Deliverable F - Project Schedule and Cost

GNG 1103 - Engineering Design

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1.0 INTRODUCTION

This deliverable will introduce the first prototype for the final concept for a working system to prevent the death of children and pets who are locked in hot vehicles. This first prototype is being created to introduce the function of the main subsystems; the schematics and coding used. Prototyping tests and objectives will also be conducted, as well as, each groupmate providing feedback on ways our prototype can improve.

2.0 PROTOTYPE OBJECTIVES

This section outlines how we will build and test our prototype, what the prototype will do, what will be considered a successful test, and why we are prototyping and testing.

2. 1 Test Objectives – the 'why'

What are the specific test objectives?

The main objective of the prototype is to have the basic system functionality: detecting temperature, motion and pressure from the sensors and turning the fan on/off in response to the inputs. More specifically, using the Arduino to detect temperature to turn the fan on if the temperature is above a certain level and no movement or pressure was detected. For the Arduino, we want to design and develop the appropriate code and connections to produce the mentioned outcomes. For the App, we want to research how to send signals from a website to the Arduino to trigger actions or view live data.

What exactly is being learned or communicated with the prototype?

The prototype will focus on the functionality of the essential subsystems. This will enable us to understand the basic functionalities of the sensors being implemented, as well as, demonstrate to what extent the user interface will be able to interact with the Arduino.

What are the possible types of results?

There are three main possible outcomes: the first, full integration of the sensors with the Arduino, this means all of our sensors are able to work in unison with the Arduino board producing the appropriate output depending on the data being received from the sensors. The second possible outcome is a partial integration of the sensors and Arduino, this would mean that not all sensors were able to work together or were compatible with the Arduino. The third possible outcome is the complete incompatibility of the sensors and Arduino, the sensors were not able to connect to the board or did not produce the expected outcomes.

How will these results be used to make decisions or select concepts?

The findings from this deliverable will allow us to analyze which sensors and subsystems are of most importance and if they can be implemented in an effective way in future prototypes. The results will also reflect if improvements are needed allowing us to increase reliability or reduce costs. The feedback received will clarify expectations, let us learn from our mistakes and meet our client's needs more directly.

What are the criteria for test success or failure?

The criteria for success are based on the functionality of each individual subsystem and the integration between all subsystems. For the temperature sensor, we want to reliably measure the temperature from 20 to 40 °C and be able to see real-time fluctuations. A failure would be considered unreliable temperature measurements and the inability to quickly determine if the temperature has changed. The motion sensor will be considered a success if it has a sensitivity range greater than one meter, otherwise, it is a failure. The pressure sensor will be considered a success if it has a measurement range greater than eight pounds. The fan will be considered a success if it can be reliably turned on with the Arduino. The system will be considered a success if it can reliably detect temperature and use the sensors to trigger the fan to turn on/off. For the user interface a success will be considered if there is a way to trigger actions on the Arduino using a website.

2.2 What and How Aspects

Describe the prototype (e.g. focused or comprehensive) and the reason for the selection of this type of prototype.

The first prototype is simply an electronic circuit simulated on Tinkercad. We chose to make the first prototype in a virtual style for multiple reasons. The first of which is to verify that the system will function as desired theoretically. It almost acts as a proof of concept so that we know which sensors can function together without any unforeseen issues arising. Another reason is so that each member of the team can easily have access to it to perform different tests or try different configurations. The third reason for this is so that we can obtain a baseline to go off of when we start physically making the prototype. A virtual sandbox where you can experiment with different configurations and adjust things on the fly allows us to find the perfect configuration with little effort and time. The prototype consists of an Arduino UNO and a breadboard. Connected are a temperature sensor, a force/pressure sensor, a motion sensor and a small speaker. The code running the system first detects whether a child is present using the pressure sensor. After this, if the temperature is too high and the motion sensor detects motion, the system is activated, and the speaker sounds the alarm. For the final product, the speaker will be replaced with the notification system and turn on the fan. The reason why the prototype is

simply a circuit instead of something resembling a product is because the final design and size of the product is not important, therefore it was not important to include in the prototype. Also, it would be difficult to accurately accomplish this in Tinkercad.

Describe the testing process in enough detail to allow someone else to build and test the prototype instead of you.

The testing process was simply trying different combinations while the system is on to make sure that there are no special unforeseen conflicts or problems. For this prototype, the testing process was rather short because of time constraints, but because of the simplicity of the system, an adequate amount of testing was accomplished.

What information is being measured?

With the virtual simulation of the circuit, we can measure temperature, motion and pressure using the sensors connected to the board. It is very difficult to collect measurement data with a virtual prototype that will exactly represent how a real prototype will perform. In a simulation, everything is executed in a perfect environment. To obtain data, we would need to use a physical prototype. For example; the motion sensor in the virtual workspace may have a further reach than a real one. Once we have the physical prototype, we will measure how accurate the temperature sensor is and how far the motion sensor can detect.

What is being observed, and how is it being recorded?

While testing, there are a few things we are specifically going to be observing. First, making sure that everything works exactly as expected is crucial for the future of the product. Therefore, we used the serial monitor to observe all of the inputs from the sensors. Also, we will be observing how effective it is even at extremes such as very hot temperatures and very high or low loads on the pressure sensor.

What materials are required, and what is the approximate estimated cost?

Our prototype consisted of an Arduino UNO, a breadboard, a speaker, a temperature sensor, a pressure sensor and a motion sensor. Since the prototype was constructed online we did not require any materials other than the provided tinker cad software and we did not have any expenses.

What work (e.g. test software or construction or modeling work or research) needs to be done?

For this specific prototype, the only work required was creating a virtual simulation of what we envision our system to be, for the next prototype however we need to construct our physical system and run multiple tests to make sure our virtual design is applicable in the real world.

How long will the test take and what are the dependencies (i.e. what needs to happen before the testing can occur)?

The testing for our first prototype should take no longer than a day, as it is a virtual prototype, our physical prototype should take about two days to fully test and only depends on the building process and receiving our parts.

When are the results required (i.e. what depends on the results of this test in the project plan)?

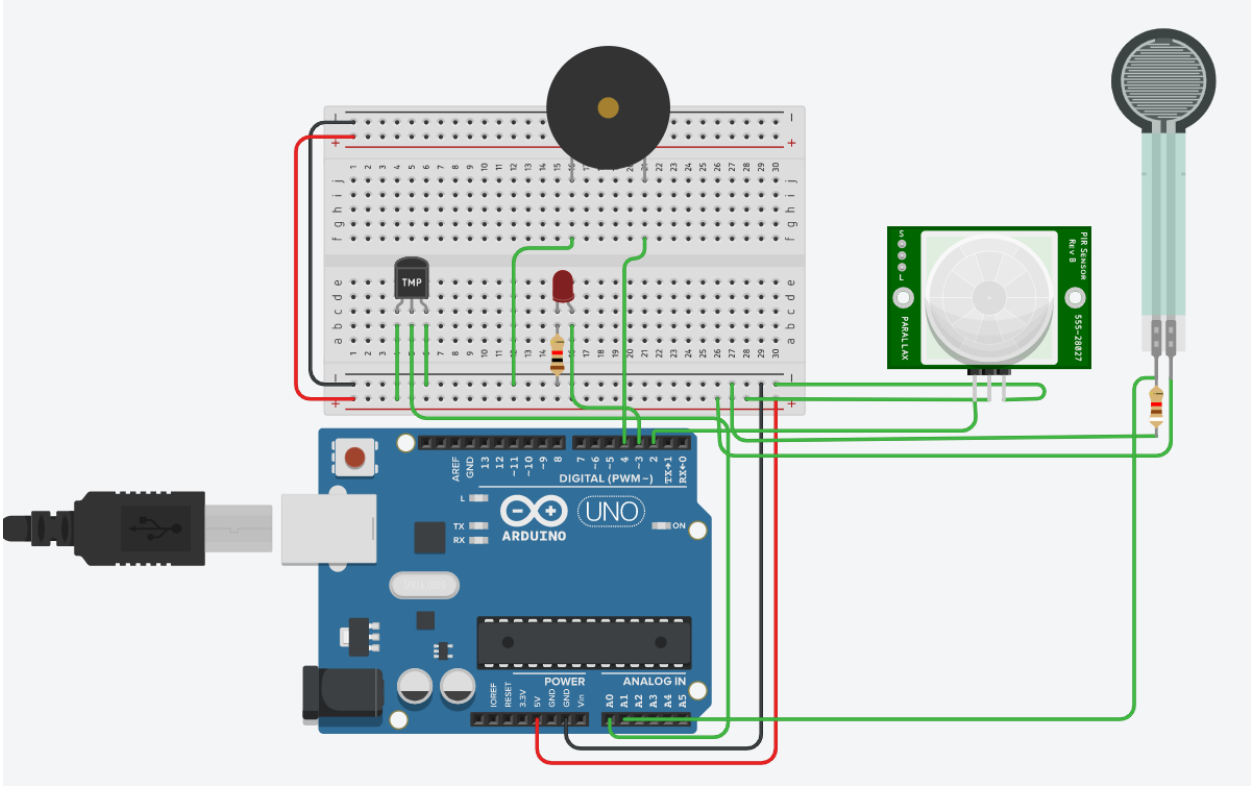
The results are required by November 4th, when this is submitted. The development of future prototypes depends on the results of these tests, as this is a test of our theory before we construct a physical model based on our design.

4.0 PROTOTYPE INFORMATION

The first prototype was developed and tested using TinkerCAD, an online 3D modeling program. The prototype developed works with the sensors and components we intend to use in our physical prototype, these are the Arduino Uno, PIR sensor, temperature sensor, piezo speaker, and resistors.

The prototype allows us to test the interaction between all our sensors and components. In this design when the temperature detected is above 28 °C, the motion sensor is HIGH, and the force on the pressure sensor is greater than 3.5 N the red LED turns on. The LED is mimicking the on/off signal that the fan will use. If the temperature detected is above 35 °C and the sensors are active the alarm will turn on.

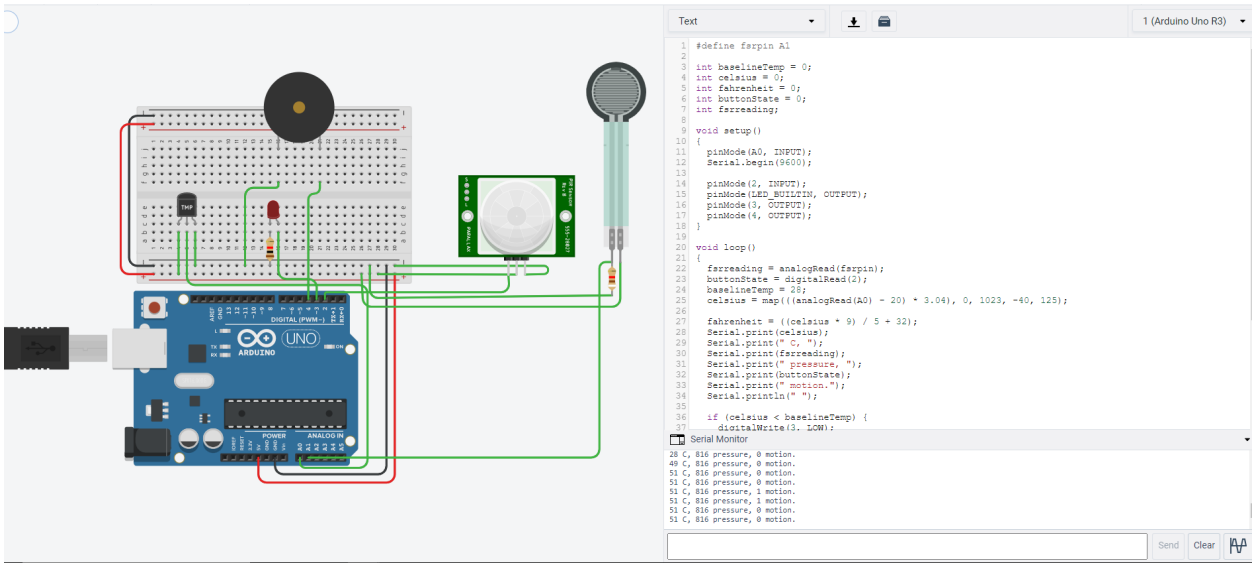
Prototype Design



Prototype Materials

Name	Quantity	Component
U1	1	Arduino Uno R3
PIR1	1	7.799499408818065 , -177.05883609613676 , -176.9723783945194 PIR Sensor
U2	1	Temperature Sensor [TMP36]
PIEZO1	1	Piezo
D1	1	Red LED
R2	1	1 kΩ Resistor
R4	1	Force Sensor
R5	1	9.1 kΩ Resistor

Prototype Schematics, Code, and Serial Monitor



Tinkercad File: https://bit.ly/3GOS5iF

4.1 SCHEDULE

Subsystem	How Results will be used or Recorded	Estimated Time
Research	The research will be used to determine the criteria of the design, the schematics, and the materials needed.	Oct 26 - Oct 30
Objectives (How and Why Questions)	Help plan out the remainder of the deliverables and the final prototype. Also will help figure out what will and won't work.	Oct 30 - Nov 1
Schematics	See if the prototype design can be compatible with vehicles and help give a visual description of our design to the client.	Nov 1-2
Code	Testing to see if the heat sensors can detect if the temperature is above 28℃. Will the alarm turn on and off? Can sensors detect if a child or pet is in a hot vehicle?	Nov 1-2
Testing	We will make a prototype using TinkerCad, which will later be used in our final prototype. See if all the coding works (see row above).	Nov 3-4

4.2 TESTING

Test	Result	Was the result expected?	Significance
Alarm shuts off when temperature returns to safe	Once the alarm is triggered, it will shut off when the temperature sensor detects a safe temperature.	yes	The concept works as expected
Extreme hot temperature	At very high temperatures, the system operates normally. The alarm system is active until the temperature returns to safety.	yes	The product will function even when exposed to high temperatures
Very little load applied to sensor	When the system detects little or no pressure applied to the sensor, the system does not activate, even when the motion sensor detects motion.	yes	Even if the motion sensor detects motion, the system will not activate. For the case of a child able to walk or crawl, this could potentially cause a problem when they leave the seat.
Remove load from sensor while alarm is active	The alarm continues to go off even when the pressure is taken off the sensor.	no	Even though it was not expected, this is a good feature to have so that even when a child leaves the seat, the alarm will continue.
Alarm can re-initiate repeatedly	Even after the alarm shuts off, the alarm can be reactivated again and again.	yes	The system will continue to work even after it's been shut off once.

4.3 ANALYSIS

From the above testing results, it can be concluded that prototype one behaves mostly as expected. The alarm shuts off when the temperature is in the normal range and is activated during very high temperatures, as expected. Moreover, test results prove that the alarm can re-initiate repeatedly and continues to blare, even when there is no pressure on the sensor. Hence, the prototype is expected to work at all times, even during circumstances when the child happens to leave the seat. However, when the sensor detects a very small load, the system does not

activate despite motion being detected. Hence our team will try to work on this issue such that it does not impact our future prototypes.

5.0 FEEDBACK

Steven's Feedback:
Developing the prototype using Tinkercad allowed us to test our subsystems and our code in a reliable environment that could be easily changed. We were able to confirm the feasibility of the project using Arduino compatible devices.

Kaitlynn's Feedback:
Thus far, our tests for our prototype are working well and the group is on schedule for our next prototype. Although for future prototypes, possibly get more outside opinions on the product itself to be less biased.

Kobe's Feedback:
The virtual prototype we used for some preliminary testing was very useful. It allowed us to build and test the circuit quickly and easily to give us a good idea as to how our next prototype would work.

Hans' Feedback:
The prototype does its job properly for the most part and the unexpected result which was obtained is still a good feature.

Ben's Feedback:
The prototype does what it is supposed to do, small bugs but nothing that can't be worked out in future models.

6.0 CONCLUSION

In this deliverable, Prototype I was developed on TinkerCad and tests were performed on the design to assess its performance and ensure that it is in accordance with the client's expectations. From the above test results, it can be concluded that prototype 1 performs as expected and the team can now proceed with prototype 2. All the feedback on prototype 1 will be considered when developing future prototypes. Prototype 1 paves the way for design improvements of future prototypes and hence gives an idea if we are on the right track.

References

Questions and Prompts obtained from BINZ Recycling Deliverable F
https://makerepo.com/tkhan005/857.gng1103-c13-binz-recycling