Terence Lee - tklee3, Jason Kang - jasondk2

ECE 110 Final Report

Introduction

For our Final Project, we wanted to design and implement an alarm system with various outputs and differing states based on certain inputs and timers. The alarm system could be applied to any private area such as a home or workplace in which the system could be utilized to ward off any intruders but still allow some level of control to the owner. Obviously, we would not want the alarm to constantly go off so this is why we implemented a disarming mechanism that will disable the alarms if the owner chose to do so. Adding on, we would need an input that would disable the disarm and allow the alarm to go off again. Also, we would not want any unwanted persons to be able to access such disarming mechanism, so we wanted to implement a way to disable the disarm system so the alarms will go off regardless. If for any reason, the owner wanted to keep the alarm running no matter what, such as an intruder or environmental hazard, they could start a timer which disables the disarming mechanism so the alarm keeps running. In regards to the design, we want to make the alarm system suitable for any environment and intuitive for the user as well. Therefore, we wanted to use multiple outputs for the rights situations. For example, the alarm would normally make a high pitched noise when triggered, but then we could use a photoresistor to detect when it is dark so there is a light output instead.

Analysis of Components

The sensors we used in our project were a photoresistor and a reed sensor. One of the issues that we ran into when trying to implement the sensor output with the alarm logic is the output signal from both sensors are High and Low impedance. As a result of this, when trying to AND together two signals, a low impedance output does not register as low for the transistor chip instead registering as high. We worked around this issue for the reed sensor by forcing the output signal to high (by adding a resistor connected to Vdd to the output node) and then feeding the result into an inverter which then outputs low. On the other hand, with the light sensor having variable output based on the light level detected, we fed the output into two consecutive inverter gates which resulted in clear high and low outputs (any output over the transistor's turn-on voltage - 2.3 V is high and vice-versa for low). For the speaker output, we needed to generate an oscillating signal in order to product the correct pitch frequency for the sound-based portion of the alarm. Since frequency is inversely proportional to how large of a capacitor and resistor used, by choosing a relatively small resistor and capacitor (100 Ohms and 0.1μF respectively), we could generate an oscillating frequency of approximately 4.0 KHz that resulted in a high pitched tone whose volume could be adjusted by changing the potentiometer resistance.

Design Description

While first planning out the project, the block diagram represented a general idea of how we wanted our circuit to behave. Initially triggered by an infrared sensor, the circuit would determine whether it is bright or dark outside and output an appropriate alarm (flashing LED/high pitched tone) and if at any point within the designated disarm period, (specified by a capacitor charging) a reed sensor detected a magnetic field, the entire system would be disabled. Despite the project idea not being exceedingly complex, turning the block diagram into a schematic proved difficult. Certain parts of the circuit like the oscillating LED and daylight sensor were easy to implement as we had done them before in prelabs/labs. On the other hand, there were much more challenging portions such as the capacitor to comparator interface and D-Flip Flop behavior, and speaker that involved more time to research and think about. Even with a rough draft schematic[1] completed, there were still parts of the circuit that we were unclear how to build such as connecting the combinational logic of the light sensor to the speaker and flashing LED so each would turn on under the right conditions. After more planning, we redesigned parts of the circuit, fixed several errors, and redrew the schematic, this time modularizing each portion of the circuit for better clarity[2].

Finally, it was time for us to assemble the circuit. Though the modularization of the schematic made assembly much less confusing, ultimately there were still glaring issues with our design. The input and output signals were not outputting properly and some of the sensors were not behaving how we expected them to. After many hours of debugging and tweaking our circuit, we were able to develop a circuit that behaved how we wanted it to and satisfied all the characteristics of an alarm. Through testing the circuit at different locations with the oscilloscope, we discovered the issue of the sensors outputting high and low impedance as discussed before. We also found that the countdown timer for the circuit was too short of a period (the capacitor would charge within microseconds) and that in order to get a longer countdown time we should use a larger capacitor and resistor. Originally, we planned to use a comparator to determine when the capacitor was finished charging however to simplify the circuit, we instead placed the output of the capacitor charging into an inverter transistor. That way, we could utilize the transistor's turn on voltage (2.3V) as the countdown timer end. Though the capacitor's charge time is 16.5 seconds to (almost) fully charge, because we set the timer to

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[1] See Appendix for Schematic
[2] See Appendix for Modularized Schematic

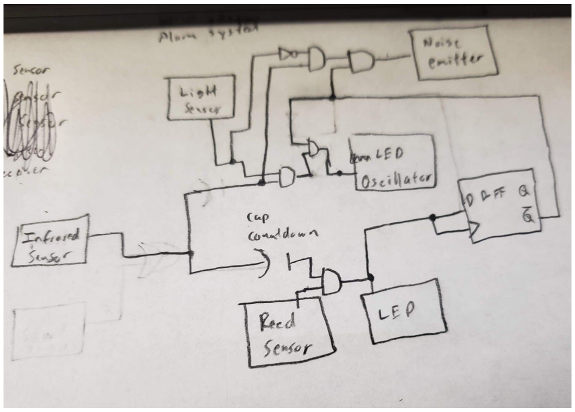
end at the transistor's turn-on voltage, the actual capacitor charge time is approximately 2-3 seconds. After troubleshooting the D-Flip Flop and figuring out to wire the reset button to PRE and ground, we added several additional LEDs so that it would be easier to see which parts of the circuits are currently functioning. To detect when the capacitor cooldown has not ended, we placed a blue LED at the output of the inverter capacitor. We also added an LED to the output of the reed sensor so that even after the alarm has been disabled people can still see when the magnetic disarm signal is triggered. Finally, we tuned the potentiometer, resistor, and capacitor values of the two oscillator portions of the circuit to optimize the output the user experiences. Unfortunately we ran out of time and could not clean of the wiring of the circuit so that everything is neat and organized however we tried our best to minimize the distance between all the different modules and cut/stripped proper wire lengths when we were able to.

Conclusions

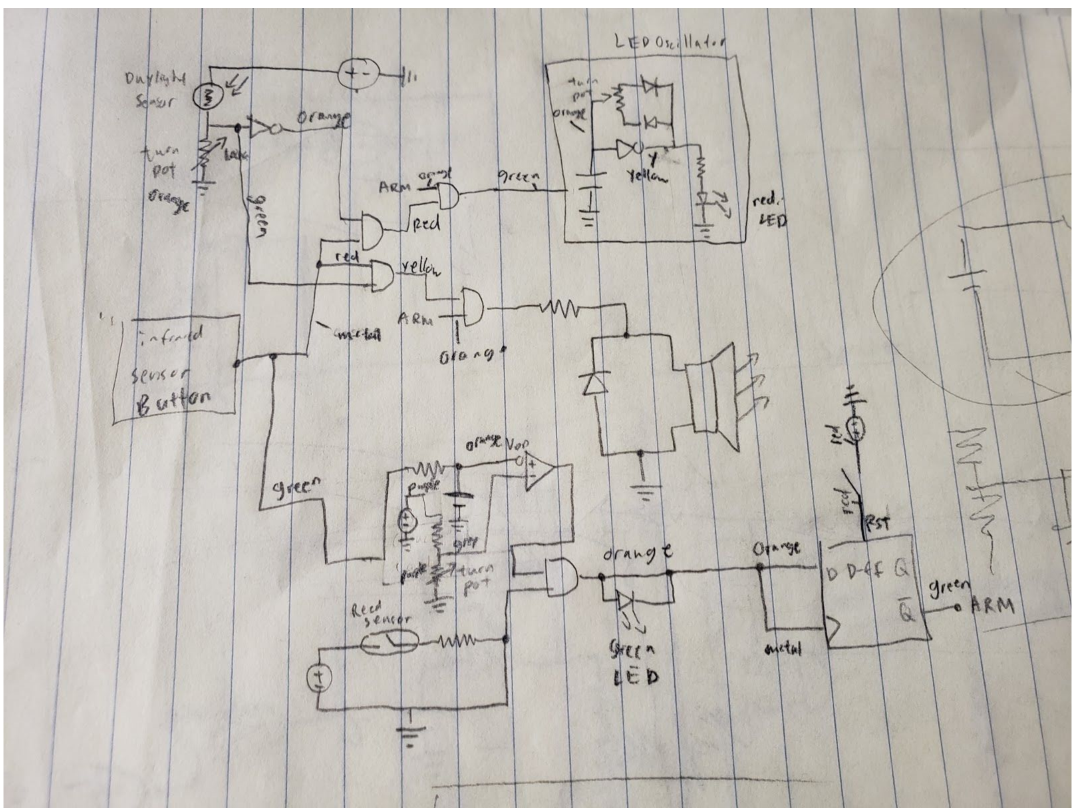
Overall, even though our alarm system did not come out and work as we initially thought, our project was a success and we were able to accurately portray the design in our demo. A large unexpected obstacle we encountered was during our initial design phase, where we initially wanted to design the locking and alarm mechanism for a car utilizing D-Flip Flops in a Finite State Machine with different sensors acting as the input and output signals. After further consultation with the TAs, it was concluded that our idea relied too heavily on d flip flops and did not utilize the knowledge we gained in 110 enough. To address this issue, we brainstormed and decided upon our final idea (the house alarm system). Though somewhat similar in concept, the house alarm system had less of a reliance on logic transistor chips and more upon the interactions between the different sensors and outputs we used. Despite this unexpected setback, we were able to keep up with our timelines and finish the project in time for the demos. Another hurdle we faced had to do with the actual circuit and correctly implementing it so the system worked how we intended. Detailed previously in the design description, there were many issues that we had to research and troubleshoot through as well as several quality of life changes made to improve the circuits functionality. All in all, our design performed all of our tasks outlined properly, and our demonstration showcased this. Our alarm output of the speaker and oscillating LED showed their respective effects, and we were able to switch between the two by changing the input to the photoresistor. The reed sensor successfully disarmed the alarm and the button we used reversed the disarm, so the alarm could be properly reset. Our timer also worked well, since we were unable to disarm the alarm after the time ran out so it kept running. Due to time constraints, there are certain portions of our circuit that could use improvement/change such as adding a discharge feature to the capacitor instead of having to manually drain the charge after each test. Ultimately, we believe that given the limited time given as well as our initial setback early on in the design process, we did well and our overall project completed the outlined tasks successfully.

Appendix:

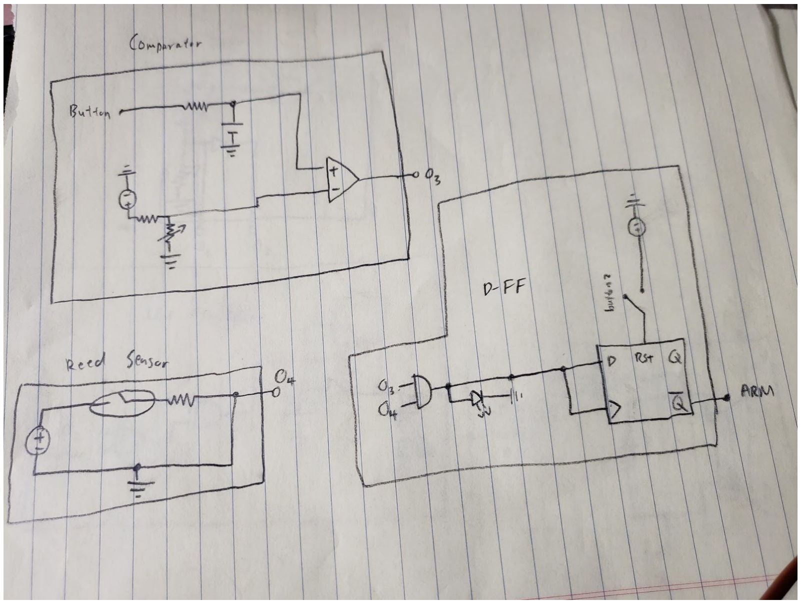
Block Diagram:

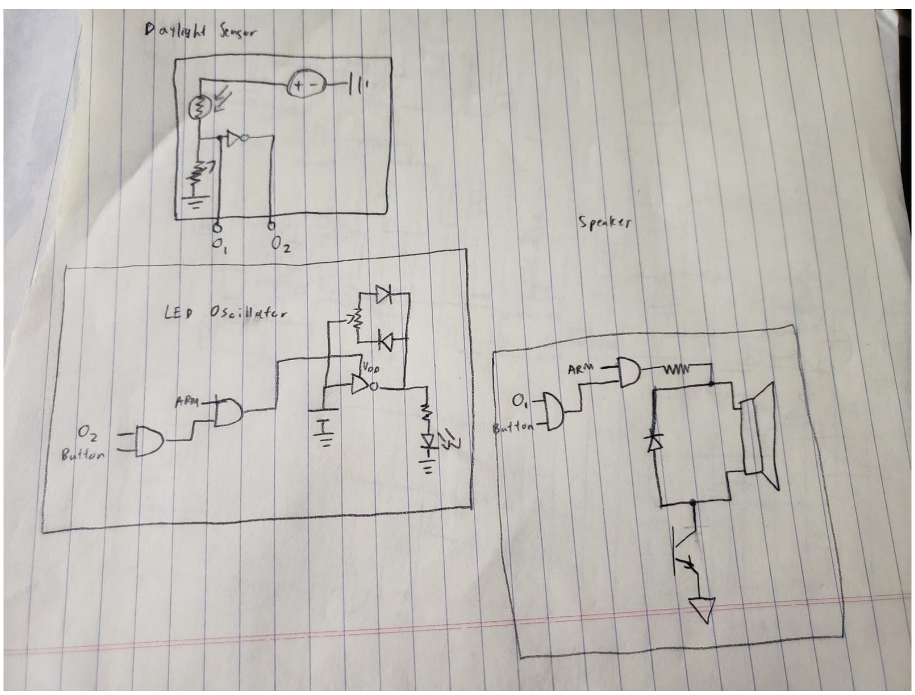


Rough Draft Schematic:

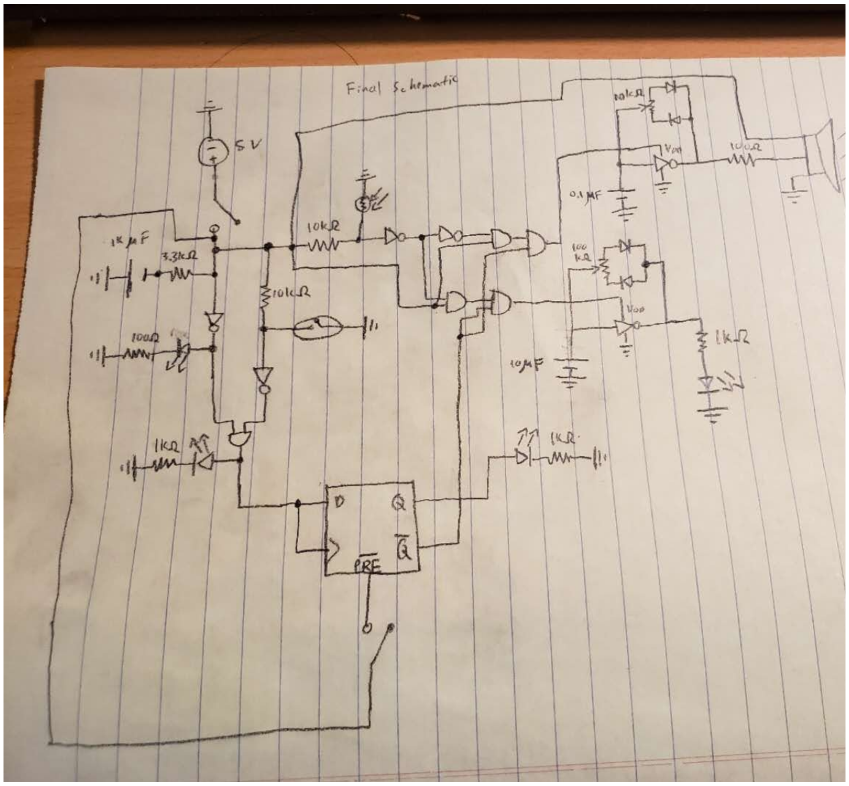


Pre Building Modularized Schematic:





Final Product Schematic:



Physical Circuit: