ECE 312 Final Project Plan
Home Alarm System
Group W1

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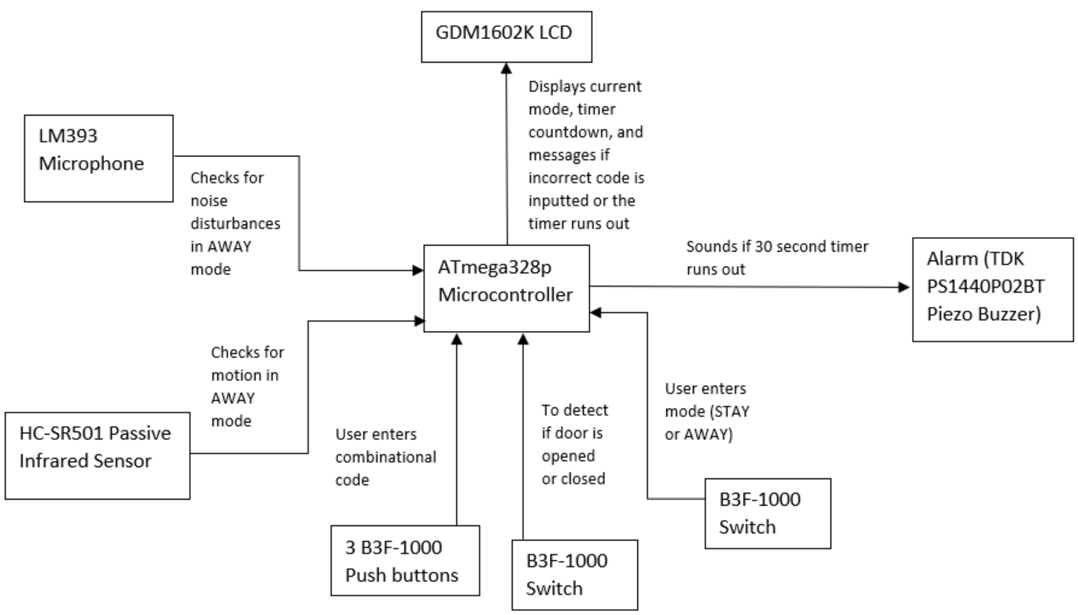
Abstract

The Home Alarm System is a product that helps keep a home secure. When a door of a home is opened, the user is prompted to enter the correct combination code before a thirty second timer runs out to disable the alarm. The user also can enable sound and motion sensors by selecting a "stay" or "away" mode. It is based on the ATmega328p microcontroller and makes use of many of its features including digital inputs and outputs, timers, and serial communication. The Home Alarm System also makes use of a GDM1602K liquid crystal display to show vital information relating to the current state of the system. This product consists of a variety of parts such as a HC-SR501 passive infrared sensor that detects motion and a LM393 microphone that detects noise disturbances. In the development process of this product, a test plan has been put into place to ensure the viability of this design. Along with this test plan, there is a six-week timeline that outlines the approximate time it will take to complete the project from the planning stage to product deployment.

Block Diagram



Hardware Design

For this project, Atmel 8-bit AVR RISC-based microcontroller ATmega328P is being used. When the Home Alarm/security system is in Home mode, 3 buttons have been designated for combinational lock along with a separate button for Home/Away switching action. Another mechanical button is incorporated inside the door to detect if it is locked or unlocked. This would provide simple digital input for the purpose of sensing the locking mechanism.

The event countdown of 30 seconds will be achieved by generating a CTC waveform exploiting TCCRnB, OCRnA, and TIMSK (for match interrupt) register, along with TCNTn (timer/counter). The firmware in detail is not discussed here, rather just the internal hardware components are mentioned for book-keeping.

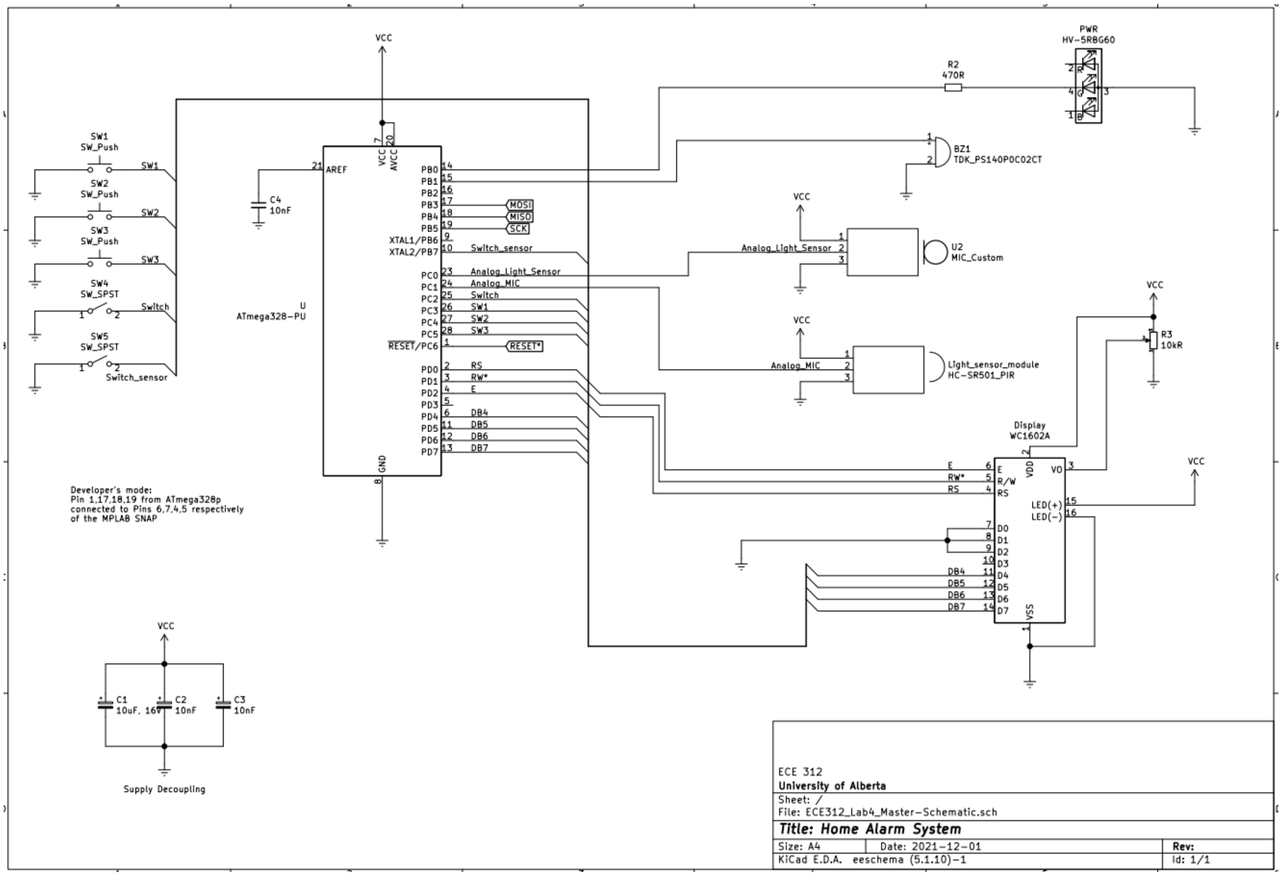
In the Away mode, a custom Sound module (LM393 op-amp implementation) along with a low cost HC-SR501 passive infrared motion sensor (PIR sensor) are being used for the purpose of motion detection. The hardware realization of the PIR sensor is rather complex compared to the sound module, hence, is not implemented as part of this project. To provide feedback to the user, a 2 line by 16-character LCD-GM1602K and external buzzer has been incorporated into the design.

Product Specifications

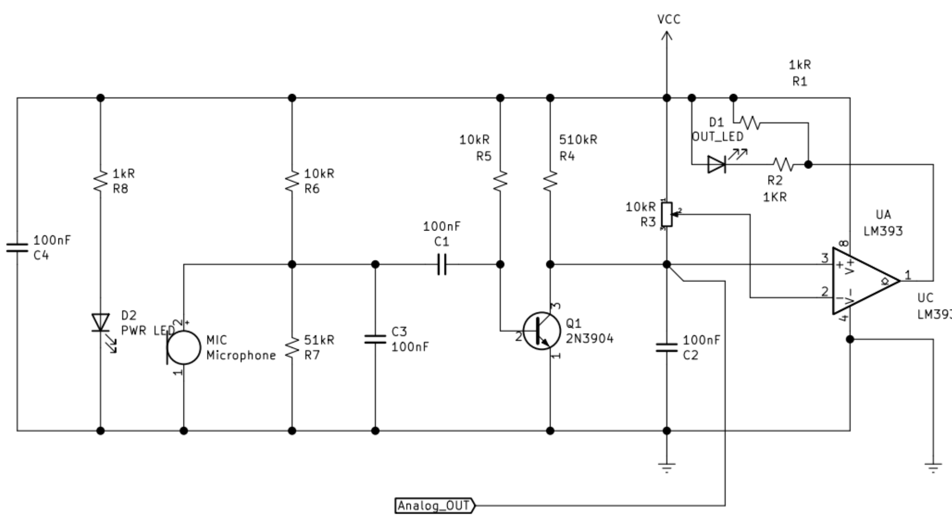
ATMEL ATmega328P				
	Min.	**Max.**		**Unit**
Operating Voltage	1.8	5.5		V
Temperature Range	-40°	85°		°C
Speed Grade @1.8-5.5V	0	4		MHz
Power Consumption at 1MHz, 1.8V, 25°C	*Active Mode*	*Power-down Mode*	*Power-save Mode*	
	0.2mA	0.1uA	0.75uA	
HC-SR501 PIR Motion Sensor Module				
Power consumption	65mA			
Sensing range	Less than 120°, within 7 meters			
TTL output	3.3V, 0V			
Trigger methods	L-disable repeat trigger, H enable repeat trigger			
Instructions: 1. Sensor module is powered up after a minute, in this initialization time intervals during this module will output 0-3 times, a minute later enters the standby state. 2. Should try to avoid the lights and other sources of interference close direct module surface of the lens, to avoid the introduction of interference signal malfunction; environment should avoid the wind flow, the wind will cause interference on the sensor. 3. The dual direction of sensor should be installed parallel as far as possible in in line with human movement. To increase the sensor angle range, the module using a circular lens also makes the probe surrounded induction, but the left and right sides still up and down in both directions sensing range, sensitivity, still need to try to install the above requirements.				
Sound Detection Module				
LM393 comparator with threshold preset				
Induction distance	0.5 meter			
Operating current	4-5mA			
Microphone Sensitivity (1kHz)	52-48 dB			
TDK PS1420P0CT Buzzer				
Sound Pressure	70dB(a)/10cm min. [at 4kHz, 3Vo-P rectangular waves, Measuring temperature: 25±5°C, humidity: 60±10%]			
Operating temperature range	-10° to +70° Celsius			
Storage conditions	+5° to +40° C, 20 to 70%RH, please use within 6 months			
Maximum input voltage	30Vo-P max. [without DC bias]			

Refer to respective datasheets for more information [1],[2],[3],[4],[5]

Master Schematic of the Project



Microphone module Schematic [12]



Description: The Sound detection sensor module is a LM393 Comparator IC implementation [1]. The LM393 IC is a low-power, low-offset voltage, dual comparator with operating voltage range of 2-36 V as a single supply. The output transistor can drive loads up to 50V and 50mA suitable for driving various loads. The 2N4401 transistor in the circuit amplifies the sound signal received via a microphone. The capacitor C1 100nF blocks external DC noise. Now, the amplified signal is fed to the LM393 voltage comparator IC.

PIR Sensor Module

Image 1.0: PIR sensor [6]

Future Design Ideas

In this project, we used a simple mechanical switch to detect the locking of the door. The working of this button is rather trivial, that is, when the button is unpressed by the act of opening the door, the stimulus is generated at the unpressed button which is used directly in digital format in the firmware plan.
In the version 2.0 of this Security system, we are planning to incorporate another sensory module detecting the opening and closing of the door. Further, another module named Fingerprint sensor R305 will be incorporated into the design exploiting UART protocol for added security.

Cost Estimate

Items	Quantity	Cost	Total Cost ($CAD)
ATMega328p	1	$4.08	$4.08
GDM1602K LCD	1	$12.56	$12.56
LM393 Microphone	1	$0.47	$0.47
HC-SR501 PIR	1	$2.79	$2.79
B3F-1000 Push Button	4	$0.95	$3.80
PS1440P02BT Piezo Buzzer	1	$1.00	$1.00
10kΩ Resistor	4	$0.19	$0.76
10kΩ Potentiometer	1	$2.22	$2.22
470Ω Resistor	1	$0.32	$0.32
10nF Capacitor	4	$0.65	$2.60
Total:			$30.60

[7], [8], [9], [10]

Flowchart Description

We start by initializing all the switches, the power LED, the buzzer using the DDR and the PORT statements. Then we initialize the LCD using user defined header and source code files from standard AVR-LibC I/O facilities[11]. The ADC is initialized by enabling bits, using the available registers. Then a mode is selected using switch 4(SW4). When set to the mode STAY, the system only checks whether the door is closed or not. Switch 5 (SW5) is responsible for checking this and if a door is open the switch returns 0, which means that there has been an intrusion detected by the system and now the user is supposed to enter the correct passcode in the allotted time interval. The system is designed to keep checking if the door is closed until there is a breach and this is achieved using a while loop which only leaves if the switch returns 1 (door open). A similar process happens in the AWAY mode as well, except we track movement inside the house using PIR Motion sensor and the microphone which are initialized using the analog to digital converter statements and the registers. If both the motion detector and the microphone are triggered, the system triggers the alarm. In the flowchart we use two variables, motion and sound, to record the feedback from the motion sensor and the microphone, respectively. Moreover, we use the internal clock as a Real Time Clock (RTC) and the user is allotted 30 seconds to input the code. This is managed using two if statements after the user inputs the code using the three switches (SW1, SW2, SW3).

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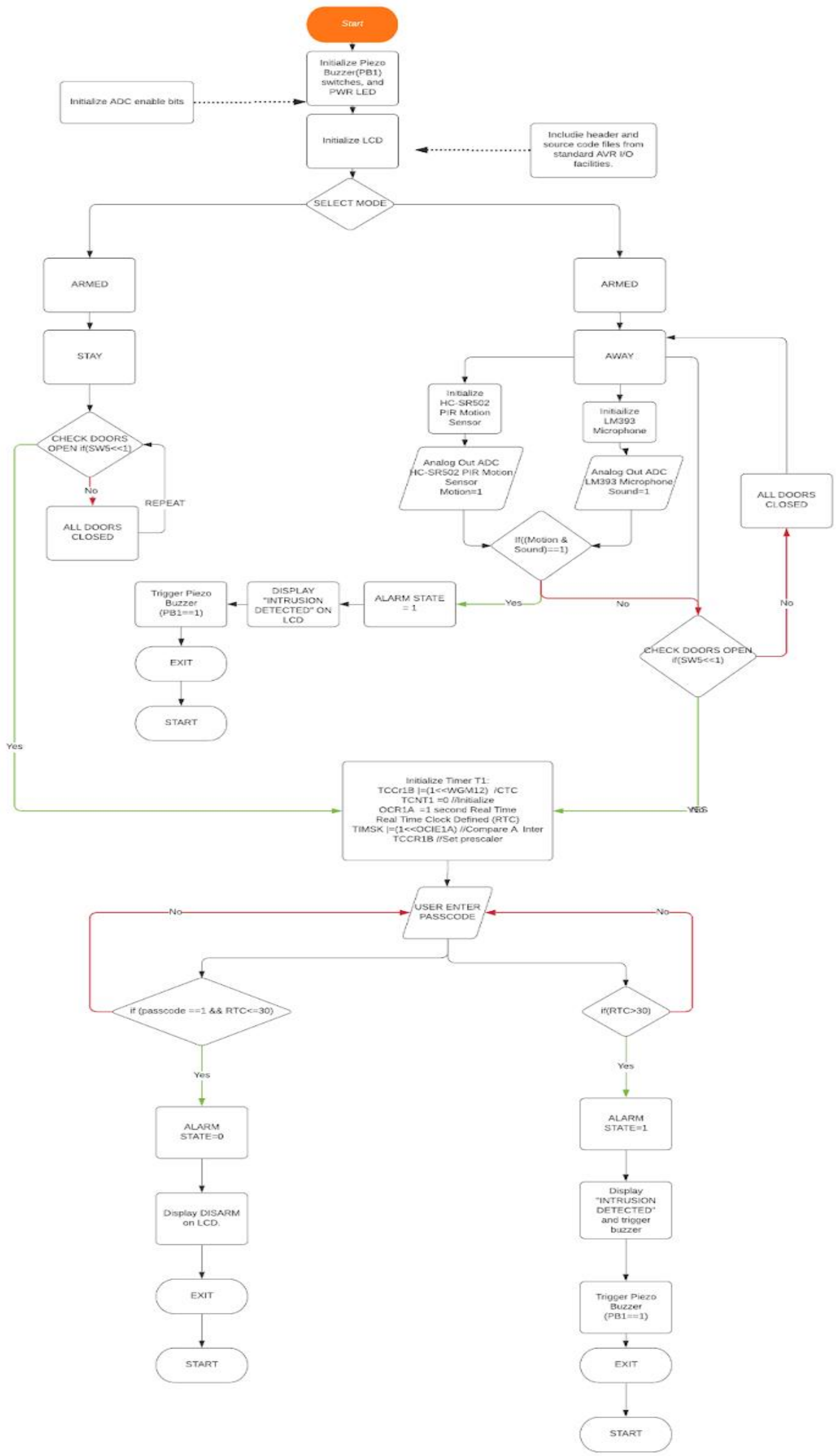
Cameron Moar | December 3, 2021



Test Plan

Follow the various tests outlined below to ensure the viability of the system. All states are in reference to the flowchart. Each test listed below should take no more than 10 minute to complete, assuming everything is functional.

1. Ensure the display properly matches the inputted state (e.g., STAY, AWAY,) and responses accordingly. Below are several subtests to verify the LCD display.
    a. Verify STAY is displayed when in the STAY state.
    b. Verify AWAY is displayed when in the AWAY mode.
    c. Verify the timer is displayed prior to the DISARM stage.
2. After the display is proven to be functional, test the STAY state. Follow the subtests below to verify the STAY state.

. Check that the DOOR OPEN condition triggers the 30 second timer prior to the CORRECT INPUT stage.

a. Ensure the DOOR CLOSED condition is continuously checked by testing at a delayed time. This is to ensure the loop is functional and it will continue to operate into the future.

3. After the display is proven to be functional, test the AWAY state. Follow the subtests below to verify the AWAY state.

. Ensure the photodiode is functional by checking it triggers the alarm when exposed to sufficient light.

a. Ensure the microphone is functional by checking it triggers the alarm when exposed to sufficient noise volume, exceeding 60 dB.

b. Trigger the OPEN-DOOR condition to verify it displays the prompt to DISARM.

4. After the AWAY and STAY states are verified, test the PASSWORD INPUT. Use the following subtests to verify the functionality of the key inputs.

. Verify the correct input disarms and resets the Alarm.

a. Verify TIMEOUT condition triggers the alarm.

b. Verify the incorrect password repeats the PASSWORD INPUT condition.

Development Sequence and Timeline

Task	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Planning - Researching						
Planning - Creating Flow Chart						
Planning - Gathering Materials						
Hardware Design and Specifications						
Develop Test Plan						
Hardware Implementation						
Program Development						
Prototype Finalization						
Testing						
Final Modifications						
Finalization and Product Deployment						

The first step in the development sequence is planning. This includes researching different ways the home alarm system idea can be implemented, as well as researching different parts that could be used to meet our specifications. After the research stage, creating a flowchart for the program is necessary to ensure that everything goes smoothly when writing code. Another important task in this stage is to gather all of the necessary parts needed and begin the hardware design. A test plan will be developed during this stage to keep the development process on track and ensure that the product will work as expected during each stage of building. After the designing and test planning, the hardware portion of the product will be constructed and shortly after, program development will begin. After the program development has concluded, a prototype will be finalized, and testing will occur directly after to ensure that the home alarm system operates as expected. During this testing, final adjustments may be needed so they will be implemented in this stage. After any final modifications have been made, the product will be finalized and launched.

Conclusion

The designed Home Alarm System uses a variety of systems to ensure security, at a low cost of $30.06. Using a LM393 Microphone, any sudden change in sound is detected. Any sound above 48 dB is detected by the system. Additionally, a HC-SR502 PIR Motion sensor can detect motion. These combined features ensure your home is secure and safe from intruders. Through the implementation of an ATmega328p, a LCD display, a microphone, a motion sensor, and other supporting components, a low budget and capable home security is developed. This system excels at preventing conventional methods of breaking and entering. Additionally, the simple interface and feedback systems allows for little confusion for the user. Some limitations of this system include difficulties changing the password, and the limited range in sensing range. In future versions, we would be taking these into account and maximize the potential of ATmega328p.

References

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