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CSCI 4302

Advanced Robotics

Spring 2017

Homework 1

**Notes**

1. **Sensing**: ability to sense walls the width of corridors in the engineering center and as narrow as twice the vehicle’s width; can operate without significant blur at 5m/s
   1. SparkFun 9DoF Razor IMU MO - $49.95
      1. SAMD21 microprocessor with an MPU-9250 9DoF (9 Degrees of Freedom) sensor to create a tiny, reprogrammable, multipurpose IMU (Inertial Measurement Unit)
      2. Monitor and log motion, transmit Euler angles over a serial port or even act as a step-counting pedometer
      3. Features three 3-axis sensors – an accelerometer, gyroscope and magnetometer – to sense linear acceleration, angular rotation velocity and magnetic field vectors
      4. <https://www.sparkfun.com/products/14001>
   2. LIDAR-Lite v3 - $149.99
      1. Range: 0-40m Laser Emitter
      2. Accuracy: +/- 2.5cm at distances greater than 1m
      3. Power: 4.75–5V DC; 6V Max
      4. Current Consumption: 105ma idle; 130ma continuous
      5. Rep Rate: 1–500Hz
      6. Laser Wave Length/Peak Power: 905nm/1.3 watts
      7. Beam Divergence: 4 m Radian x 2 m Radian
      8. Optical Aperture: 12.5mm
      9. Interface: I2C or PWM
      10. <https://www.sparkfun.com/products/14032>
   3. Ultrasonic Sensor – HC – SR04 - $3.95
      1. Operating Voltage: 5V DC
      2. Operating Current: 15mA
      3. **Measure Angle: 15°**
      4. **Ranging Distance: 2cm - 4m**
      5. <https://www.sparkfun.com/products/13959>
2. **Electronics**: capable of driving itself independently of ‘shore power’ for at least twenty minutes
   1. 12.0V 2800mAh Rechargeable NiHm Battery Pack
      1. <http://www.robotshop.com/en/120v-2800mah-rechargeable-nimh-battery-pack.html>
   2. 3.5” TFT LCD 320x480 Touch Display for Raspberry P
      1. <http://www.robotshop.com/en/35i-tft-lcd-320x480-touch-display-raspberry-pi.html>
   3. USA Raspberry Pi Micro USB Power Supply Charger – 5V 1500ma
      1. <https://www.amazon.com/Raspberry-Pi-Micro-Supply-Charger/dp/B00DZLSEVI>
3. **Computation**: at least 1 GHz, quad-core processor; at least 64 GB storage; at least 1 GB memory
   1. Samsung 64GB 80MB/s EVO Select Micro SDXC Memory Card
      1. <https://www.amazon.com/Samsung-Select-Memory-MB-ME64DA-AM/dp/B01DOB6YQA/ref=pd_pgd_B010Q588D4_B01DOB6YQA/165-2851743-1769706?pf_rd_m=ATVPDKIKX0DER&pf_rd_s=lpo-top-stripe-1&pf_rd_r=QJNDAZCH629YHZZ36BCJ&pf_rd_t=201&pf_rd_p=2786512802&pf_rd_i=B010Q588D4>
   2. Raspberry Pi 3 - $39.95
      1. **Broadcom BCM2837 64bit ARM Cortex-A53 Quad Core Processor SoC running @ 1.2GHz**
      2. **1 GB RAM**
      3. 4 x USB2.0 Ports with up to 1.2A output
      4. Expanded 40-pin GPIO Header
      5. Video/Audio Out via 4-pole 3.5mm connector, HDMI, CSI camera, or Raw LCD (DSI)
      6. **Storage: microSD**
      7. 10/100 Ethernet (RJ45)
      8. BCM43143 WiFi on board
      9. **Bluetooth** Low Energy (BLE) on board
      10. Low-Level Peripherals:
          1. 27 x GPIO
          2. UART
          3. I2C bus
          4. SPI bus with two chip selects
          5. +3.3V
          6. +5V
          7. Ground
      11. Power Requirements: 5V @ 2.4 A via microUSB power source
      12. <https://www.sparkfun.com/products/13825>
4. **Mechanical**: all sensors, electronics and compute mounted on a four-wheeled vehicle
   1. ~~Smart Car Chassis 4WD - $28.99~~ 
      1. <http://www.robotshop.com/en/smart-car-chassis-4wd.html>
   2. Iron Man-1 4WD Indoor Chassis - $80.00
      1. <http://www.robotshop.com/en/iron-man-1-4wd-indoor-chassis.html>
5. **Safety**: at least capable of being remotely killed from within 5m line-of-sight
   1. Make use of Raspberry Pi’s **Bluetooth connection** to make a remote kill command
6. **Budget**: $500

**BOM**

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| --- | --- | --- | --- |
| **COMPONENT** | **QUANTITY** | **COST** | **LINK** |
| **Sensing** | | | |
| SparkFun 9DoF Razor IMU MO | 1 | $49.95 | <https://www.sparkfun.com/products/14001> |
| Ultrasonic Sensor – HC – SR04 | 1 | $3.95 | <https://www.sparkfun.com/products/13959> |
| LIDAR-Lite v3 | 1 | $149.99 | <https://www.sparkfun.com/products/14032> |
| **Electronics** | | | |
| 12.0V 2800mAh Rechargeable NiMh Battery Pack | 1 | $48.99 | <http://www.robotshop.com/en/120v-2800mah-rechargeable-nimh-battery-pack.html> |
| 3.5” TFT LCD 320x480 Touch Display for Raspberry Pi | 1 | $24.99 | <http://www.robotshop.com/en/35i-tft-lcd-320x480-touch-display-raspberry-pi.html> |
| Raspberry Pi Micro USB Power Supply Charger – 5V 1500ma | 1 | $8.42 | <https://www.amazon.com/Raspberry-Pi-Micro-Supply-Charger/dp/B00DZLSEVI> |
| **Computation** | | | |
| Raspberry Pi 3 | 1 | $39.95 | <https://www.sparkfun.com/products/13825> |
| Samsung 64GB 80MB/s EVO Select Micro SDXC Memory Card | 1 | $19.99 | <https://www.amazon.com/Samsung-Select-Memory-MB-ME64DA-AM/dp/B01DOB6YQA/> |
| **Mechanical** | | | |
| Iron Man-1 4WD Indoor Chassis | 1 | $80.00 | <http://www.robotshop.com/en/iron-man-1-4wd-indoor-chassis.html> |
|  |  |  |  |
| Total (foreseen) cost = $426.23 | | | |
| **Miscellaneous** | | | |
| Screws, bolts, cables, replacement parts, etc… + ~$50 such that stays under max budget of $500 | | | |

**Write Up**

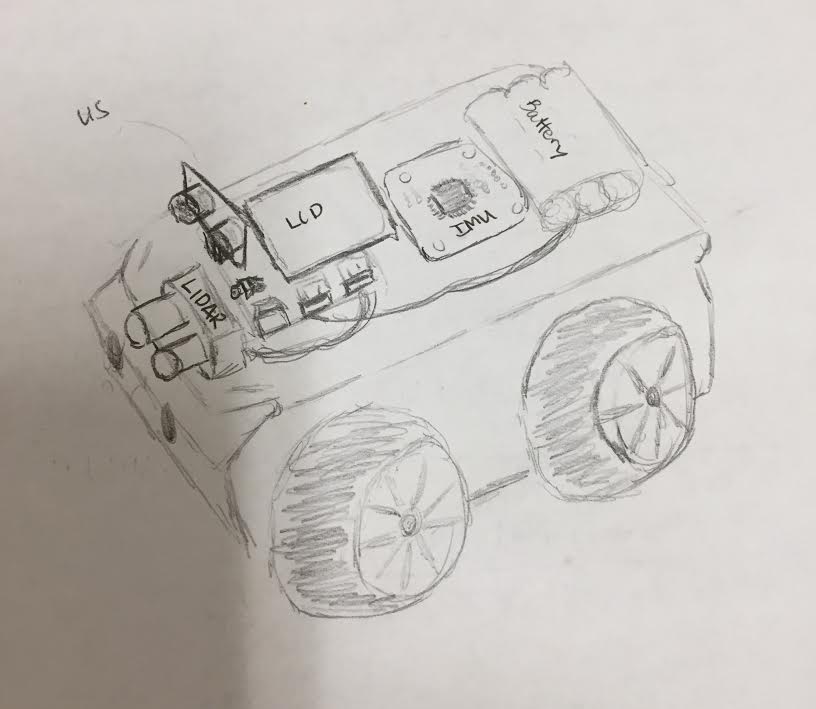
My “Iron Man” robot is optimal for indoor conditions and meets all requirements. I decided to make use of three separate sensors, the IMU, US and LIDAR, whose combined efforts should allow for practical control indoors. The US and LIDAR sensors will work to capture walls, boundaries, and other obstacles up to a range of 4m and 40m, respectively, and the IMU along with the other sensors will play a role in maintaining the robot odometry while moving.

To ensure the robot has plenty of power to meet the 20 minute minimum I opted in for a 12V battery as well as a separate charging pack meant for Raspberry Pi. Along with these electrical appliances I also decided to get an LCD screen as I like to see feedback from and on the robot. This doesn’t make a difference in being “optimal” for the environment but it is still a nice feature to have.

For the computation aspect of the robot I found that Raspberry Pi 3 would be a good fit. This is a quad core processor running at 1.2 GHz, which surpasses the minimum requirement. It also has 1 GB of RAM and a micro SD card slot that can support a 64 GB card. This single board computer also supports Bluetooth connections which I plan to utilize for accomplishing remote kill calls via a laptop command.

Lastly, and as stated before, the “Iron Man” chassis was built for indoor environments so there should be no problem handling those surfaces with this 4WD robot.

**Sketch of Iron Man**

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