S.H.I.N.E 2.0

(Saving Humans In Need Everywhere 2.0)

"We Make Your Future S.H.I.N.E.

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PUBLISHED: FEBRUARY 14, 2020

Problem Statement

When disaster strikes, people panic, which can cause them to not know what to do. This can result in many of them getting hurt or even dying in the event of a natural disaster, such as earthquakes. These disasters often make rescuing people difficult for rescuers, so they often rely on robots. The problem is that many of these high tech robots are expensive and lack certain tools. Our product is a way to help organizations, our disaster relief programs can help rescue lives while being inexpensive yet multifunctional. Our robot has to have a wide range of uses and be sturdy enough to endure any terrain while being at a low cost.

The Client

Disaster relief organizations rely on rescue robots to perform dangerous rescue operations. In the past, people would go and try to rescue others which would often result in casualties and put them in dangerous circumstances. That's why now in the modern world they use rescue robots. These rescue robots can cost around $10,000+ and because plenty of robots can be destroyed the cost to the client can be enormous. That's why our product would need to be an inexpensive alternative to our client while being versatile in many different situations and reliable as any error can cause loss of human life. It would have to be able to detect humans, send messages to the client, and be wirelessly controlled.

Client Research

Every year, over 100,000,000 people are affected by natural disasters. The reason why is because the people who try to help out can be the one getting hurt while getting to the other person. Another reason is that the oxygen that they are breathing can be contaminated with all the cement and other materials that the building has. Which can be bad for a person to be breathing. According to Search and Rescue Robots - Current Application on Land, Sea, and Air,

“In the past decade, the number of people killed by natural disasters each year has ranged from as low as 14,389 in 2015 to as high as 314,503 in 2010, according to the International Federation of Red Cross and Red Crescent Societies.” These statistics given in the article show how many are affected by natural disasters every year. What exactly can help people from being killed or save them during a natural disaster? A search and rescue robot is exactly what we need today, search and rescue robots form a great part of our society today during natural disasters it helps search and rescue organizations. Nowadays robots are high-priced and insufficient, our robot is not high-priced and very sufficient.

The same article also said that, “At the moment robots aren’t nearly as nimble as humans when it comes to traversing uneven and unpredictable ground” even though the robots are not as agile as humans to move through places as people would be but sending the robots is a better option than sending a human. Many people would consider sending a robot to take their job or that maybe we don't think they are capable of doing their job but sending a robot is less risky than sending them first. The point of the robot being sent first to any natural disaster is that when it's time for the first responders to go in they know exactly what is in their way.

On land, one major advantage robots currently bring to the table is their size. Small robots can be built to fit into places humans can’t. Robots can travel through small tunnels underground, pass through small gaps, or fit into tiny pockets of air beneath fallen buildings.

Criteria

- It needs to be extremely cheaper than the search and rescue robots that are already available.
- It needs to be able to detect humans and notify the global organization if a human has been found.

- It needs to be able to detect dangerous gases and be able to notify people nearby of it so that they can stay away from the area if they have the opportunity to do so.
- They need to be able to control the robot wirelessly.
- The robot should have a camera of some sort to see what the car is seeing.
- It needs to be able to fit inside holes and gaps that are too small for people to go into.

The Product

What we, as a team, initially decided to build to help our client was a cheap and multifunctional robotic vehicle. Our robot would be an on-land robot instead of aerial. We would include a smoke sensor to detect the air quality and either a PIR sensor or microwave sensors to locate humans. We would decide upon a Bluetooth module, or GSM module to send the readings of the PIR sensor to the client. We were also planning on including a buzzer to notify people if dangerous gases are nearby. Not to mention, our robot will be no bigger than 1 ft x 1 ft x 1 ft so that it can fit in some holes that are too small for the organizations to go into. If we make the robot very small, we would be more limited in the number of things that the robot can do.

Design Process

Initially, we went online to look at search and rescue robots that were already made before. Based on the criteria that the client provided us, and the research we did regarding what the search and rescue robots have in them, we brainstormed two ideas. Both ideas were cheap and multifunction robots that would solve the client's needs.

Idea 1: Our first idea was a robot made with cardboard as its base and 4 TT with lightweight rubber wheels. It would have an RCWL-0516 microwave sensor to detect humans that are lost and/or trapped, and an MQ-7 carbon monoxide sensor to detect carbon monoxide that is in the area. A piezo buzzer would be included as well to make a sound to alert people nearby of the

carbon monoxide that is in the air. That way, the people, if they have the opportunity to do so, can stay away from the area. It would have an HC-06 Bluetooth module to be able to control the robot and an Arducam-2MP-Plus to know where the robot is going in real-time. You would use a mobile phone or a laptop to stream what the robot is seeing using the camera's IP address (which you would type into Google). Also, a GSM module would be used to send data in case the PIR sensors picked up any human movement. All of this would be powered with 2 9V batteries and 1 Arduino Uno. The schematic of this is found in the appendix.

Idea 2: The alternative was a simpler and rudimentary design. Instead of cardboard, we would have a pre-made acrylic base. It would still have 4 TT motors and lightweight rubber wheels, which would be controlled through Bluetooth with an HC-06 Bluetooth module. The motors, as well as the Bluetooth module for the wheels, would be powered with its own Arduino Uno, and 2 9V batteries. The global organizations can use their phone and install Arduino Bluetooth Control to control the robot through Bluetooth. It would have a PIR sensor, a green LED, and an HC-05 Bluetooth module to detect if a human has been located. If it has been located, the green LED will light up, and the reading will be sent onto the global organization's laptop or PC (if they have Arduino IDE installed) through Bluetooth. Instead of a camera, it would have a smartphone that would be on the robot. Global organizations can use their phone to receive a video call from the robot. The main difference with this idea is that this prototype would contain a red LED and a piezo buzzer to alert the lost or trapped person, if it was still conscious, about possible gases and/or smoke that is dangerous. All of the other sensors that were not connected to the other Arduino Uno will be connected to another Arduino Uno with 1 9V battery. A schematic of this is found in the appendix.

We decided to choose idea 2 for the initial prototype. The reasons why we went with that idea are as follows:

- It covers the criteria that the client gave us
- The PIR sensor is cheaper than microwave sensor
- How we will be video streaming is cheaper than the one from idea 1.
- It includes a more durable base since acrylic is stronger than cardboard.
- The MQ-2 can detect more dangerous gases, as well as smoke, than the MQ-7 which only detects carbon monoxide.
- It includes both a buzzer and LED to notify people about any harmful gases nearby so that people can stay away from the area if they have a chance.
- It includes an HC-05, which is cheaper than the GSM module, which notifies the global organizations of the readings from the PIR sensor so they can know if a human has been found in those locations.

Create

The main goal of S.H.I.N.E. 1.0 is to detect people that are trapped and/or hurt in places that are too dangerous or too small for the organizations to go into. These include places like collapsed buildings, small tunnels, etc. It also needs to have a sensor to detect any natural gasses, such as methane, propane, hydrogen, and carbon monoxide that is found in the air. Most importantly, there has to be a way for organizations to be able to see where the robot is going in real-time. The prototype we ended up creating is manually controlled. It uses 4 TT motors, each with a lightweight plastic rubber tire. You control through Bluetooth, with the help of an HC-06 Bluetooth module, and an app called Arduino Bluetooth Control, which is an app with a remote to control the car. It also includes an MQ-2 sensor that detects smoke and/or harmful gasses in

the atmosphere. If harmful gas or smoke is detected, a red LED lights up and a piezo buzzer makes a sound indicating that people nearby should stay away from that area if they have the opportunity to do so. The robot also includes a PIR sensor that detects human movement. If the sensor detects any human activity in the area that they are investigating, a green LED will light up indicating that they have been found and that they should not move, and the readings of the sensor will be sent wirelessly, through Bluetooth, to the Arduino serial monitor. This is so that global organizations can know that a human is in that area and that they should rescue them. Lastly, we included a free government phone to video call. This is the method that we used to be able to see what the robot is seeing in real-time.

The Arduino is essential to the prototype functionality. It allows us to be able to program how we want the car to move. It gives us a variety of ways to make the motors move. We chose to make it be controlled through Bluetooth with an Android phone that has Android Remote Controller installed. With the Arduino, we were also able to adjust the sensitivity of the PIR sensor to make it be triggered by certain movements. We adjusted it to make it sensitive to human movements. The Arduino allows us to simultaneously turn on an LED when a human has been found. We were also able to make the piezo buzzer have a variety of sounds. There is an infinite amount of sounds to choose from in the Arduino library. For our project, we wanted to make it sound like a fire notifier, so we used tones 800 and 600. Not to mention, it also allowed us to simultaneously turn on the LED, and make a sound with the buzzer when the smoke and dangerous gases have been found. The smoke sensor, when used with Arduino, allowed us to put a sensitivity onto the sensor so that it can be triggered by certain types of smoke. We wanted it to detect harmful gases, such as methane and propane, so we initially set the sensitivity to 300. Lastly, the Arduino allowed us to use an HC-05 Bluetooth module to send the PIR sensor readings, of whether a

human had been found or not, wirelessly through Bluetooth. The laptop or PC that the organizations will use, which has Arduino IDE installed, will receive those readings which the organizations can see.

One of the main failures of our robot is that the Arduino, that was in charge of all the sensors, did not operate successfully. It only focused on the detection of humans, rather than detecting humans and detecting harmful gases and smoke. Whenever the Arduino tried to focus on both sensors simultaneously, the readings would get mixed up. We did further research and according to a post on Stack Exchange, “To use multiple loops at the same time you need an Arduino Due Board.” That is when we figured out that we cannot include multiple void loops in our code since it could only focus on 1 void loop. To fix this issue, we had to use 3 Arduino Uno boards. One Arduino board focused on the motors, the second Arduino board focused on the PIR sensor, and the last Arduino Uno focused on the MQ-2 sensor. It was vital for us to do this to do our tests. The modifications for the final design will include the 3 Arduino Unos. Another failure was that the PIR sensor did not successfully detect humans both in the back and front of the car. It was only able to detect humans, at a very good range, from the front of the car.

Assessment of the Product

When we completed our prototype we conducted several tests to see the effectiveness of our robot. We tested the gas sensors, the durability of the robot, and PIR sensitivity. According to “How MQ2 Gas/Smoke Sensor Works? And Interface it with Arduino,” the gas sensor “...can detect LPG, Smoke, Alcohol, Propane, Hydrogen, Methane and Carbon Monoxide concentrations anywhere from 200 to 10000ppm.” With this information, we assessed the distance needed to set off the PIR sensor, as seen in the appendix. We increased the sensitivity to 300 to make sure we can detect lower amounts of toxic gas. We also tested how hard it would be

to destroy the robot's chassis when we conducted this experiment. It was made of a weak material that broke easily. After we tested we realized it wasn't strong enough for its purpose so we replaced the chassis material with a harder acrylic (¼" thick). We also tested the PIR sensor, a digital sensor, seeing its range which we estimated to be around 9 meters after we did 10 trials as seen in the appendix. A variety of other tests were conducted to make sure that our search and rescue robot will be as effective as possible. They are found in the appendix.

Math and Science Concepts

Weight Distribution-

The use of tracks and wheels is different and both can be beneficial. For example in the article "Weight Distribution Transfer," they mentioned that "The amount of weight that is supported by each tire can and does change when we physically adjust the heights of the springs and as the car travels around the racetrack." This made us notice other options which were tracks for the car. We learned that the tracks were a better option because they can easily move around in dangerous terrain. Real-Life use of this is found in the military as they have tanks that use tracks that have helped because they can move around over rough terrain.

Entropy-

Entropy is the measured amount of energy released from gases that spreads energy. This is used on the smoke sensor used on the robot to detect bad gases. When the area of the smoke is bigger the PPM (Parts per million) near the smoke sensor decreases. The sensor would be less likely to activate so we needed to increase the sensitivity. This concept was the main reason we made the sensor more sensitive.

Modifications and Improvements (Final Design):

- Include 3 Arduino Unos. One will be for the motors, the other will be for the PIR sensor, and the last one will be for the MQ-2 sensor. This will allow the Arduino sensors and motors to run smoothly without any issues.
- Include thicker acrylic (¼" thick) to protect the components from getting damaged. The acrylic should enclose the project to protect it from falling items
- Include a louder piezo buzzer so that people from far can hear the alarm for when dangerous smoke or gas has been detected.
- Include a PIR sensor in the back so that if a robot passes by the human and it isn't seeing the person with the front PIR sensor, the back one can cover it. Also, more land will be covered if we do so.
- Include VEX 393 motors, since they are stronger than the TT motors.
- Include VEX sprockets and tread links to give the car a tank-like, while giving it better mobility. It will be able to run smoother on more dangerous and rough terrains.
- Include 1 more LED of each color. 1 green LED and 1 red LED will be in the front of the car and 1 green LED and 1 red LED will be in the back so that people can have a better chance of seeing the signs if they did not see them from the front or back of the car.
- Include rechargeable batteries for the Arduino in charge of the motors because the batteries die in less than 20 minutes. The other Arduino have regular batteries that can last for a few days before dying completely.

Final Design:

Our final design fixes all of the issues that we had prior. It includes an enclosed acrylic base to protect the Arduino compartments. The set-up is still the same as the initial prototype, except that we have an Arduino board for each main sensor (PIR, MQ-2, and motors) to allow for the

sensor to function accordingly. Each sensor also has its code pertaining to its role. There is a PIR sensor in the front and back to detect humans from both sides, a louder buzzer so that the people can hear the buzzer from far, and 1 LED of each kind on both the front and back of the car to allow people to see the symbolistic colors very easily. We also added VEX motors and tread links to provide the car a tank-like look and to provide better mobility for more rough terrains. Not to mention, we have also improved upon the battery that the motors use. There are rechargeable batteries to power the motors and the Arduino board that controls the motors. This helps the organizations in a way that they don't have to spend a lot of money on batteries (since they initially died in a few minutes). The other Arduino doesn't waste its battery that fast (it lasts a few days before dying). The free phone is still being used as the camera for the robot, and the car is still controlled through bluetooth. The cost of the robot was inexpensive (costing only $190.69). Therefore, this search and rescue robot is a viable solution for our client.

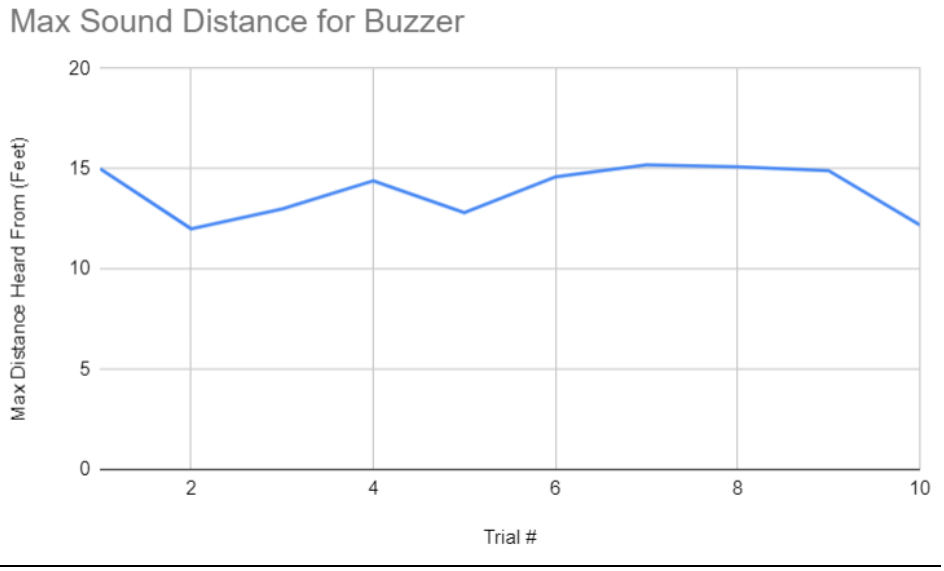
Appendices

Gas Sensor Test

We lowered the sensitivity to 100 to detect smoke from an incense stick. We did our tests based on that

Distance from sensor (Inches)	Did it Activate?
12	**No**
10	**No**
8	**Yes**
6	**Yes**

Buzzer Test



We tested the buzzer to see what is the max distance in which the buzzer can be heard from in feet. The distance was not very far, so we added a louder buzzer to our final design.

9V Battery Test (TT Motors)

Time (Minutes)	**Battery Status**
1	Good (Powering Motors)
2	Good (Powering Motors)
3	Good (Powering Motors)
4	Good (Powering Motors)
5	Good (Powering Motors)
6	Good (Powering Motors)
7	Good (Powering Motors)
8	Good (Powering Motors)
9	Good (Powering Motors)
10	Good (Powering Motors)
11	Bad (Not Powering Motors)

The test here tells us that the 9V battery (which powered the motors) only lasted 10 full minutes before dying. It was not a good battery choice because the organizations would have to spend more on buying replacement batteries.

9V Battery Test (Sensors)

Time (Hours)	**Battery Status**
1	Good (Powering Motors)
6	Good (Powering Motors)
12	Good (Powering Motors)
18	Good (Powering Motors)
24	Good (Powering Motors)
30	Good (Powering Motors)
36	Good (Powering Motors)
42	Good (Powering Motors)
48	Good (Powering Motors)
54	Good (Powering Motors)
60	Bad (Not Powering Motors)

The test here tells us that the 9V battery (which powered the sensors) only lasted 60 full hours before dying. It was a good solution for the client because it powered the sensors a long amount of time before dying.

Durability Test (Acrylic)

What did we drop: 5 pound metal scrap

Drop height: 10 feet

Results-

Initial D 

Final Design Acrylic Piece:

The final design acrylic piece was more durable than the initial design acrylic piece. They only made a very small crack, unlike the initial design which shattered into pieces. The final design will do a good job protecting the Arduino components.

PIR Range Test

The x-axis is the trial number and the y-axis is the range at which it is activated in feet.

The PIR sensor covered a good amount of area for detecting humans. The only issue, though, is that it does not detect people from the back. That is why we put a PIR sensor in the back for the final design.

Ground Terrain Test (TT Motors and Wheels)

Type of Terrain Being Covered	**Did It Successfully Function In That Terrain?**
Rock Terrain	No
Hills	No
Flat Surface	Yes

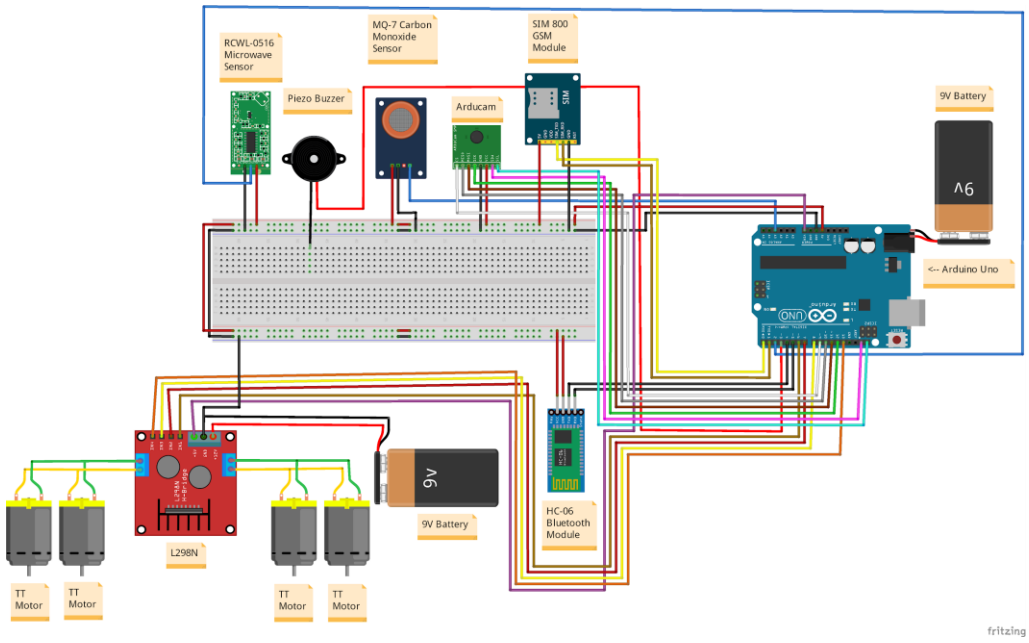
The TT motors and wheels are not a good choice for the car because it barely covers any terrains that the organizations will experience. The only terrain that it covered was a flat cement surface.

Ground Terrain Test (Vex Motors and Tread Links)

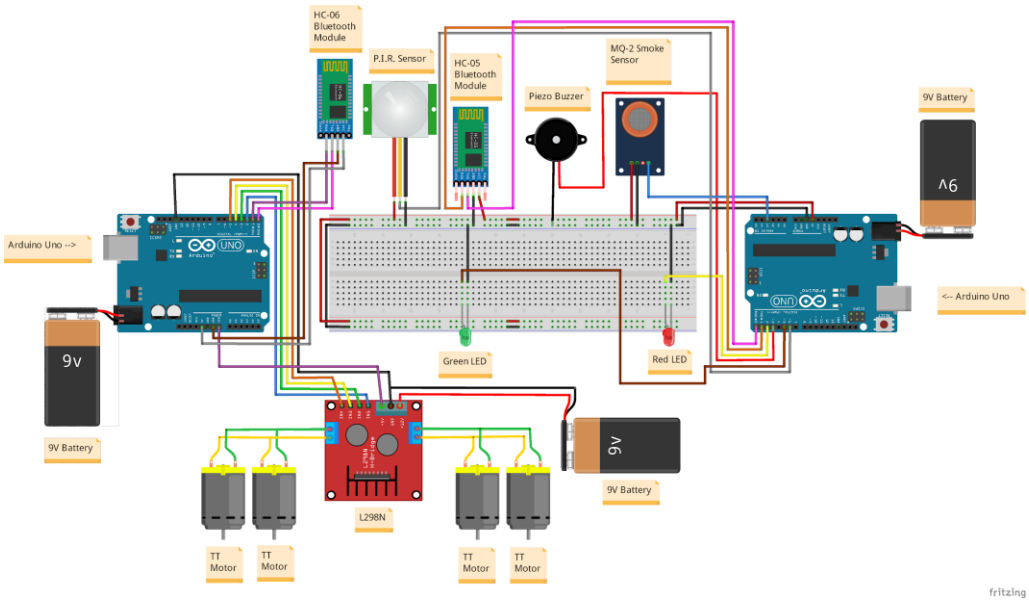
Type of Terrain Being Covered	**Did It Successfully Function In That Terrain?**
Rock Terrain	Yes
Hills	Yes
Flat Surface	Yes

The VEX motors with the tread links covered every terrain that we tested. It is a better solution for the client. It will be more useful for the client if it can cover more terrains, unlike the TT motors which only covered the flat surface terrain.

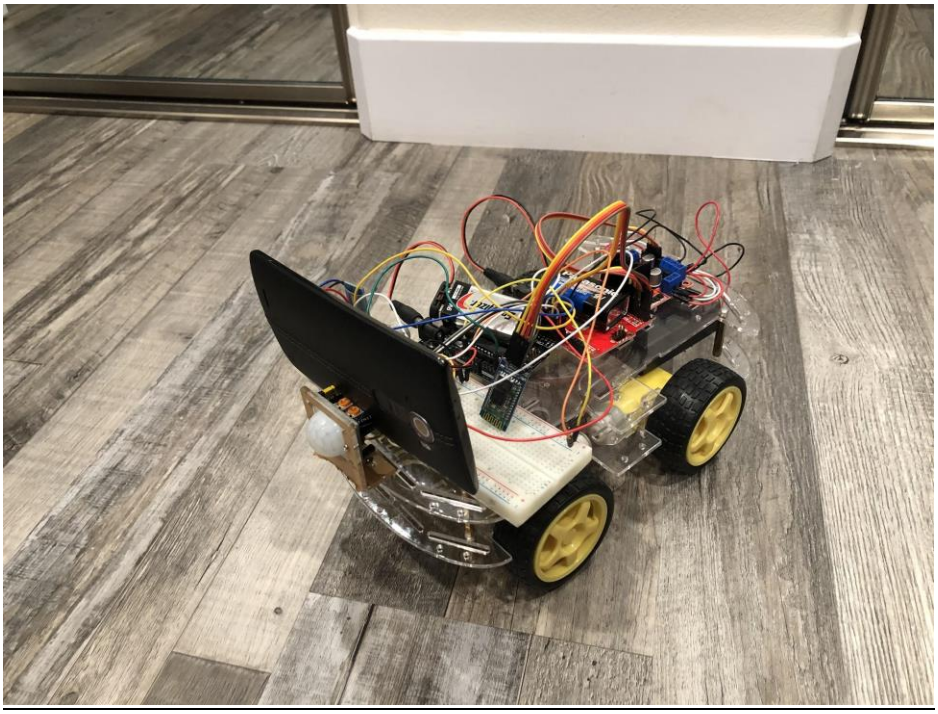
Idea 1 Sketch:

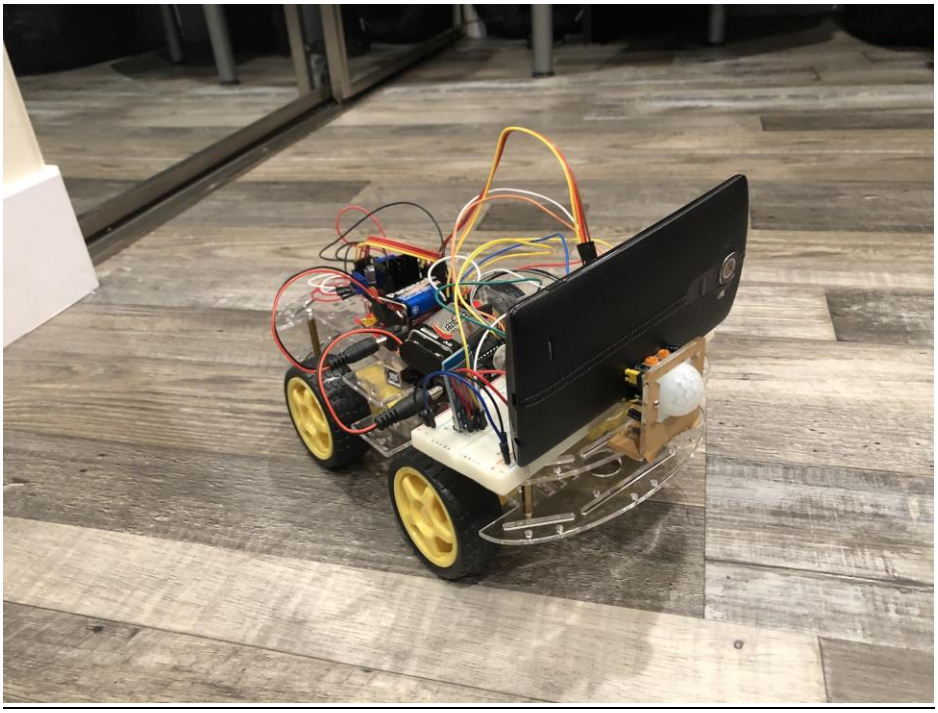


Idea 2 Sketch:



Initial Prototype Picture:





Prototype Code-

Code 1- Wheels with Bluetooth Module:

```
char t; // The HC-06 will store a character value

void setup() {
  pinMode(2, OUTPUT);  // Left motors forward (Pin 2) is output
  pinMode(3, OUTPUT);  // Left motors reverse (Pin 3) is output
  pinMode(4, OUTPUT);  // Right motors forward (Pin 4) is output
  pinMode(5, OUTPUT);  // Right motors reverse (Pin 5) is output

  Serial.begin(9600); // Get the Arduino ready to communicate with the serial monitor
  // At a rate of 9600 bits per seconds

}

void loop() {
  if (Serial.available()) { // If serial monitor readings are available regarding the motors
    t = Serial.read(); // The HC-06 will read the readings
    Serial.println(t); // The Hc-06 will print the readings on the Arduino Bluetooth Control
  }

  if (t == '1') { // Move forward (all motors rotate in forward direction)
    digitalWrite(2, HIGH); // Left motor will be going forward
```

```
    digitalWrite(3, LOW); // Left motors will not go reverse
    digitalWrite(4, HIGH); // Right motors will be going forward
    digitalWrite(5, LOW); // Right motors will not go reverse
  }

  else if (t == '2') { // Move reverse (all motors rotate in reverse direction)
    digitalWrite(2, LOW); // Left motors will not be going forward
    digitalWrite(3, HIGH); // Left motors will be going reverse
    digitalWrite(4, LOW); // Right motors will not be going forward
    digitalWrite(5, HIGH); // Right motors will be going reverse
  }

  else if (t == '3') { // Turn right (left side motors rotate in forward direction, right side motors doesn't rotate)
    digitalWrite(2, LOW); // Left motors will not be going forward
    digitalWrite(3, LOW); // Left motors will not be going reverse
    digitalWrite(4, HIGH); // Right motors will be going forward
    digitalWrite(5, LOW); // Right motors will not be going reverse
  }

  else if (t == '4') { // Turn left (right side motors rotate in forward direction, left side motors doesn't rotate)
    digitalWrite(2, HIGH); // Left motors will be going forward
```

```
    digitalWrite(3, LOW); // Left motors will not be going reverse
    digitalWrite(4, LOW); // Right motors will not be going forward
    digitalWrite(5, LOW); // Right motors will not be going reverse
  }

  else if (t == '5') { // Stop (all motors stop)
    digitalWrite(2, LOW); // Left motors will not be going forward
    digitalWrite(3, LOW); // Left motors will not be going reverse
    digitalWrite(4, LOW); // Right motors will not be going forward
    digitalWrite(5, LOW); // Right motors will not be going reverse
  }
  delay(100); // Wait 0.1 seconds before repeating the code from void loop again
}
```

Code 2- Sensors:

```
#include <SoftwareSerial.h> // Library used for serial communication with a digital pin other
than that of the serial port
SoftwareSerial mySerial(0, 1); // RX, TX pins for HC-05 module


//PIR Sensor
long unsigned int lowIn1; //the time when the sensor outputs a low impulse
```

```
long unsigned int pause = 5000; //the amount of milliseconds the sensor has to be low before we
                        // Assume all motion has stopped

int pirPin1 = 6; // The digital pin connected to the PIR sensor 1's output

boolean lockLow1 = true;
boolean takeLowTime1;

int greenLed = 5; // The digital pin connected to the green LED

//Smoke Sensor
int redLed = 2; // The digital pin connected to the red LED
int buzzer = 3; // The digital pin connected to the buzzer
int smokeA0 = A3; // The analog pin connected to the MQ-2 sensor
int sensorThres = 200; // The minimum value that the MQ-2 sensor needs to detect smoke and/or
harmful gases

void setup() {
  pinMode(redLed, OUTPUT); // Set the red LED as output
  pinMode(greenLed, OUTPUT); // Set the green LED as output
  pinMode(buzzer, OUTPUT); // Set the buzzer as output
  pinMode(smokeA0, INPUT); // Set the MQ-2 sensor as input
```

```
  // put your setup code here, to run once:
  mySerial.begin(9600); //Send the MQ-2 readings to the HC-05 serial monitor found on the
Arduino IDE
  pinMode(pirPin1, INPUT); // Set the PIR sensor as input
}
void loop() {
  if (digitalRead(pirPin1) == HIGH) { // If the readings of the PIR sensor is high
    if (lockLow1) {
      lockLow1 = false; // Human motion was detected
      mySerial.println("Living Thing Found! (PIR 1)"); // The HC-05 serial monitor will print
                                          // Out that a human was found by the PIR sensor
      digitalWrite(greenLed, HIGH); // The green LED will turn on

      delay(1000); // Wait 0.2 seconds before moving on to the next line of code
    }
    takeLowTime1 = true; // Make sure this is only done at the start of a HIGH phase
  }

  if (digitalRead(pirPin1) == LOW) {

    if (takeLowTime1) {
      lowIn1 = millis(); // Save the time of the transition from high to LOW
      takeLowTime1 = false; // Make sure this is only done at the start of a LOW phase
```

```
  }
  if (!lockLow1 && millis() - lowIn1 > pause) { // If the sensor is low for more than the given
pause
    lockLow1 = true; // Assume that no more motion is going to happen

    mySerial.println("Living Thing Lost (PIR 1)"); // The HC-05 serial monitor will print
                                    // Out that a human was lost according to the PIR sensor
    digitalWrite(greenLed, LOW);

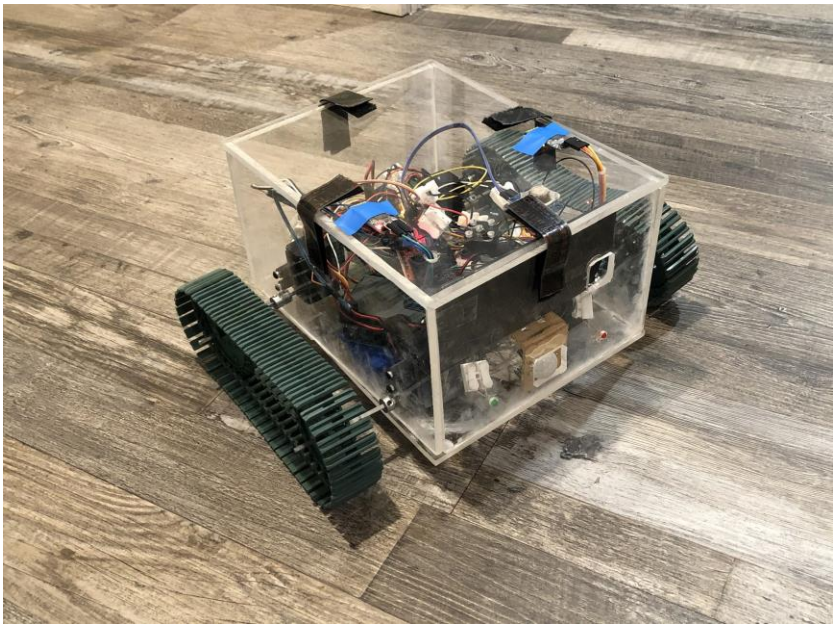
    delay(1000); // Wait 0.2 seconds before moving on to the next line of code
  }
  void smoke();
  int analogSensor = analogRead(smokeA0);

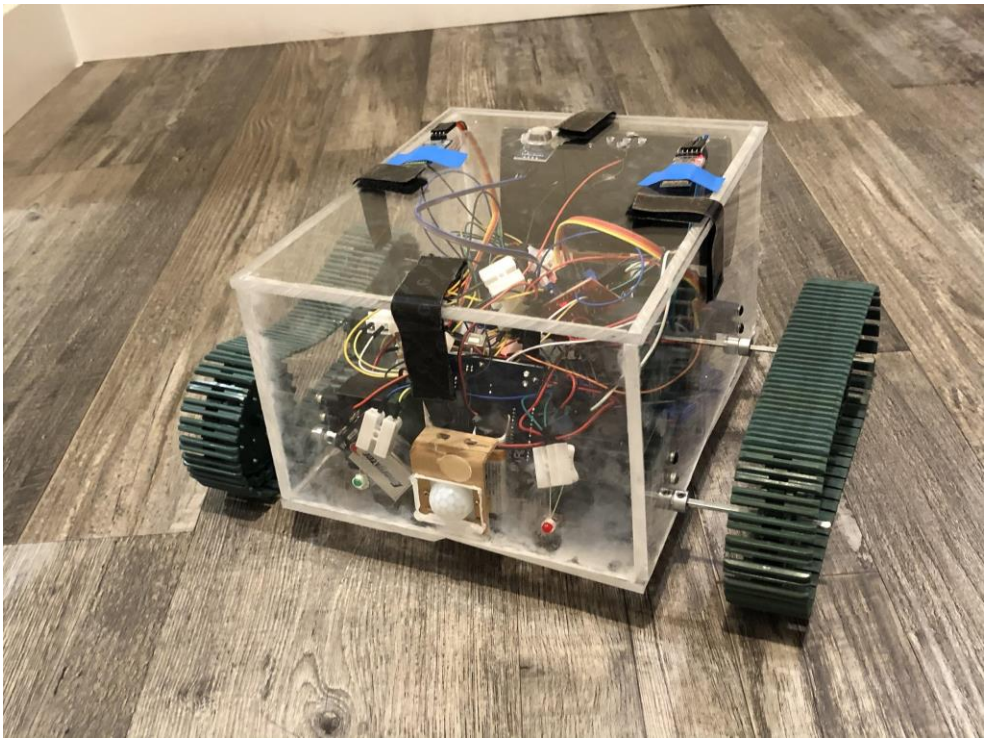
  Serial.println(analogSensor); // Print the MQ-2 Sensor's readings onto the serial monitor
  if (analogSensor > sensorThres) // If the MQ-2's readings of the air is greater than the
sensorThres
                        // (200), then there is smoke and/or dangerous gas in the air.
  {
    digitalWrite(redLed, HIGH); // The red LED will turn on
    tone(buzzer, 800, 800); // The buzzer will make a sound from tone 800 and 800
    delay(200); // Wait 0.2 seconds before moving on to the next line of code
    tone(buzzer, 600, 800); // The buzzer will make a sound from tone 600 and 800
```

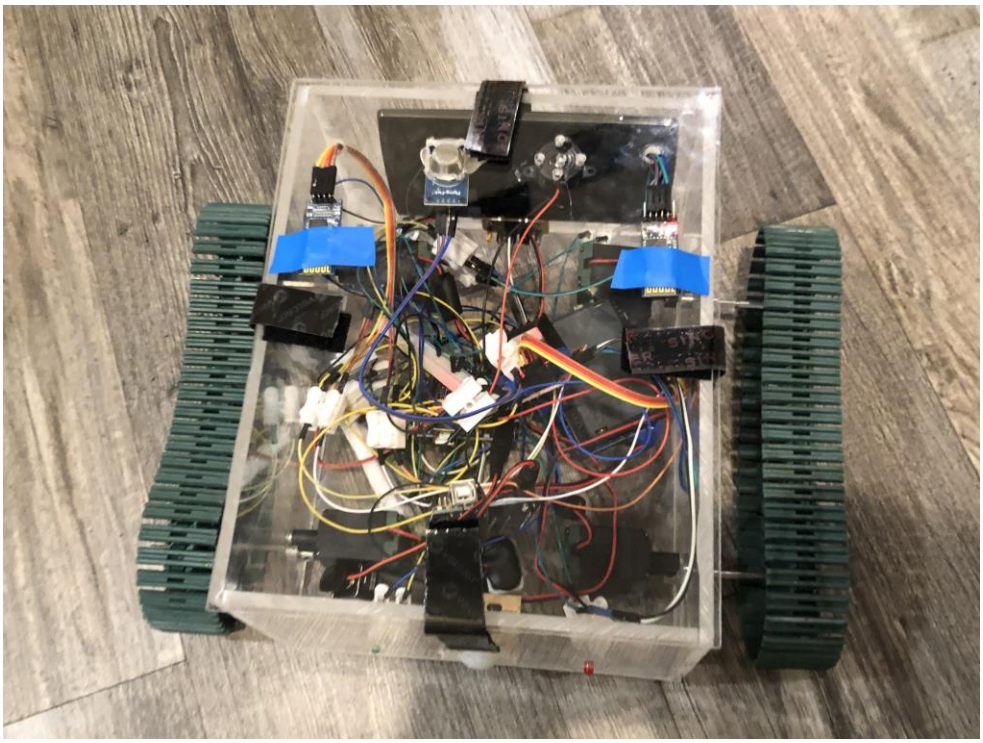
```
    delay(200); // Wait 0.2 seconds before moving on to the next line of code


  }
  else
  {
    digitalWrite(redLed, LOW); // The red LED will be off; it will not turn on
    noTone(buzzer); // The buzzer will give off no tone
  }
  delay(100); // Wait 0.1 seconds before moving on to the next line of code. In this case,
        //it will repeat the void loop again
 }
}
```

Final Design Picture:







Final Design Code

Code 1- Wheels with Bluetooth Module:

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char t; // The HC-06 will store a character value

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  Serial.begin(9600); // Get the Arduino ready to communicate with the serial monitor
  // At a rate of 9600 bits per seconds

}

void loop() {
  if (Serial.available()) { // If serial monitor readings are available regarding the motors
    t = Serial.read(); // The HC-06 will read the readings
    Serial.println(t); // The Hc-06 will print the readings on the Arduino Bluetooth Control
  }

  if (t == '1') { // Move forward (all motors rotate in forward direction)
    digitalWrite(2, HIGH); // Left motor will be going forward
```

```
    digitalWrite(3, LOW); // Left motors will not go reverse
    digitalWrite(4, HIGH); // Right motors will be going forward
    digitalWrite(5, LOW); // Right motors will not go reverse
  }

  else if (t == '2') { // Move reverse (all motors rotate in reverse direction)
    digitalWrite(2, LOW); // Left motors will not be going forward
    digitalWrite(3, HIGH); // Left motors will be going reverse
    digitalWrite(4, LOW); // Right motors will not be going forward
    digitalWrite(5, HIGH); // Right motors will be going reverse
  }

  else if (t == '3') { // Turn right (left side motors rotate in forward direction, right side motors doesn't rotate)
    digitalWrite(2, LOW); // Left motors will not be going forward
    digitalWrite(3, LOW); // Left motors will not be going reverse
    digitalWrite(4, HIGH); // Right motors will be going forward
    digitalWrite(5, LOW); // Right motors will not be going reverse
  }

  else if (t == '4') { // Turn left (right side motors rotate in forward direction, left side motors doesn't rotate)
    digitalWrite(2, HIGH); // Left motors will be going forward
```

```
    digitalWrite(3, LOW); // Left motors will not be going reverse
    digitalWrite(4, LOW); // Right motors will not be going forward
    digitalWrite(5, LOW); // Right motors will not be going reverse
  }

  else if (t == '5') { // Stop (all motors stop)
    digitalWrite(2, LOW); // Left motors will not be going forward
    digitalWrite(3, LOW); // Left motors will not be going reverse
    digitalWrite(4, LOW); // Right motors will not be going forward
    digitalWrite(5, LOW); // Right motors will not be going reverse
  }
  delay(100); // Wait 0.1 seconds before repeating the code from void loop again
}
```

Code 2- PIR Sensors, Green LED's, and Bluetooth Module:

```
#include <SoftwareSerial.h> // Library used for serial communication with a digital pin other
than that of the serial port
SoftwareSerial mySerial(0, 1); // RX, TX pins for HC-05 module

//PIR Sensor
long unsigned int lowIn1; //the time when the sensor outputs a low impulse
long unsigned int lowIn2; //the time when the sensor outputs a low impulse
```

```
long unsigned int pause = 5000; //the amount of milliseconds the sensor has to be low before we
                        // Assume all motion has stopped

int pirPin1 = 2; // The digital pin connected to the PIR sensor 1's output
int pirPin2 = 3; // The digital pin connected to the PIR sensor 1's output

boolean lockLow1 = true;
boolean takeLowTime1;
boolean lockLow2 = true;
boolean takeLowTime2;

int greenLed1 = 5; // The digital pin connected to the green LED
int greenLed2 = 6; // The digital pin connected to the green LED

void setup() {
  pinMode(greenLed1, OUTPUT); // Set the green LED as output
  pinMode(greenLed2, OUTPUT); // Set the green LED as output

  mySerial.begin(9600); //Send the MQ-2 readings to the HC-05 serial monitor found on the
Arduino IDE
  pinMode(pirPin1, INPUT); // Set the PIR sensor as input
  pinMode(pirPin2, INPUT); // Set the PIR sensor as input
```

```
}

void loop() {
 if (digitalRead(pirPin1) == HIGH) { // If the readings of the PIR sensor is high
   if (lockLow1) {
     lockLow1 = false; // Human motion was detected
     mySerial.println("Living Thing Found! (PIR 1)"); // The HC-05 serial monitor will print
                                                     // Out that a human was found by the PIR sensor
     digitalWrite(greenLed1, HIGH); // The green LED will turn on
     digitalWrite(greenLed2, HIGH); // The green LED will turn on



     delay(1000); // Wait 0.2 seconds before moving on to the next line of code
   }
   takeLowTime1 = true; // Make sure this is only done at the start of a HIGH phase
 }

 if (digitalRead(pirPin1) == LOW) {


   if (takeLowTime1) {
     lowIn1 = millis(); // Save the time of the transition from high to LOW
     takeLowTime1 = false; // Make sure this is only done at the start of a LOW phase
   }
```

```
  if (!lockLow1 && millis() - lowIn1 > pause) { // If the sensor is low for more than the given
pause
    lockLow1 = true; // Assume that no more motion is going to happen

    mySerial.println("Living Thing Lost (PIR 1)"); // The HC-05 serial monitor will print
                                        // Out that a human was lost according to the PIR sensor
    digitalWrite(greenLed1, LOW); // The green LED will turn off
    digitalWrite(greenLed2, LOW); // The green LED will turn off


    delay(1000); // Wait 0.2 seconds before moving on to the next line of code
  }
   if (digitalRead(pirPin2) == HIGH) { // If the readings of the PIR sensor is high
  if (lockLow2) {
    lockLow2 = false; // Human motion was detected
    mySerial.println("Living Thing Found! (PIR 2)"); // The HC-05 serial monitor will print
                                          // Out that a human was found by the PIR sensor
    digitalWrite(greenLed1, HIGH); // The green LED will turn on
    digitalWrite(greenLed2, HIGH); // The green LED will turn on


    delay(1000); // Wait 0.2 seconds before moving on to the next line of code
  }
```

```
    takeLowTime2 = true; // Make sure this is only done at the start of a HIGH phase
   }

  if (digitalRead(pirPin2) == LOW) {

    if (takeLowTime2) {
      lowIn2 = millis(); // Save the time of the transition from high to LOW
      takeLowTime2 = false; // Make sure this is only done at the start of a LOW phase
    }
    if (!lockLow2 && millis() - lowIn2 > pause) { // If the sensor is low for more than the given
pause
      lockLow2 = true; // Assume that no more motion is going to happen

      mySerial.println("Living Thing Lost (PIR 2)"); // The HC-05 serial monitor will print
                                          // Out that a human was lost according to the PIR sensor
      digitalWrite(greenLed1, LOW); // The green LED will turn off
      digitalWrite(greenLed2, LOW); // The green LED will turn off

      delay(1000); // Wait 0.2 seconds before moving on to the next line of code
    }
   }
   }
}
```

Code 3- Smoke Sensor and Red LED's

```
//Smoke Sensor
int redLed1 = 2; // The digital pin connected to the red LED
int redLed2 = 3; // The digital pin connected to the red LED
int buzzer = 4; // The digital pin connected to the buzzer
int smokeA0 = A3; // The analog pin connected to the MQ-2 sensor
int sensorThres = 200; // The minimum value that the MQ-2 sensor needs to detect smoke and/or
harmful gases
void setup() {
  pinMode(redLed1, OUTPUT); // Set the red LED as output
  pinMode(redLed2, OUTPUT); // Set the red LED as output
  pinMode(buzzer, OUTPUT); // Set the buzzer as output
  pinMode(smokeA0, INPUT); // Set the MQ-2 sensor as input

}

void loop() {
int analogSensor = analogRead(smokeA0);

    Serial.println(analogSensor); // Print the MQ-2 Sensor's readings onto the serial monitor
```

```
  if (analogSensor > sensorThres) // If the MQ-2's readings of the air is greater than the
sensorThres
                                  // (200), then there is smoke and/or dangerous gas in the air.
  {
    digitalWrite(redLed1, HIGH); // The red LED will turn on
    digitalWrite(redLed2, HIGH); // The red LED will turn on


    tone(buzzer, 800, 800); // The buzzer will make a sound from tone 800 and 800
    delay(200); // Wait 0.2 seconds before moving on to the next line of code
    tone(buzzer, 600, 800); // The buzzer will make a sound from tone 600 and 800
    delay(200); // Wait 0.2 seconds before moving on to the next line of code


  }
  else
  {
    digitalWrite(redLed1, LOW); // The red LED will be off; it will not turn on
    digitalWrite(redLed2, LOW); // The red LED will be off; it will not turn on
    noTone(buzzer); // The buzzer will give off no tone
  }
  delay(100); // Wait 0.1 seconds before moving on to the next line of code. In this case,
          //it will repeat the void loop again
}
```

Itemized Budget Sheet (Prototype)

Part	Unit Dimensions	Retail Price $	Price Per Unit $	Quantity Used	Total Cost $	Retail Source
Elegoo UNO Board	3” x 2.1”	$10.90	$10.90/ Board	1 Board	$10.90	Amazon.com
SparkFun Redboard	2.7” x 2.1”	$19.95	$19.95/ Board	1 Board	$19.95	SparkFun.com
Breadboard 830 Point	2.2” x 7”	$1.65	$1.65/Breadboard	1 Bread board	$1.65	AliExpress.com
4 WD Robot Chassis Kit	70 mm x 22 mm	$16.88	$16.88/ Kit	1 Kit	$16.88	AliExpress.com
HC-06 Bluetooth Module	26.7 mm x 13 mm	$2.23	$2.23/Bluetooth Module	1 Bluetooth Module	$2.33	AliExpress.com

L298N Motor Driver	43 mm x 43 mm	$1.34	$1.34/ Motor Driver	1 L298N Motor Driver	$1.34	AliExpress.com
PIR Sensor with Holder	1.27” x 0.96”	$1.10	$1.10/ PIR Sensor With Holder	1 PIR Sensor With Holder	$1.10	AliExpress.com
100 Piece 5mm LED Assorted Kit	5mm x 31.7 mm/ LED	$1.55	About $0.02/ LED	2 LED’s (1 Green and 1 Red)	$0.04	AliExpress.com
Piezo Buzzer	12 mm x 9.5 mm	$0.88 for 10 Buzzers	$0.09/ Buzzer	1 Buzzer	$0.09	AliExpress.com
9V Battery Button Power Cable Battery Buckle Snaps Power Cable Connector	6” x 0.5”	$1.25 for 10 Battery Buckle Snaps Power Cable Connector	$0.13/Battery Buckle Snaps Power Cable Connector	2 Battery Buckle Snaps Power Cable Connector	$0.26	AliExpress.com
9V Battery Snap Connector Clip with Wire Holder Cable Leads Cord	15.5 mm × 1.4 mm	$0.41 for 10 9V Battery Snap Connectors	About $0.04/9V Battery Snap Connector	1 9V Battery Snap Connector	$0.04	AliExpress.com
Male to Male Jumper Wires	Assorted Sizes	$1.75 For 120 Male to Male Wires	$0.01/ Wire	25 Male to Male Wires	$0.25	AliExpress.com
Male to Female Jumper Wires	Assorted Sizes	$3.36 for 120 Wires	$0.03/Wire	11 Male to Female Wires	$0.33	AliExpress.com
9V Battery	1.9 in × 1 in × 0.6 in	$1.00	$1.00/Battery	3 9V Battery	$3.00	City Fashion Center in Lynwood California

Obama Free Phone (Safelink)	5.91” x 3” x 0.39”	$0.00	$0.00/Phone	1 Obama Free Phone	$0.00	Plaza Mexico in Lynwood California
Electric Tape	¾” x 20 yds	$2.29	About $0.04/Foot of Tape	3 Inches of Tape	About $0.01	Ekono 99 Cents Store
				Total Cost	$58.17	

- Itemized Budget Sheet (Final Design)

Part	Unit Dimensions	Retail Price $	Price Per Unit $	Quantity Used	Total Cost $	Retail Source
Arduino Uno R3 (Clone)	3” x 2.1”	$2.98	$2.98/Board	3 Boards	$8.94	AliExpress.com
Half Breadboard	2.2” x 7”	$1.65	$1.65/Breadboard	1 Bread board	$1.65	AliExpress.com
Acrylic Sheet	¼” x 36” x 10”	$23.00	$23.00/Sheet	1 Sheet	$23.00	Ebay.com
VEX 2-Wire 393 Motors (Comes With 2 6-32 x ¼” Screws)	2.19” x 1.82” x 0.93”	$10.00	$10.00/Motor With 2 Screws	4 Motors and 8 Screws	$40.00	The Roadium Open Air Market in Redondo Beach
VEX Axles (4 Pack)	Each Axle: 4”x 0.125”	$4	$1/Vex Axle	4 Vex Axles	$4	The Roadium Open Air Market in Redondo Beach
VEX Shaft Collar	0.433” x 0.260”	$8.99	About $0.56/Shaft Collar	12 Shaft Collars	$6.72	Store.robotmesh.com
VEX 24 Tooth High Strength Sprocket	Approximately 3.16” Outer Diameter	$14.49	$3.62/Sprocket	4 Sprockets	$14.49	Vexrobotics.com

110 VEX Tank Tread Links	Each Tread Link: 0.69” x 1.5”	$15.00	About $0.14/ Tread Link	110 Vex Tread Links	$15.00	The Roadium Open Air Market in Redondo Beach
Energy Shield 2 Basic-Rechargeable Battery for Arduino	2.8” x 2.1”	$29.95	$29.95/1 Rechargeable Battery	1 Rechargeable Battery	$29.95	Amazon.com
Lithium Ion Battery Pack - 3.7V 6600mAh	69mm x 54mm	$29.50	$29.50/1 Lithium Ion Battery	1 Lithium Ion Battery	$29.50	Adafruit.com
HC-06 Bluetooth Module	26.7 mm x 13 mm	$2.23	$2.23/Bluetooth Module	1 Bluetooth Module	$2.33	AliExpress.com
L298N Motor Driver	43 mm x 43 mm	$1.34	$1.34/ Motor Driver	1 L298N Motor Driver	$1.34	AliExpress.com
PIR Sensor with Holder	1.27” x 0.96”	$1.10	$1.10/ PIR Sensor With Holder	1 PIR Sensor With Holder	$1.10	AliExpress.com
100 Piece 5mm LED Assorted Kit	5mm x 31.7 mm/ LED	$1.55	About $0.02/ LED	4 LED’s (2 Green and 2 Red)	$0.08	AliExpress.com
Piezo Buzzer	1.18” in diameter 0.43” in depth	$0.84	$0.84/ Buzzer	1 Buzzer	$0.84	AliExpress.com
9V Battery Button Power Cable Battery Buckle Snaps Power Cable Connector	6” x 0.5”	$1.25 for 10 Battery Buckle Snaps Power Cable Connector	$0.13/Battery Buckle Snaps Power Cable Connector	2 Battery Buckle Snaps Power Cable Connector	$0.26	AliExpress.com
Male to Male	20 cm x 0.2 cm	$0.96	$0.01/ Wire	28 Wires	$0.28	AliExpress.com

Jumper Wires		For 65 Male to Male Wires				
Male to Female Jumper Wires	Assorted Sizes	$3.36 for 120 Wires	$0.03/Wire	25 Male to Female Wires	$0.75	AliExpress.com
9V Battery	4.5” x 2”	$1.00	$1.00/Battery	2 9V Battery	$2.00	City Fashion Center in Lynwood California
2 Pin Wire Connectors	20mm x 17.5mm x 13.5mm	$1.96/20 pcs	About $0.10/Wire Connector	18 Wire Connectors	$1.80	Aliexpress.com
Electric Tape	¾” x 20 yds	$2.29	About $0.04/Foot of Tape	4 Inches of Tape	About $0.01	Ekono 99 Cents Store
Velcro	32” x 1”	$6.65	About $0.21 Per Inch of Velcro	32 Inches of Velcro	$6.65	Ekono 99 Cents Store
				Total Cost	$190.69	

Bibliography:

- “American Red Cross.” American Red Cross, www.redcross.org/.“Arduino - PIR Sensor.”
- Tutorialspoint, - www.tutorialspoint.com/arduino/arduino_pir_sensor.htm.Bolles, Bob. “Weight Distribution - Analyzing Your Setup For Faster Lap Times - Circle Track Magazine.” Hot Rod, Hotrod, 14 June 2016, www.hotrod.com/articles/ctrp-0706-weight-distribution-transfer/.
- Doroftei, Daniela, et al. “Introduction to the Use of Robotic Tools for Search and Rescue.” IntechOpen, IntechOpen, 23 Aug. 2017, www.intechopen.com/books/search-and-rescue-robotics-from-theory-to-practice/introduction-to-the-use-of-robotic-tools-for-search-and-rescue.
- Last Minute Engineers. “In-Depth: How MQ2 Gas/Smoke Sensor Works? & Interface It with Arduino.” Last Minute Engineers, Last Minute Engineers, 13 Dec. 2019, lastminuteengineers.com/mq2-gas-senser-arduino-tutorial/.
- Soffar, Heba. “Rescue Robots (Mobile Robots) Types, Uses, Advantages and Disadvantages.” Science Online, 29 Aug. 2019, www.online-sciences.com/robotics/rescue-robots-mobile-robots-types-uses-advantages-and-disadvantages/.
- Walker, Jon. “Search and Rescue Robots – Current Applications on Land, Sea, and Air.” Emerj, Emerj, 21 Nov. 2019, emerj.com/ai-sector-overviews/search-and-rescue-robots-current-applications/.
- “Wheels vs Tracks: Advantages and Disadvantages.” Lite Trax, 1 Mar. 2018, litetrax.com/wheels-vs-tracks-advantages-disadvantages/.

- Hek. “Gas Sensor: MySensors - Create Your Own Connected Home Experience.” MySensors, www.mysensors.org/build/gas.
- RobbeRobbe 3911 gold badge11 silver badge55 bronze badges, et al. “Can I Make Multiple Void Loops with Arduino Uno?” Arduino Stack Exchange, 1 Apr. 1967, arduino.stackexchange.com/questions/37684/can-i-make-multiple-void-loops-with-arduino-uno/51723.

Front Cover Picture

- Rarieya, Yvonne. “Experts Say Collapsed Buildings Expose Gaps in Kenya's Construction Sector.” CGTN Africa, 19 Mar. 2018, africa.cgtn.com/2018/03/19/experts-say-collapsed-buildings-expose-gaps-in-kenyas-construction-sector/.