



Mechatronics Final Project: Firefighting Boe-Bot

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Outline

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- Goals
- Mechanical Design
- Electrical Design
- Software Design
- Bill of Materials
- Conclusion
- Demo

Motivation

- Firefighting is highly dangerous
 - High levels of carbon monoxide
 - Low visibility due to smoke
 - Unstable structures
- Apart from the use of fire hoses there is a need to enter building in search remaining fires

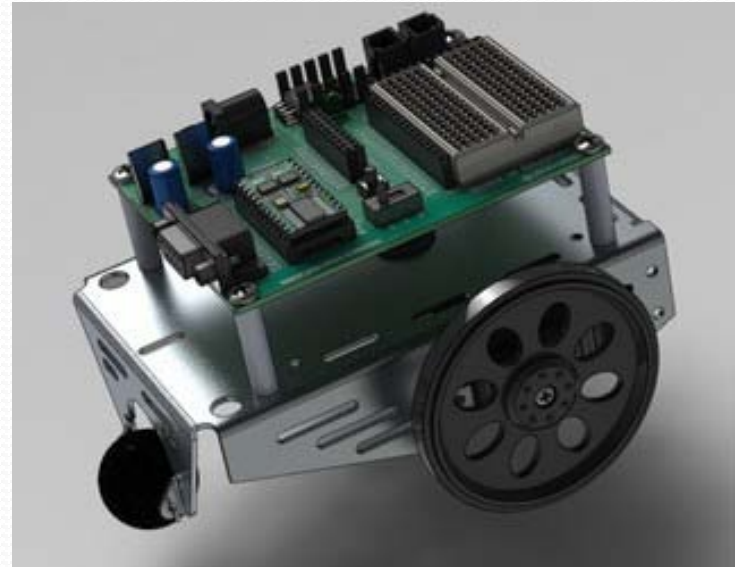
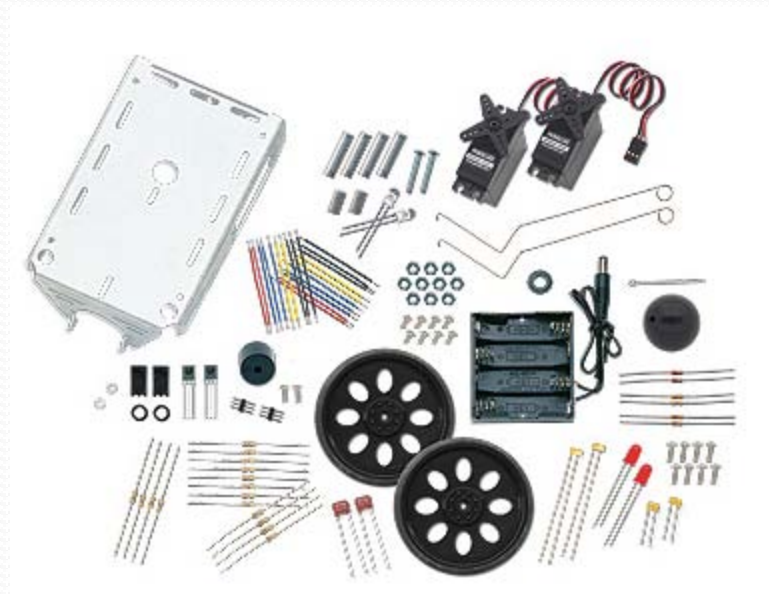


Goals and Features

- Goals:
 - Detect and locate fire
 - Position within a safe distance of the fire
 - Extinguish fire
- Features:
 - Allow for human interaction through Wii Nunchuck and LEDs for remote communication
 - Able to transfer information remotely without the need of a debug window

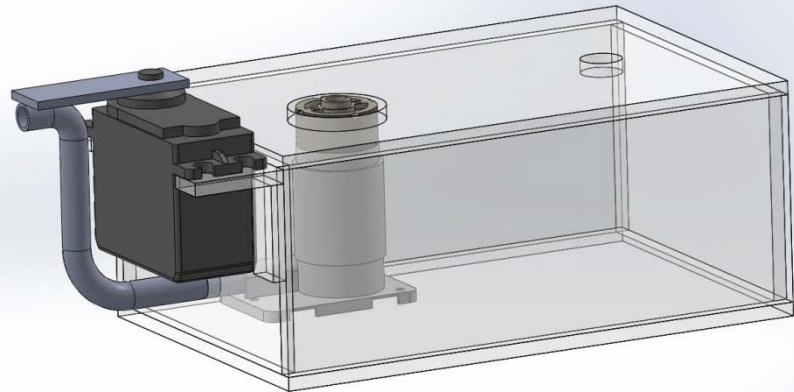
Mechanical Design

The design will utilize the Parallax Boe-Bot parts kit as a platform

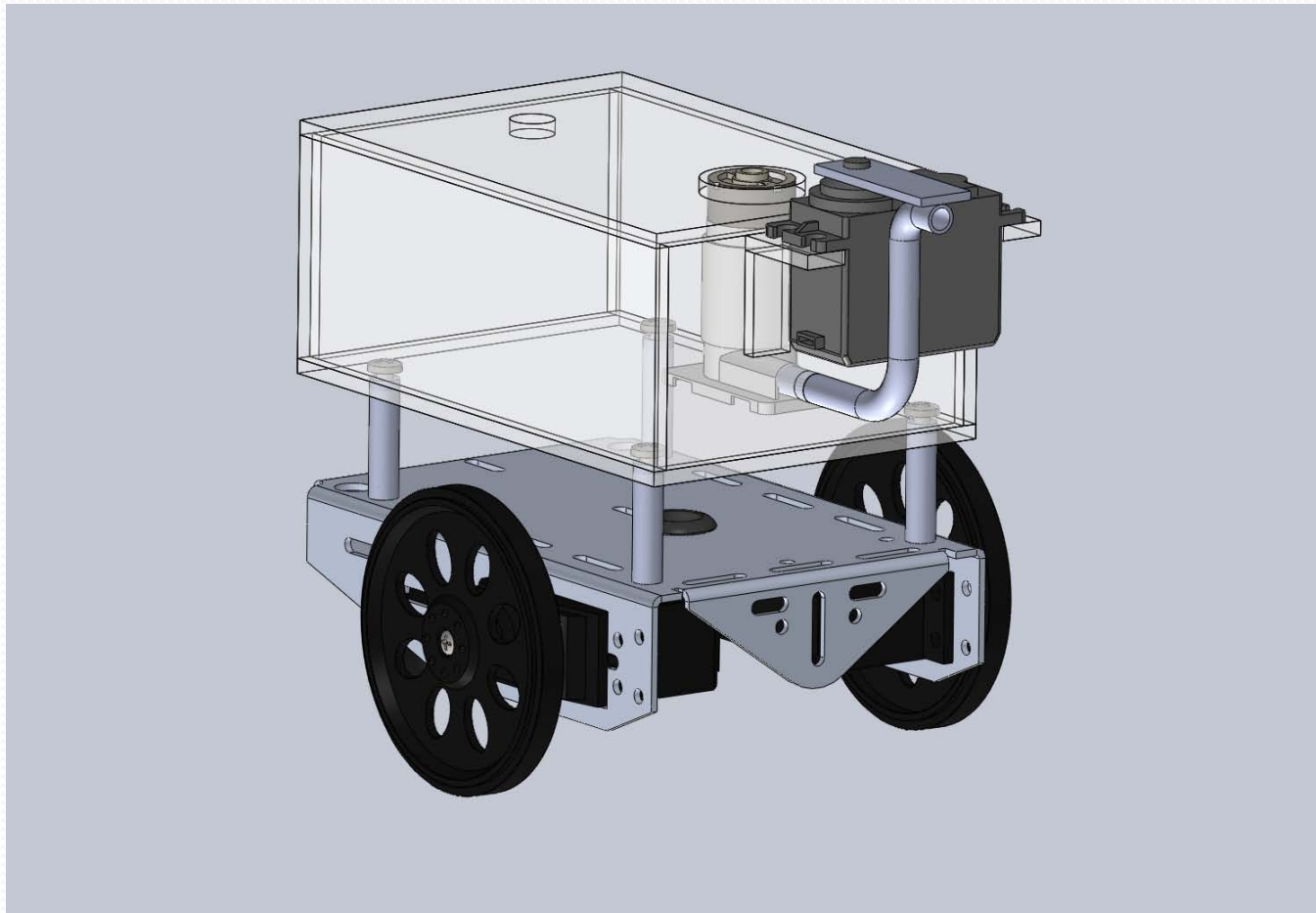


Mechanical Design

- Plexiglass water tank
 - Dimensions: 5" x 3.25" x 2"
 - Pump in tank
 - Servo mounted to spread water
 - Hole to fill tank

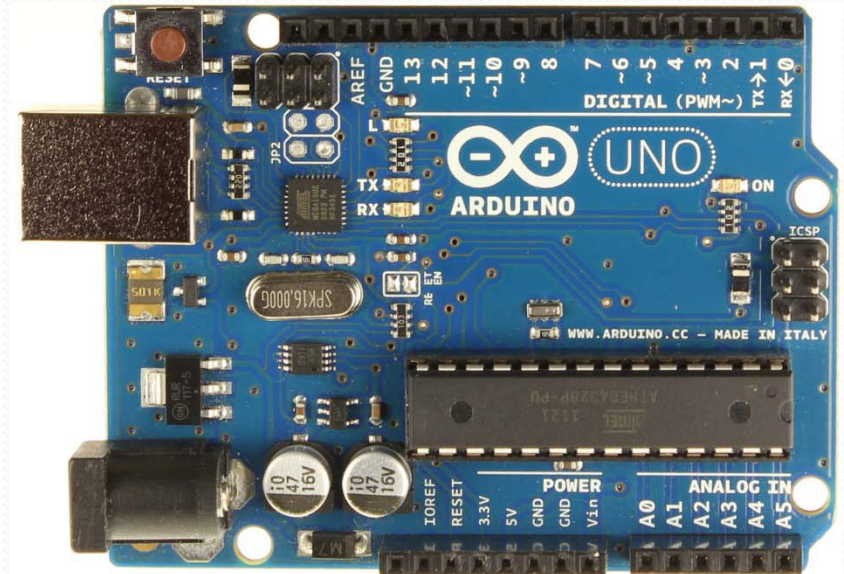


Final Design



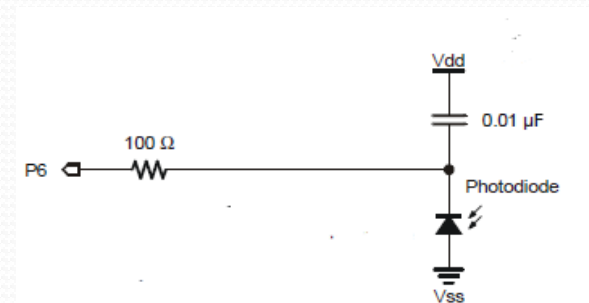
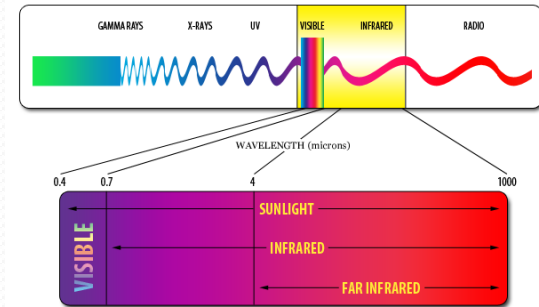
Electrical Design: Microcontroller

- Arduino Uno R3
 - 14 digital I/O pins
 - 5 volts
 - 40 mA source/sink per pin
 - 6 pins provide PWM
 - 6 analog inputs (10 bit)
 - Open-source



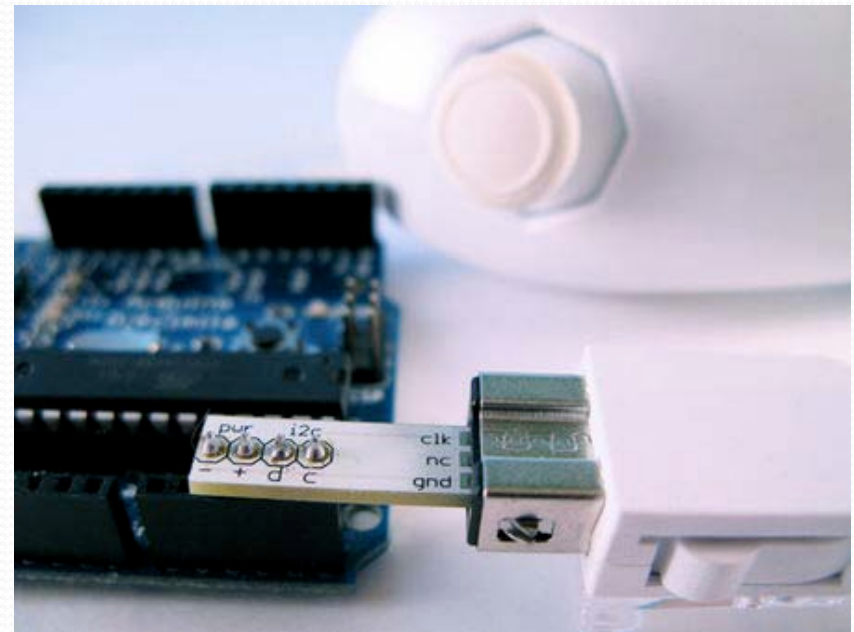
Photodiodes: Infrared LEDs

- Forward biased
 - LED emits infrared light
- Reverse biased
 - LED detects infrared light (photodiode)
 - Utilized to detect flame
- Increasing sensitivity
 - Smaller capacitor: 10 pf



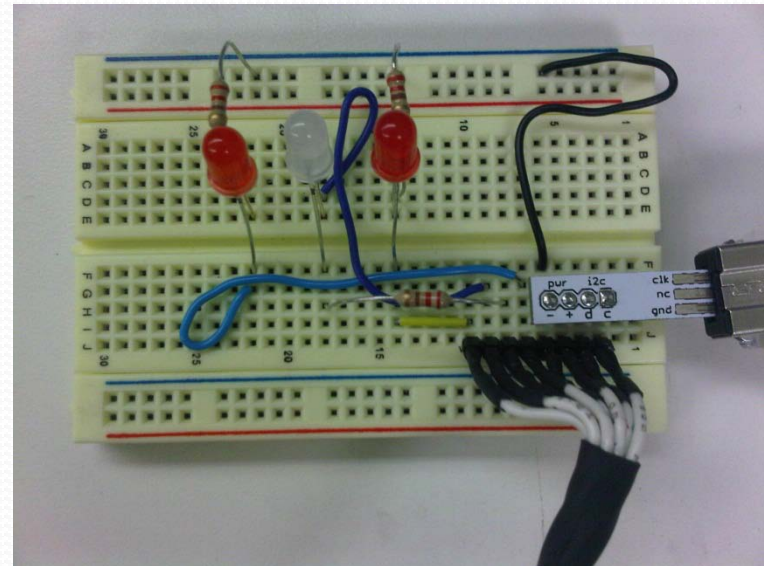
Vehicle Control: Wii nunchuck

- Analog stick
- Two buttons
- Three-axis accelerometer
- New Wiichuck adaptor
 - I²C communication

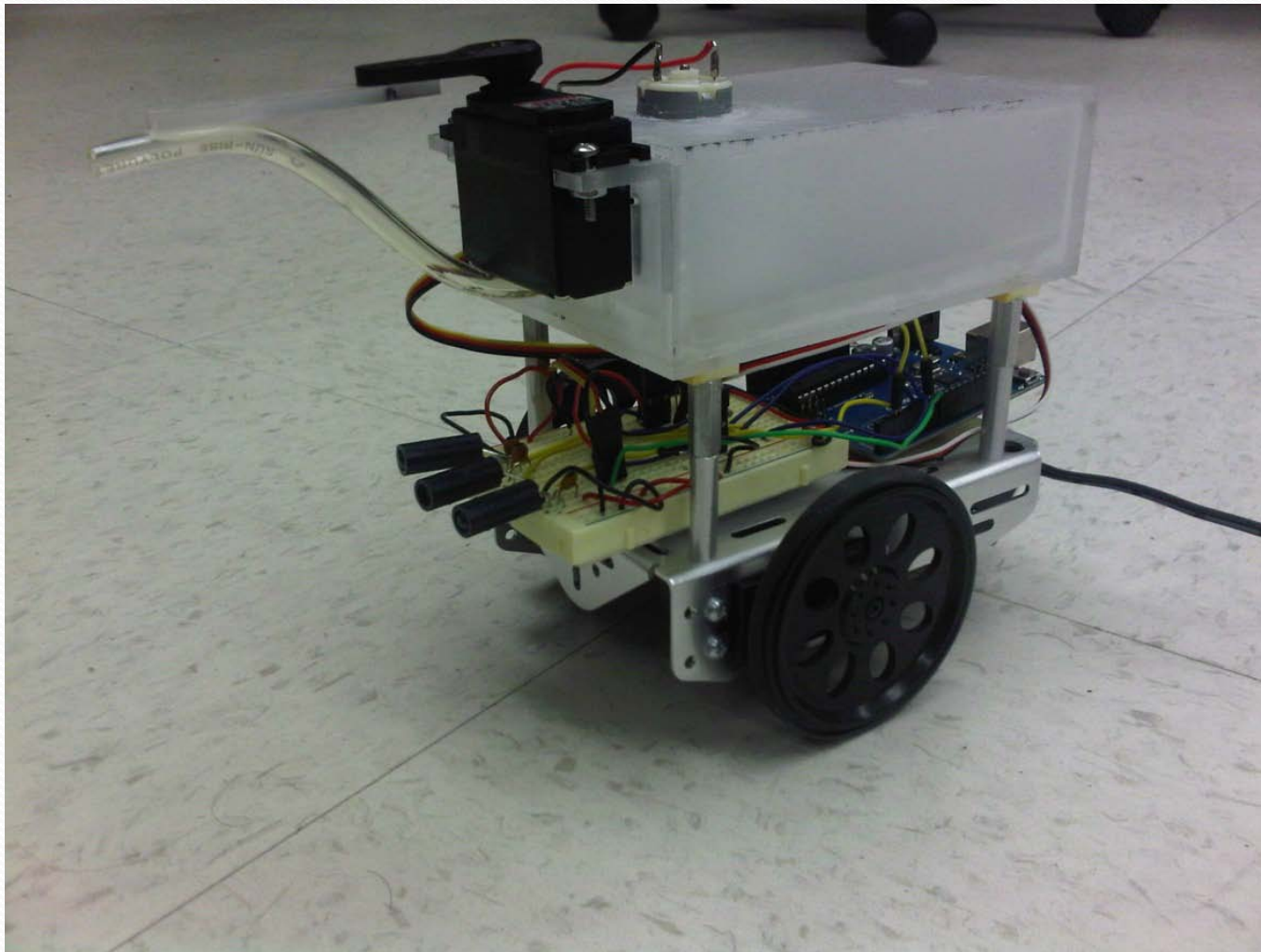


LED Indicators

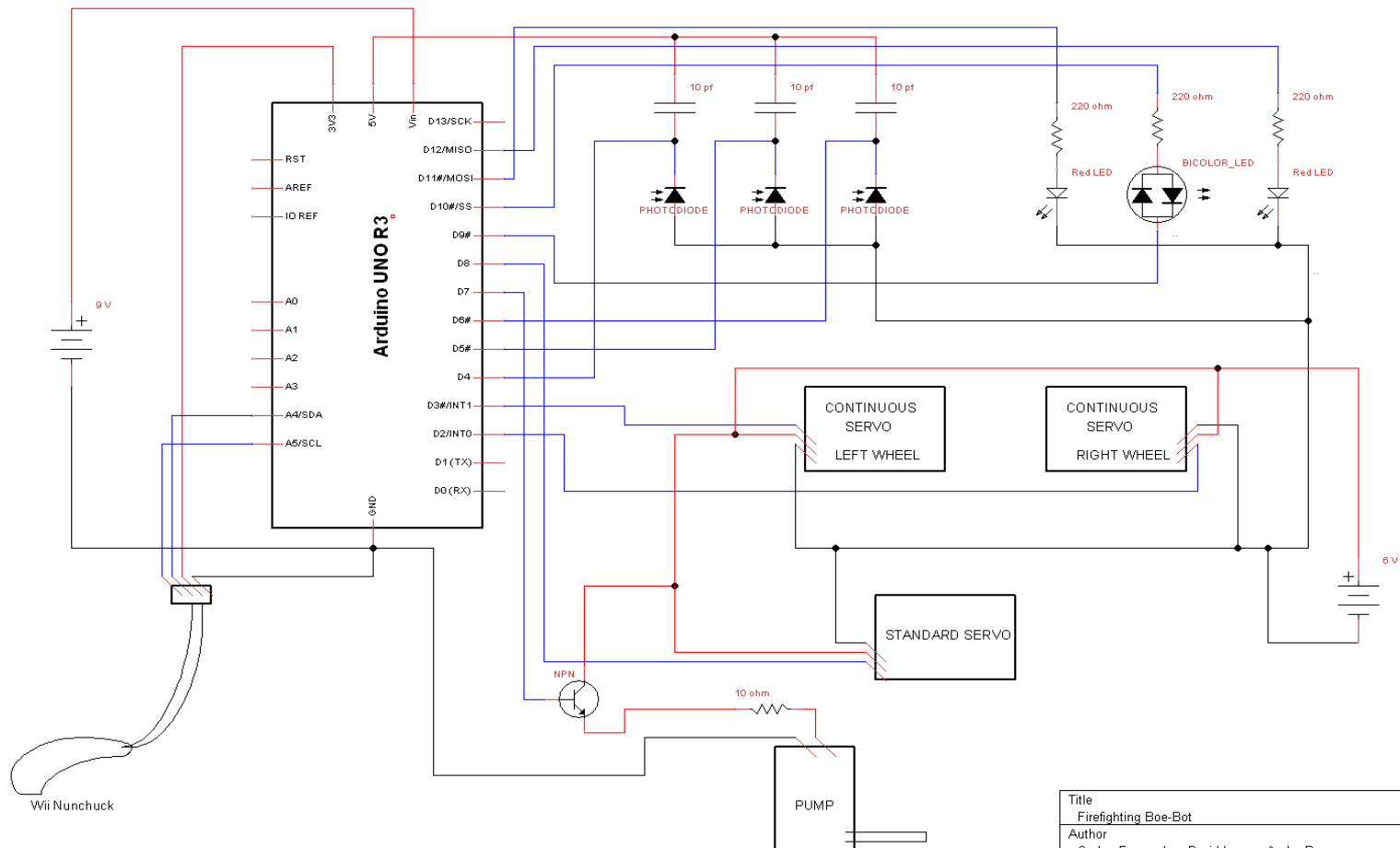
- 3 LEDs
 - Left: red LED
 - Center: bi-color LED (red/green)
 - Right: red LED
- Indicates direction of fire



Final Product



Electrical Design



Title Firefighting Boe-Bot		
Author Carlos Fernandez, David Lopez, Andre Roman NYU Poly		
File C:\Users\CJ\Documents\TinyCad\firebot.dsn	Document	
Revision 1.0	Date 12/15/2012	Sheets 1 of 1

Software Design

- Main routine

```
void loop() {
  updateSensors();
  lightLEDs();
  nunchuk.update();
  if (nunchuk.zButton) {
    digitalWrite(pumpPin, HIGH);
    delay(200);
    digitalWrite(pumpPin, LOW);
  }
  else {
    waterPump.writeMicroseconds(map(nunchuk.accelX, 300, 700, 1300, 1700));
  }
  getDir();
  drive(sp, turn);
}
```

Software Design

- RCTime() allows for the use of BS2 RCTime function within the Arduino environment

```
long RCTime(int sensPin){
  long result = 0;
  pinMode(sensPin, OUTPUT);           // make pin OUTPUT
  digitalWrite(sensPin, HIGH);       // make pin HIGH to discharge capacitor - study the schematic
  delay(10);                          // wait a ms to make sure cap is discharged

  pinMode(sensPin, INPUT);           // turn pin into an input and time till pin goes low
  digitalWrite(sensPin, LOW);        // turn pullups off - or it won't work
  while(digitalRead(sensPin)){       // wait for pin to go low
    result++;
  }
  return result;                      // report results
}
```

Software Design

- getDir() subroutine maps the min and max values of nunchuck analog stick to the servos min and max pulse width values

```
void getDir() {
  const int ymax = 220;           // Max y-axis analog stick value
  const int center = 125;        // y-axis center value
  const int ymin = 30;          // Min y-axis analog stick value
  spd = map(nunchuk.analogY, ymin, ymax, 1450, 1550); // map analog values to servo pulse widths
  const int xmax = 227;         // Max x-axis analog stick value
  const int xcenter = 127;      // x-axis center value
  const int xmin = 27;         // Min x-axis analog stick value
  turn = map(nunchuk.analogX, xmin, xmax, -15, 15); // map analog values
}
```


Software Design

- drive() subroutine sends pulse width to servo motors
 - Uses getDir() data to drive the vehicle as needed

```
void drive(int spd, int turn) {  
    int rightSpeed = spd;  
    int leftSpeed = map(spd, 1450, 1550, 1550, 1450);  
    rightWheel.writeMicroseconds(rightSpeed + turn);  
    leftWheel.writeMicroseconds(leftSpeed + turn);  
}
```

Limitations

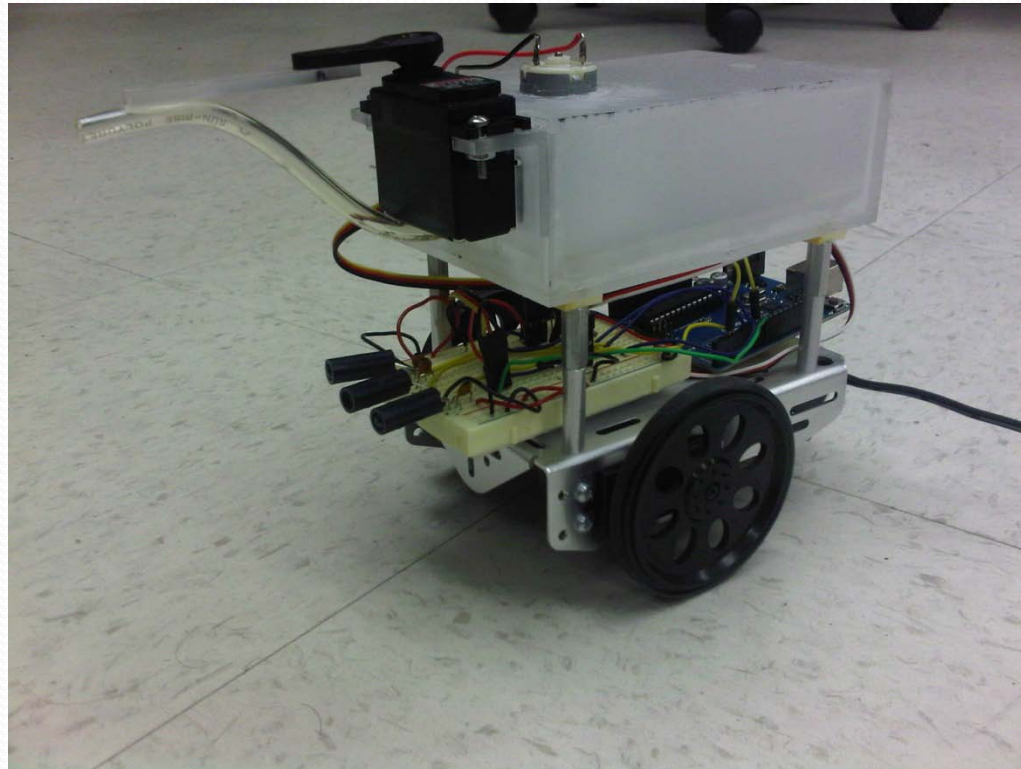
- Fires must be at sensor level
- Requires direct line of sight of fire
- Blue flames are not detected by Infrared LEDs
- Not fireproof

Bill of Materials

Item	Description	Vendor	Part No.	Quantity	Price per unit	Prototype	Production
1	Boe-Bot Robot Kit	Parallax Inc.	28132	1	\$81.99	\$81.99	\$65.59
	1/16" cotter pin		700-00023				
	1" tail wheel		700-00009				
	(4) rubber band tires		721-00002				
	(2) plastic wheels		721-00001				
	(8) 3/8" 4-40 pan head screws		700-00002				
	(2) 4-40 flathead screws		700-00016				
	(8) 7/8" 4-40 pan head screws		700-00028				
	(2) 7/8" 4-40 pan head screws		710-00007				
	(10) 4-40 zinc-plated nuts		700-00003				
	(4) 1" round 4-40 standoff		700-00060				
	(2) spacer, 1/2" round		713-00007				
	13/32" rubber grommet		700-00025				
	(2) nylon washers (screw size #4)		700-00015				
	(2) 3-pin headers		451-00303				
	(2) Parallax continous rotation servos		900-00008				
	(2) infrared LEDs		350-00003				
	(2) LED standoffs		350-90000				
	(2) LED shields for 350-90000		350-90001				
	Jumper wires (2 bags of 10)		800-00016				
	Aluminum chassis		700-00022				
	battery holder with cable and barrel plug		700-00038				
2	Arduino Uno R3	SmartProjects		1	\$25.00	\$25.00	\$25.00
3	infrared LEDs	Parallax Inc.	350-00003	2	\$0.99	\$1.98	\$1.52
4	Wii Nunchuk Controller	Nintendo		1	\$20.00	\$20.00	\$20.00
5	WiiChuck Adapter	Sparkfun Electronics	DEV-09281	1	\$1.95	\$1.95	\$1.56
6	10 pf Capacitors	Mouser Electronics	140-500N2-100F-RC	3	\$0.10	\$0.30	\$0.26
7	Breadboard	Sparkfun Electronics	PRT-09567	2	\$5.59	\$11.18	\$9.52
8	Plexiglass Case	Proffesional Plastics		1	\$20.00	\$20.00	\$20.00
9	Standard Servo	Parallax Inc.	900-00005	1	\$12.99	\$12.99	\$11.69
10	Pump	Lightobject	EXP-7L9	1	\$8.95	\$8.95	\$6.70
11	Resistor Kit - 1/4 W	Sparkfun Electronics	COM-10969	1	\$7.95	\$7.95	\$6.36
12	Break Away Headers	Sparkfun Electronics	PRT-00116	1	\$1.50	\$1.50	\$1.20
13	Red LED	Parallax Inc.	350-00006	2	\$0.50	\$1.00	\$0.80
14	Bi-color LED	Parallax Inc.	350-00005	1	\$0.99	\$0.99	\$0.79
	TOTAL					\$195.78	\$170.99

Demo

- Demo



Conclusion

- A wheeled robot can fight fires, given a tank and a pump
- Can be scaled up for larger situations
- Similar wheeled robots can be used to navigate buildings in search of fire and extinguish them
 - Can also be used to make paths for rescue



THANK YOU!