Pothole Tracker

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Pothole Tracker

Team 5

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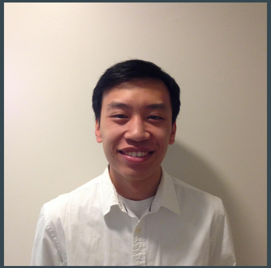

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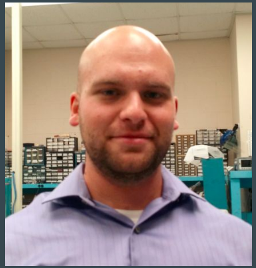

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Why are Potholes a Problem?

- Damaging to cars
- According to AAA pothole damage costs drivers $6.4 billion a year
- Repairs can range from $50 (wheel alignment) - $500 (alloy wheel)
- Can average about $2000 in repairs over life span of a car

The solution: Pothole Tracker

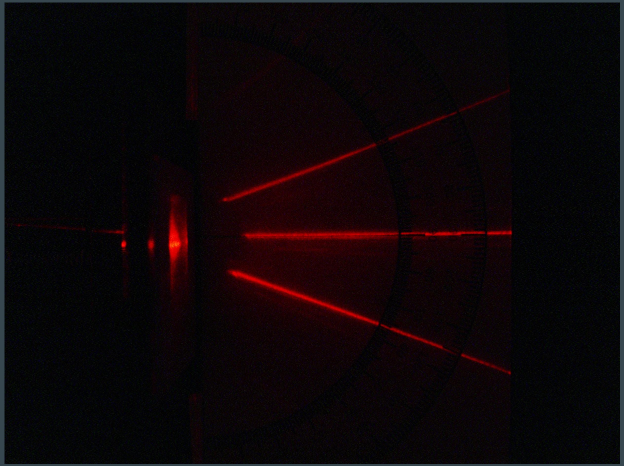
Requirement Analysis

- Detect potholes using image processing and accelerometer
- Correctly identify potholes with 80% success rate
- Correctly map location of pothole to 40 yard radius
- Store location, size, and depth into database
- Cost must be under $500

Implementations

- 3D Reconstruction
- Vibrations
- Image Processing

3D Reconstruction (Lasers)



- Time of Flight Concept
- Difficult to generate a controlled matrix of lasers
- Slight accuracy advantage over sonar implementation
- Need to cover whole road by rotating a laser
- Expensive and difficult to implement
- Time delay issues

Laser Product Specifics

Product: Lidar Lite

- Price: $84.55
- Error of 1 inch and functions up to 40 meters
- Shoots only a single beam, therefore we would need to rotate the device on a pivot to scan the entire road
- Reading time: 20ms *(at 35mph with no rotation there is a 1 foot blind spot)*
  - the blind spot increases with introduction of rotation and increasing speeds
- Danger of laser radiation when tampering with device
- Conclusion: A laser approach is too expensive and would not yield efficient results

Vibrations (Accelerometer)

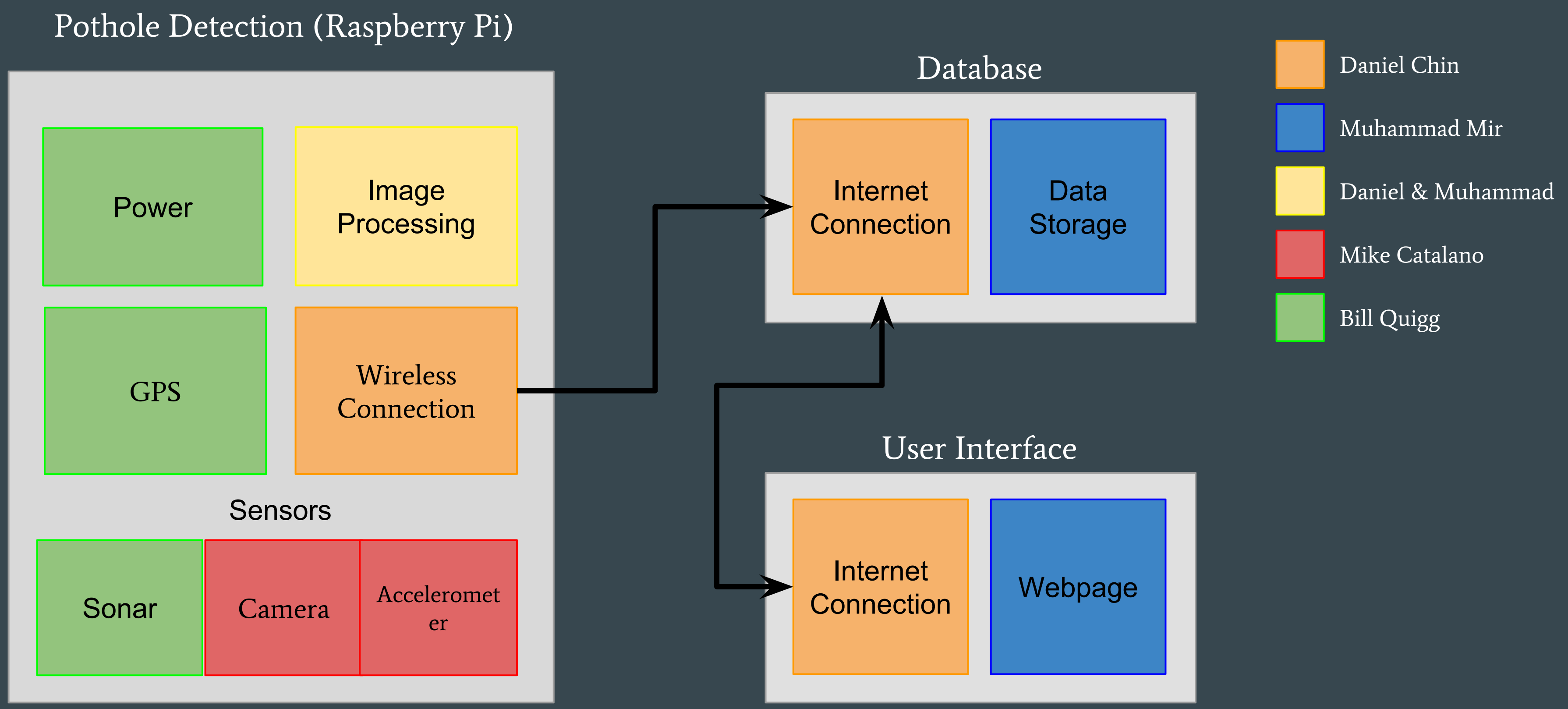
- Simple to implement
- Must sustain impact in order to collect data
- Vertical acceleration is analyzed to discern potholes from other road features
- Depth of pothole can be extrapolated from measurements

http://electronics.stackexchange.com/questions/56238/accelerometer-data-smoothing-filtering-pothole-detection

Image Processing

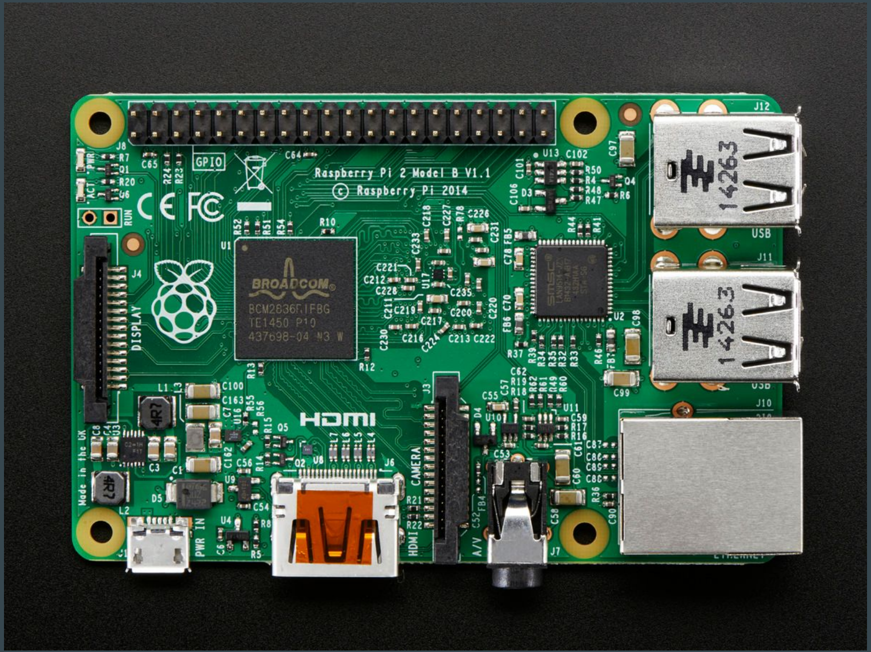
- Averages between 80-85% accuracy
- Can be low cost for testing purposes
- Complicated computations required to manipulate image
- Be able to gather data without needing to run over the pothole

Block Diagram



Raspberry Pi 2 Model B

- 900 MHz quad-core ARM Cortex-A7
- 1 GB RAM
- 4 USB ports
  - WiFi USB dongle
- Camera interface
- HDMI Interface
- Coded in C/C++



Power

Power Source - Cigarette lighter adapter (5V)

- All components operate on 5V or 3.3V
- Raspberry Pi has 4 USB ports (5V) and 3.3V/5V supply pins
- The GPS, Wifi Dongle, Accelerometer, Camera, and Pi itself will all consume power
- We plan on supplying all the power to the Raspberry Pi and then feeding it to the components attached to the Pi
- GPS (25mA), Dongle (70mA), Accelerometer (140uA), Camera (250mA), Pi (600mA)
- Max Power = (600mA+250mA+70mA+25mA+140uA)*5V = 945.1mA*5V = 4.73W
- The car outlet can source 4.73W and the Pi will function safely at that wattage

GPS - Adafruit Ultimate GPS

- GPS location update
  - Gives latitude and longitude to 4 decimals of precision (max error for both lat and long is 36 feet)
  - By the pythagorean theorem max error of GPS is 51 feet
  - Max update rate: 10 Hz
  - 5ft error due to 10 Hz update rate when driving 35mph
- Quick GPS location lock
  - 12 Channels
- Antenna
  - GPS L1 Frequency: 1575.42 MHz
- Inputs
  - Satellite Signal
  - Raspberry Pi Record Location Command
- Outputs
  - Location sent to Raspberry Pi

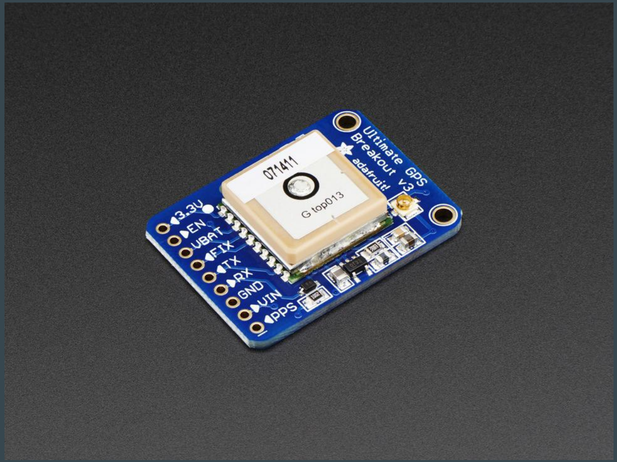
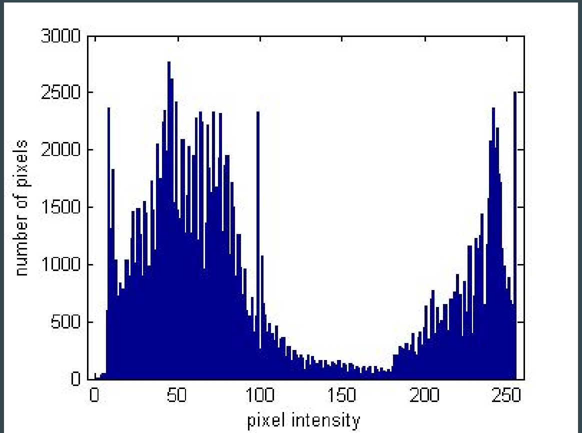
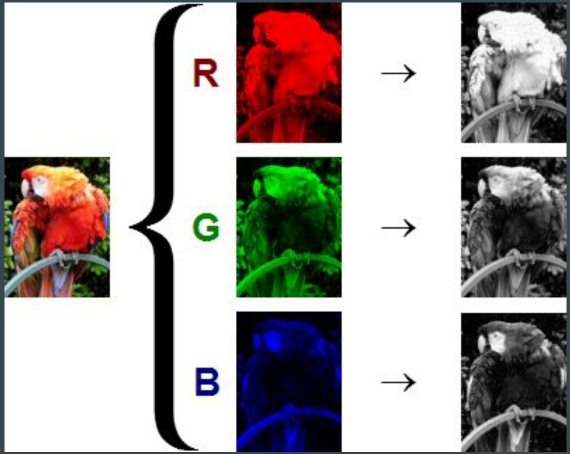


Image Processing Specifics

- Convert image from RGB to gray scale(black and white pixels)
- This makes the image into a binary one(each pixel is a 0 or 1 based on whether the value is greater or less than the threshold(T)
- Use Otsu's method for calculating threshold(T)
- Sort through and set threshold(T) such that background and potholes are separated
- The resulting image displays the pothole in white and the background in black
- Use edge detection to map pothole(size, depth)

$$g(x,y) = \begin{cases} 1, & o(x,y) \leq T \\ 0, & o(x,y) > T \end{cases}$$





Internet Connections (WiFi/Ethernet)

- Fast and reliable connection
- Send the processed information along with GPS location to database
- Display database information to web page
- WiFi
  - USB 802.11n Dongle
    - 150 Mbps max throughput
  - UMass Wireless Network

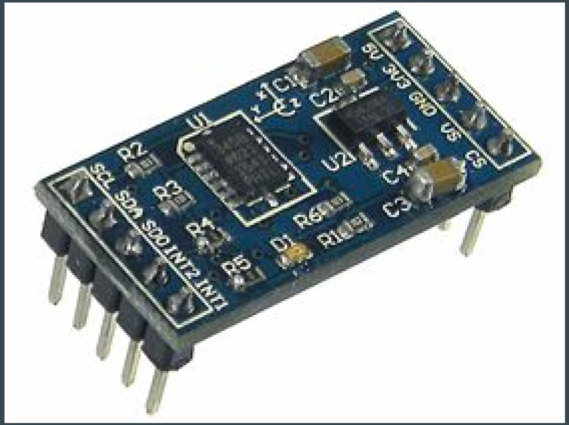
Camera

- Price: ~$30
- Camera resolution must be high enough to identify potholes
- The resolution cannot be too high as processing time will suffer
- Minimum shutter speed
- Possibly mount to bumper or roof of car
- 5MP, supports image resolutions up to 1080p

Accelerometer

Product: Triple-Axis Accelerometer - ADXL345

- Price: $4.95
- Acceleration range of ± 4g
- Typical driving conditions don’t exceed ± 3
- Low power consumption - 3.3V, 140uA



The Database/Webpage

- Wirelessly transmit data(location, size, depth) to a database
- Be able to view data on a webpage
- Display map with pothole locations

Problems

- Depth from image processing
- Wireless may not be available at all times
    - Store data until WiFi is available

MDR Deliverable

- Processed image and algorithms
- Parts (Raspberry Pi, wireless, gps, camera, accelerometer)
- Database for storing pothole specs will be set up

Questions?