabling the alarm when the sensor is at a logic high. More accurate sensors could have made the alarm system more reliable, although our goal was to make it affordable and efficient. A sound made when the alarm is enabled would have been suitable for the system, however, we did not get to creating a sound from the board.

VI. REFERENCES

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