Home Security Station

A Host of Sensors to Provide Protection to the Home

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Abstract – With use of the Nexys DDR 4 board, our group has implemented a host of various sensors that could be used to protect a home against numerous dangers that lie in wait for the home owner or residing tenant.

I. INTRODUCTION

The home security station was developed under the guise that the world we are in is ever changing. And at the forefront is the idea to be able to protect one's own home with the latest technology to be able to secure it. Our group intends on utilizing digital ports on the board to be able to detect motion and or sound with a variety of sensors, such as wide-angle motion through infrared and sound through an impact sensor. This design was downgraded from the original which was to include a temperature sensor and a vibration sensor.

Items used for this project that were learned in class that would prove useful to the project will be the use of state machines (to check and verify data collected from the sensors and to correctly detect an activation of the system). State machine will also be used to collect data input from the user such as arming and disarming the system. There would also be the use of a register in order to store disarming passcode for the system and use them for comparison during the disarming procedure. Counters will be implemented in order to reduce or increase sensitivity of the system for the system components that don't already have the capability via their configuration.

With the system in its current configuration the home security alarm will be able to detect a glass break or loud noise using a sound impact sensor (Fig.1), as well as, a proximity motion detector (Fig.2) signaling someone may be attempting to enter the home. The infrared detection will allow the unit to see motion within a 360-degree path to signal the alarm to sound, while armed, within an appropriate amount of time.

II. METHODOLOGY

Board Design –

With the use of the Nexys DDR 4 Board (Fig. 3) as our base, the board will have minimal amount of external interfaces. This is two-fold approach at this time, one for simplicity of showing the capabilities of the systems, the other for showing that with a simple interface, it would be hard to incorrectly set up the system by an installer of such a system in the home. The boards J ports will be used to hook up our 2 motion sensors and our one sound sensor for the demonstration purpose of this project. The sound sensor will be enabled through port JA and use its supplied 3.3 volt line and ground and then signal will be detected though JA1. The motion sensors will be mounted to port JB, and JC and use their respective voltage and ground and also be detected though pin 1 of the Pin sets.

The sensors themselves will be hooked up using small bread boards to be able to set them up away from the main unit and not be hooked directly into the board this especially will show how it would truly work in a real life scenario with having units being placed a distance away from the main control box.

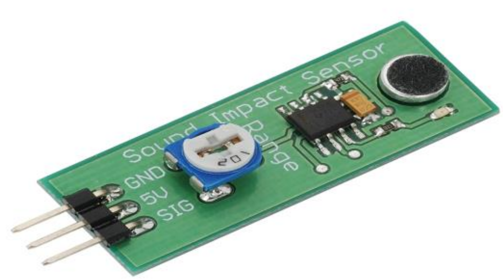

Figure 1: (Sound Impact Sensor)

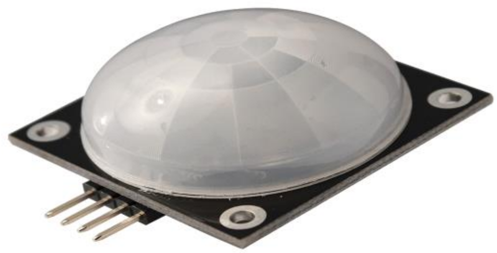

Figure 2: Wide angle proximity sensor.

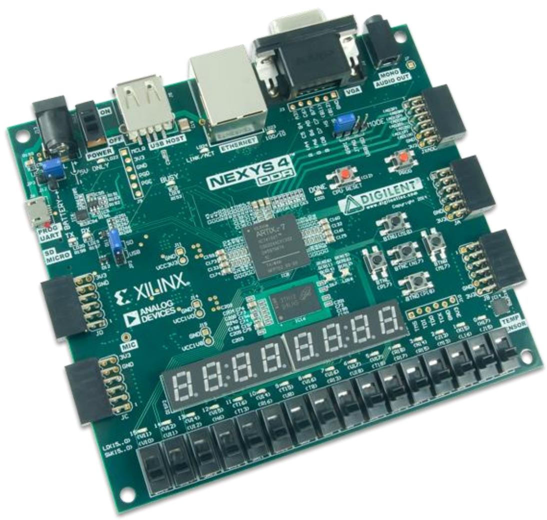

Figure 3. NEXYS 4DDR by DIGILENT

Our hope is to also use the switch based control as well to toggle the alarm off and possibly a single switch movement to arm the alarm. The switches on the bottom of the board will primarily be used to control the sensitivity of some of the components as we find necessary. The CPU reset button will be disabled to show how the system would work in a real home scenario and hopefully we can have the system powered on a battery back for demonstration purposes if the part can be acquired, if not the system will run off a 5V source via micro-USB to the board hub.

Programming-

Programming of the board will entail the use of many of the features of the board. First and for most the use a multiple state machines will be necessary to garner the correct implementation of the alarm system components and a flow chart will be provided to show the operation of these devices within a hierarchy setup of use. State machines will also be used to detect the disarm code via the switch inputs 11 down to 7 as well.

The use of counters will also be for two separate items for this project. One important feature that the counter will act for will be the countdown prior to alarm activation. By using code to count the number of clock ticks we will be able to break down a "typical" amount of time needed to get to the board and shut it down prior to sounding the alarm. The other use for the counter will be for items that do not have a sensitivity control and by implementing a counter our group will be able to determine this by making the unit test a result, wait a certain amount of time then test it again, so if two positive values are attained the system will take its result as a system activation.

One aspect of the code design was the use of flip-flops with enables to control the alarm signals. The enable will be handled by the state machine or control circuit. The data received into the flip-flop is an on or off signal which will in turn control the leds for purpose of monitoring the alarm system. The alarm will stay on until the code is entered by the home owner. Initial designs incorporated the functionality of a sequence detector but due to time constraints the design changed for sake of simplicity.

The FSM actually controls the flow of the signals and performs this task with the usage of algorithms. Based on the state of the power and armed (sw<0> & sw<15> respectively) the finite state machine would enter into an on and armed state and immediately detect any motion or sounds until the system is turned off. The FSM controls the sensors enable as well as the enables for the leds. It really is a great design and could be expanded fairly easily by adding more sensors and also a speaker or silent alarm which would notify the controlling authority.
Further actions taken during the programming piece should be relatively simple and should be very easy to layout and construct.

III. EXPERIMENTAL SETUP

For the setup of the alarm system, our group once again used the JA-JC ports on the board to allow for the signals to come in from the ported sensors that were hooked up to the board. By using these digital ports our alarm was able to detect a very simplistic but yet effect way of getting the information to the board. Since the sensor worked in a logic one format being that when inactive they produce no voltage through the signal cable "0" and when detection of their respective item came though they produced a "1". Using this digital element helped with the simplicity of the product of itself since it was not coded using the embedded analog to digital decoder on the board.

After the sensors were hooked up and good to go our group was able to construct a rather easy program for set up. Since we approached this project as in making something that could be used by someone wanting to put a simple home break in detection system into their home we did not want to be over extravagant on the programming aspect however we did want to utilize aspects that we had learned in class such as state machines, counters, and registers.

After the system was programmed and set to go, we were able to test the system, although it is "extremely" sensitive it is a good working model of something that could be used as a very basic home security system.

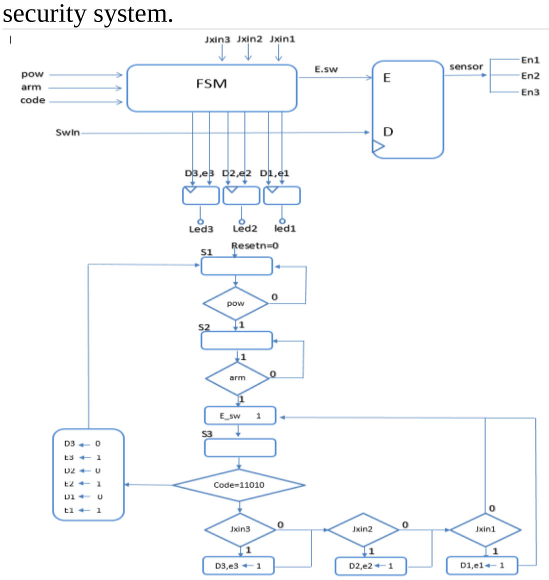

Figure 3. FSM using ASM and Hardware diagram

IV. RESULTS

Results of our project came as a very basic home security system. After a couple program re-writes over the course of the project period we were able to derive a working model of the project, granted it was not as deep as a project as we were hoping.

Some of the difficulties we had run into during this project was the ability to get good working sensors that worked appropriately with our board. Other than the sound detection and motion capture, most of the sensors we purchased either simply did not work or could not be detected by the board due to their extremely unreliable output. Also with programming between a few people it was hard to stay on the same page and we found that the more cooks in the kitchen the more problems began to surface with our overall design of the project. Finally, due to our time constraints we were unable to program a way or set a way to notify the owner of the alarm of an activation. Since that is the primary purpose of an alarm and we fail to complete that within the allotted time for the project but down the road if this project became something more viable for public use it would be nice to hook into blue tooth or WAN to have someway of notifying the home owner of a possible trip in the home.

V. CONCLUSIONS

Over the course of the last two weeks while trying to assemble this project we have learned quite a bit on programming ideals, how to appropriately acquire knowledge and pieces to the puzzle to solve it. The realization of how important teamwork is and that organization is everything. If given another opportunity the focus from the beginning would and must be the design. A well described design and matching state machine will prove necessary and provide the backbone of any design. Many challenges were faces but we were able to produce a system albeit not any where near perfect but as a good base for something much better down the road. The information we have learned in this class has provided all the members of this group with a great base understanding of VHDL coding and the way in which computers behave at the process level.

We would like to thank Professor Llamocca for his help in the waning hours of the project time to help us get it running as well, for without his help we would have been presenting something that was not functional at all.