Parking Sensor Project

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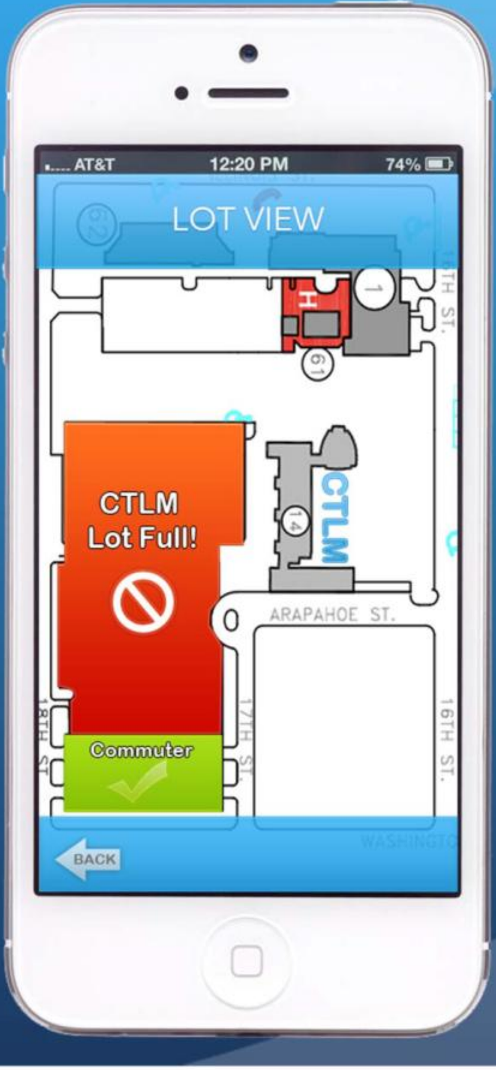
Tired of being late to class because you can’t find a place to park? Us too.

So we are doing something about it.

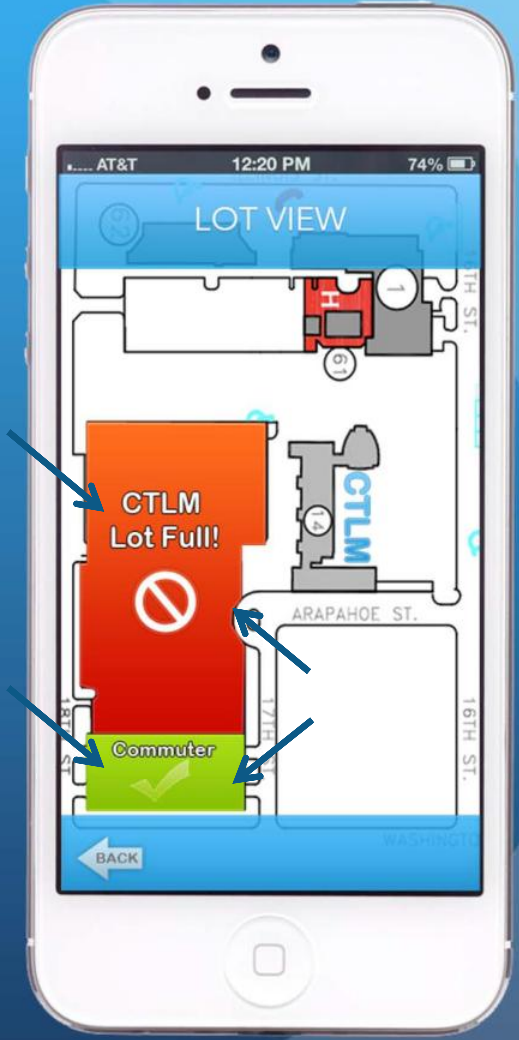
-Imagine an app and web page that shows you, in real-time, the exact parking status of every lot on campus?

-Or perhaps a text message when you are close, based on your GPS coordinates?

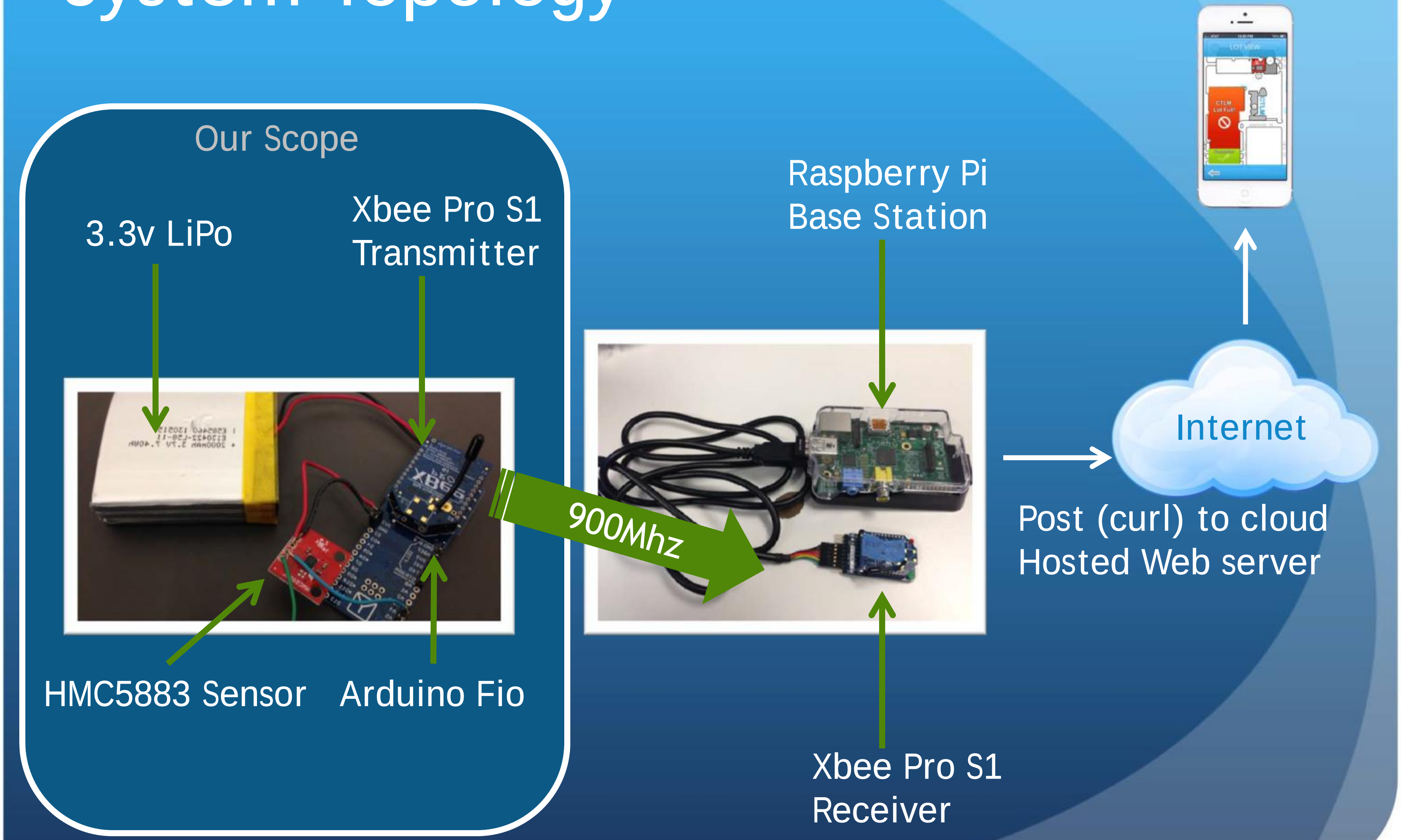
-How?



A sensor for every entrance and exit.



System Topology



Phone or Computer

Our Scope

3.3v LiPo

Xbee Pro S1
Transmitter

HMC5883 Sensor

Arduino Fio

900Mhz

Raspberry Pi
Base Station

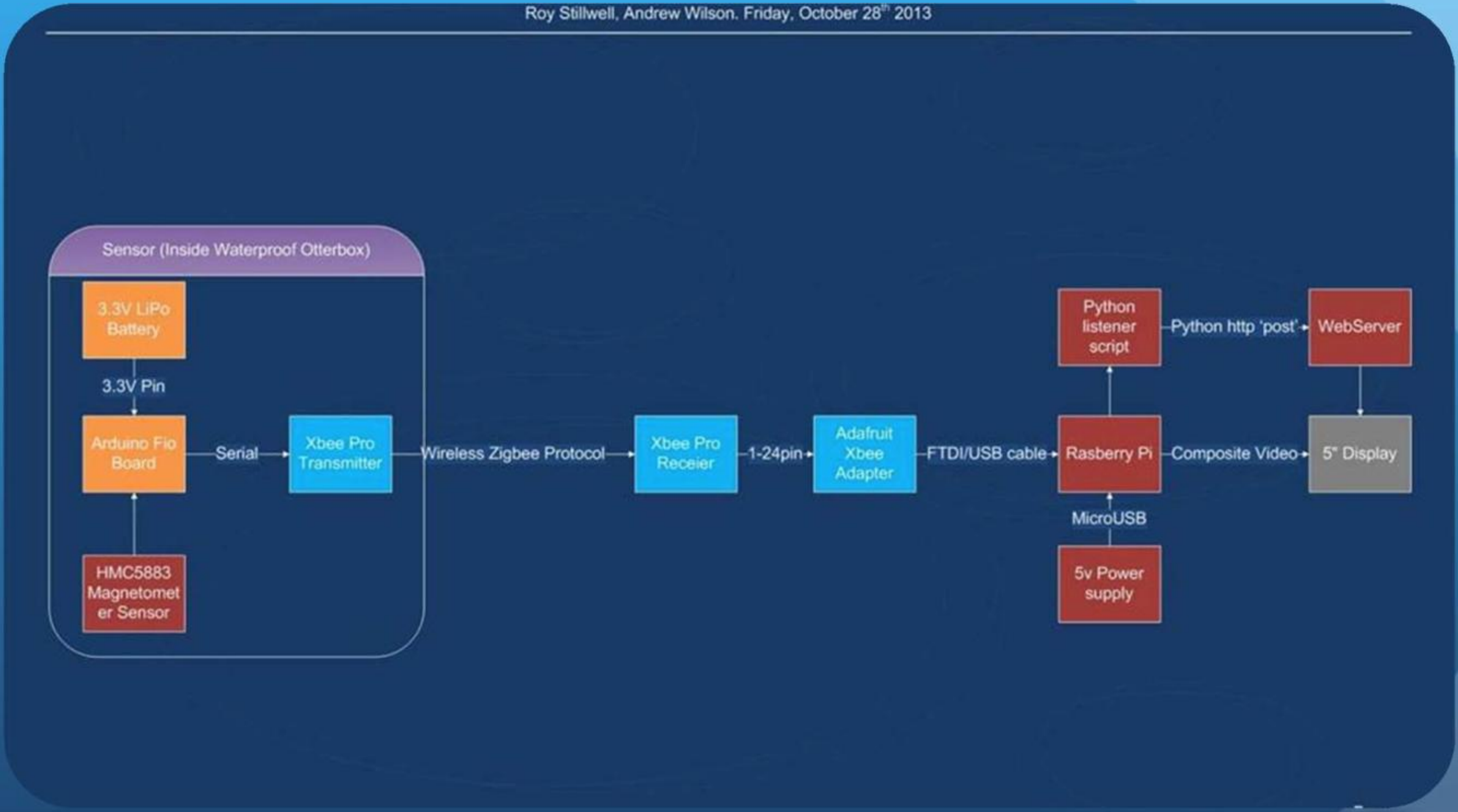
Xbee Pro S1
Receiver

Internet

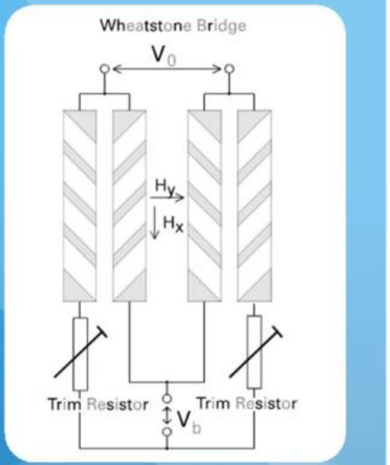
Post (curl) to cloud
Hosted Web server

Block Diagram

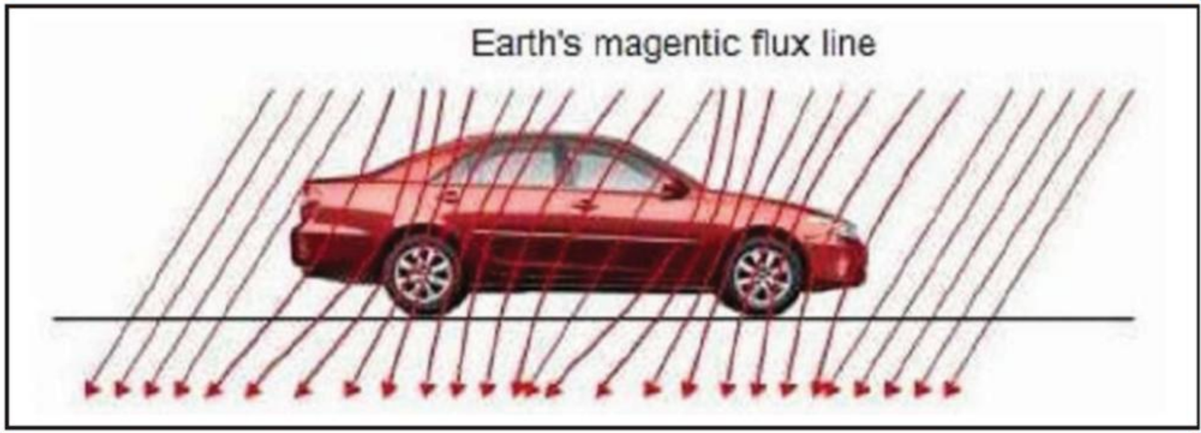
Roy Stillwell, Andrew Wilson. Friday, October 28th 2013



How The Sensor Works.



- At the heart is the HMC5883L magnetometer.
- It is magnetoresistive sensor that detects magnetic fields and does an onboard A/D conversion.



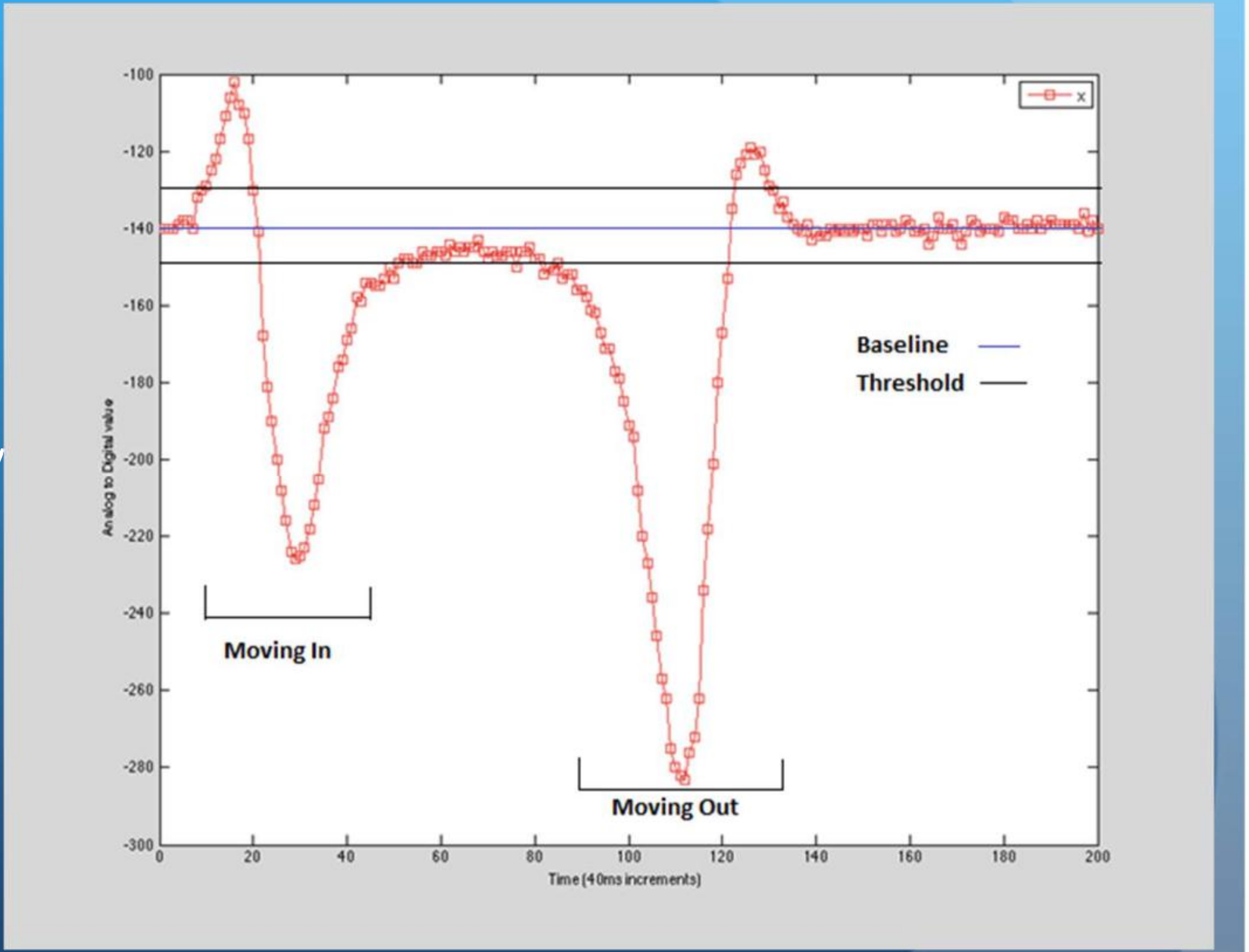
- The 2007 Nobel Prize in Physics awarded to Albert Fert and Peter Grünberg for the discovery of GMR

- Strips made of $Ni_{81}Fe_{19}$ Evaporated on Silicon wafers

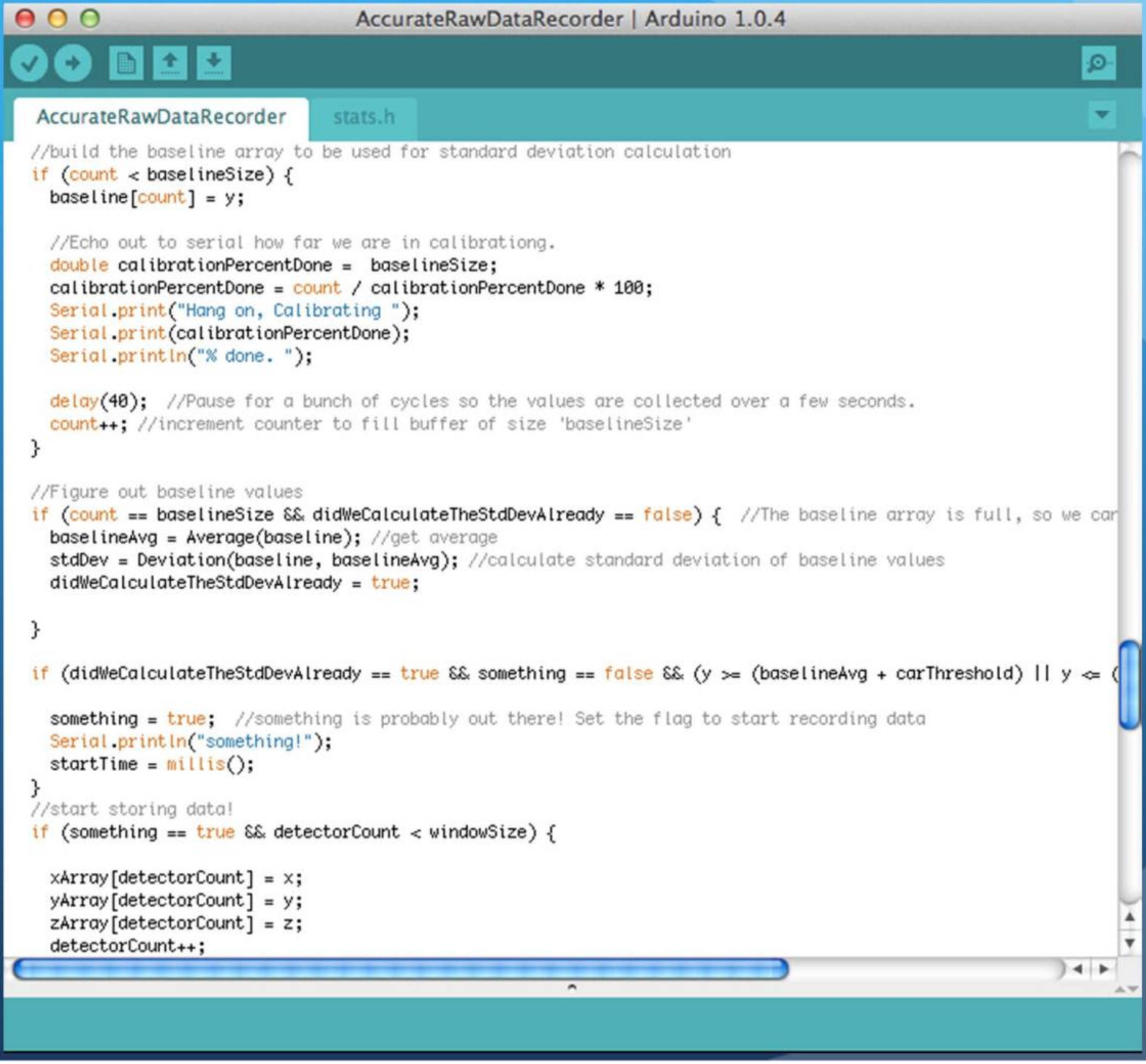
http://www.intranse.in/its1/sites/default/files/D2-S2-03_Study%20of%20Magnetometer%20Signals%20for%20Vehicle.pdf
http://www.diodes.com/_files/products_appnote_pdfs/zetex/an20.pdf
https://en.wikipedia.org/wiki/Giant_magnetoresistance

Calculating The Values

- Arduino calculates an average base value
- Continually compares magnetic field against base value(75 Hz).
- If the value differs from the base value by a threshold, the value is stored in an array.
- Use this array to determine what direction a vehicle is traveling.



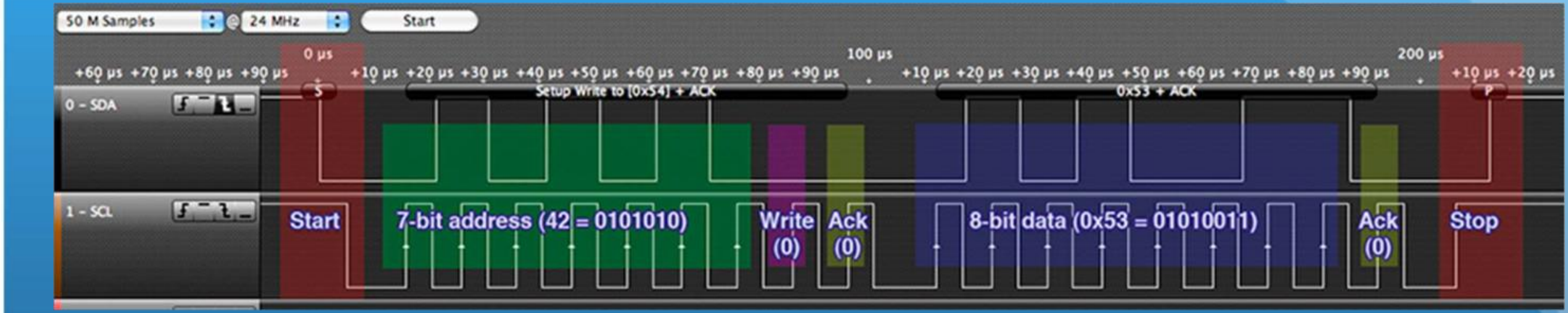
Detection Code



```
//build the baseline array to be used for standard deviation calculation
if (count < baselineSize) {
  baseline[count] = y;

  //Echo out to serial how far we are in calibrationg.
  double calibrationPercentDone =  baselineSize;
  calibrationPercentDone = count / calibrationPercentDone * 100;
  Serial.print("Hang on, Calibrating ");
  Serial.print(calibrationPercentDone);
  Serial.println("% done. ");

  delay(40);  //Pause for a bunch of cycles so the values are collected over a few seconds.
  count++; //increment counter to fill buffer of size 'baselineSize'
}

//Figure out baseline values
if (count == baselineSize && didWeCalculateTheStdDevAlready == false) {  //The baseline array is full, so we car
  baselineAvg = Average(baseline); //get average
  stdDev = Deviation(baseline, baselineAvg); //calculate standard deviation of baseline values
  didWeCalculateTheStdDevAlready = true;

}

if (didWeCalculateTheStdDevAlready == true && something == false && (y >= (baselineAvg + carThreshold) || y <= (

  something = true;  //something is probably out there! Set the flag to start recording data
  Serial.println("something!");
  startTime = millis();
}
//start storing data!
if (something == true && detectorCount < windowSize) {

  xArray[detectorCount] = x;
  yArray[detectorCount] = y;
  zArray[detectorCount] = z;
  detectorCount++;
```

Receiving and Transmitting The Data

- Data is received by Arduino from sensor using I2C protocol.


50 M Samples
24 MHz
Start
0 µs
100 µs
200 µs
+60 µs +70 µs +80 µs +90 µs
+10 µs +20 µs +30 µs +40 µs +50 µs +60 µs +70 µs +80 µs +90 µs
+10 µs +20 µs +30 µs +40 µs +50 µs +60 µs +70 µs +80 µs +90 µs
+10 µs +20 µs
S
Setup Write to [0x54] + ACK
0x53 + ACK
P
0 - SDA
1 - SCL
Start
7-bit address (42 = 0101010)
Write (0)
Ack (0)
8-bit data (0x53 = 01010011)
Ack (0)
Stop

- Arduino uses our algorithm to detect if vehicle travels in or out.
- Arduino uses the transmit pin to send data to XBEE using standard RS232
- XBEE sends data to receiving XBEE with proprietary Zigbee protocol
- Receiving XBEE is connected to Raspberry Pi via FTDI cable.
- Using python, the Pi monitors the serial port and forwards data to web server.

Conclusion

- The entire project is ongoing.
- Our scope focuses on the sensor, detection algorithm, and wireless sensor data transmission.
- Entire Prototype system we hope to have running by the end of the semester. May look something like below.
- Questions?