Autonomous Rugged Maze Navigating Robot

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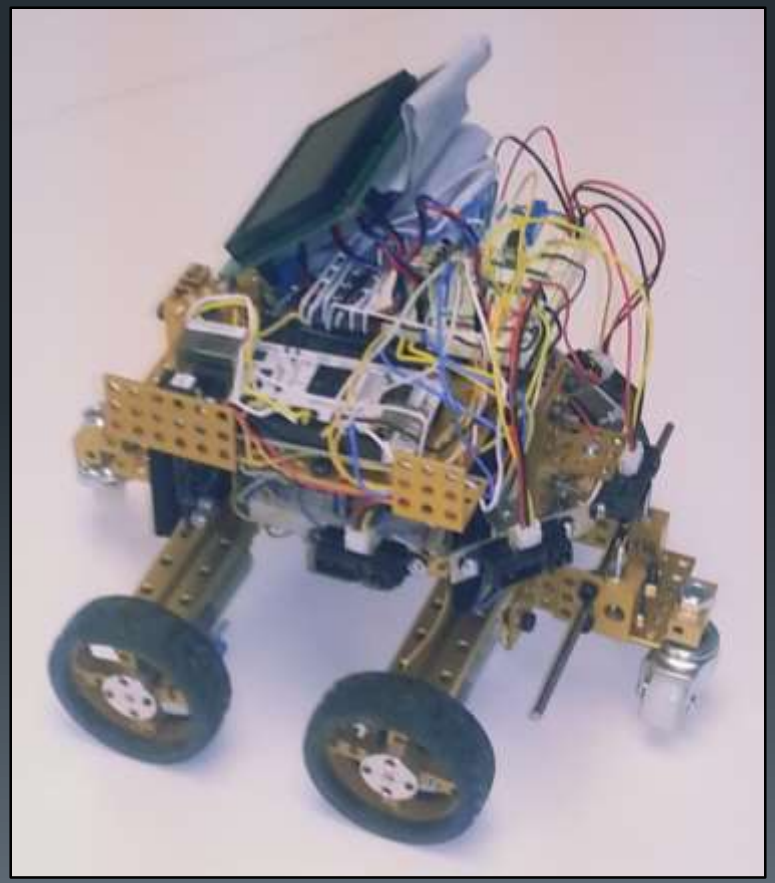
4/27/2013

Senior Design II

Objective 1

- 4WD Autonomous Robot to venture through a rugged maze
  - Slip Detection – Shaft Encoder
  - Sense maze walls with sensors (IR, etc.)
  - 3-axis accelerometer to measure tilt
  - LCD display (system status)
  - Host processor: TI BeagleBone
    - Bonescript



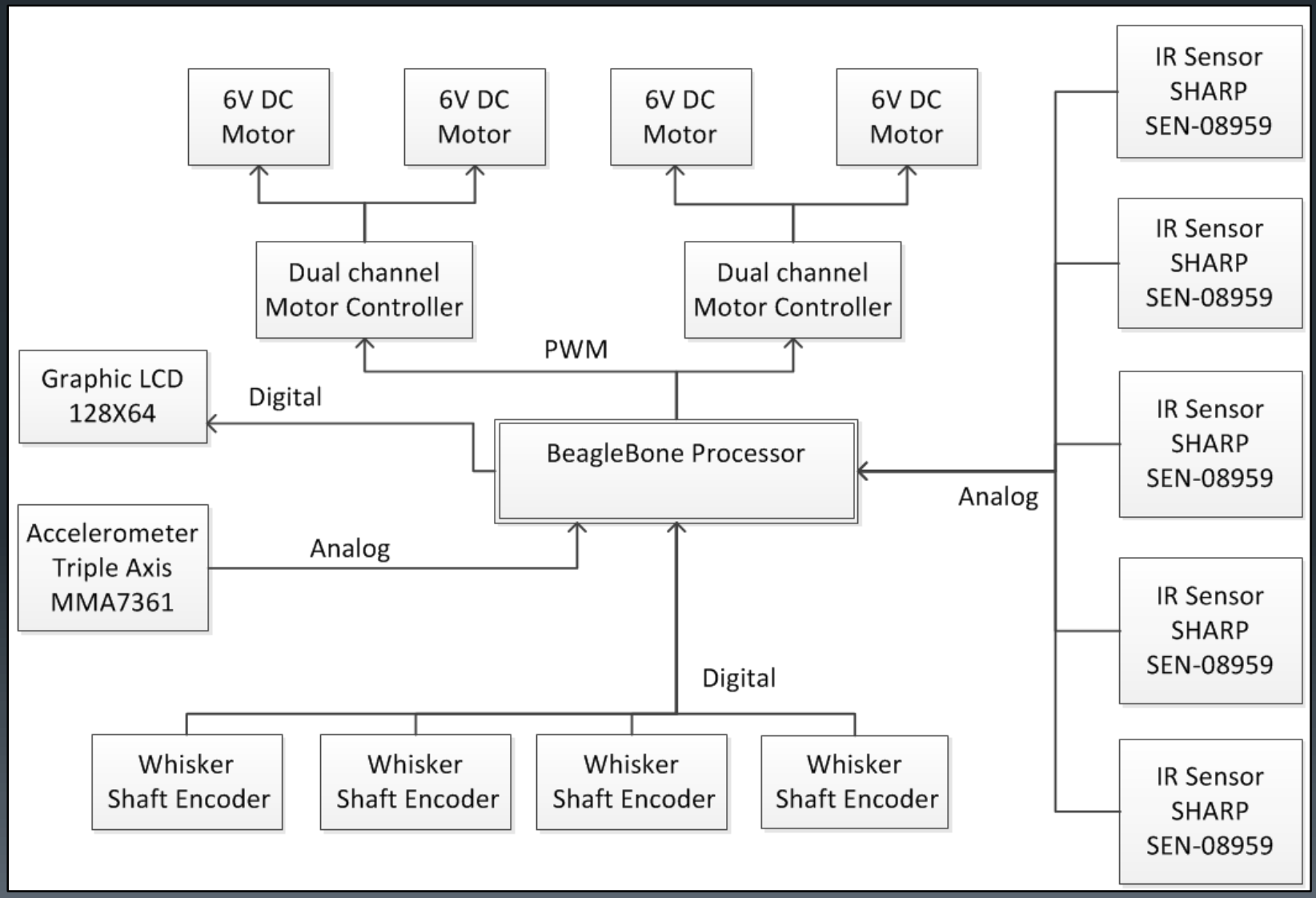
Objective 2

- Maze Mapping

The Maze

- Rugged
  - Plaster
  - Smallest Width = 20 cm
  - Average Width = 30 cm
  - Max Grade = 60°
- Flat
  - Width = 40 cm

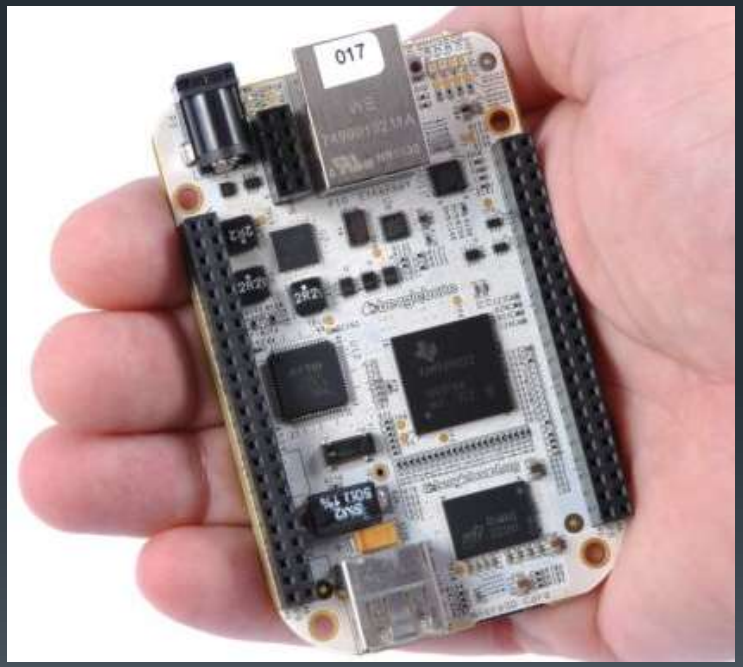
Block Diagram



Processor

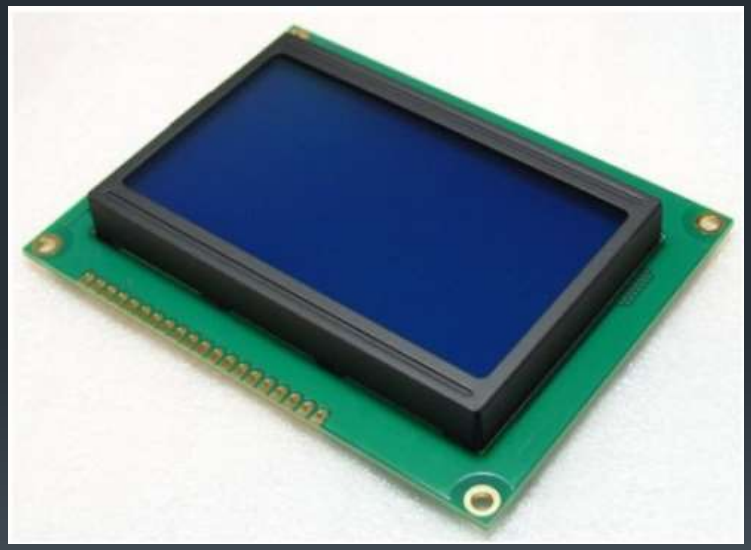
Texas Instruments BeagleBone

- ARM architecture, Linux operating system using Bonescript development environment
- 3.3 V (250 mA) and 5 V (1 A) output power lines
- 66 GPIO pins
  - VOH 3.3 V, 4-6 mA / VOL 0.4 V
  - VIH 2.0 V / VIL 0.8 V
- 8 PWM signals
- 7 ADC channels – 1.8 V
- 5 V, 2 A Power Supply
- Memory
  - 256 MB 400 MHz EEPROM
  - 4GB Micro-SD Flash Memory

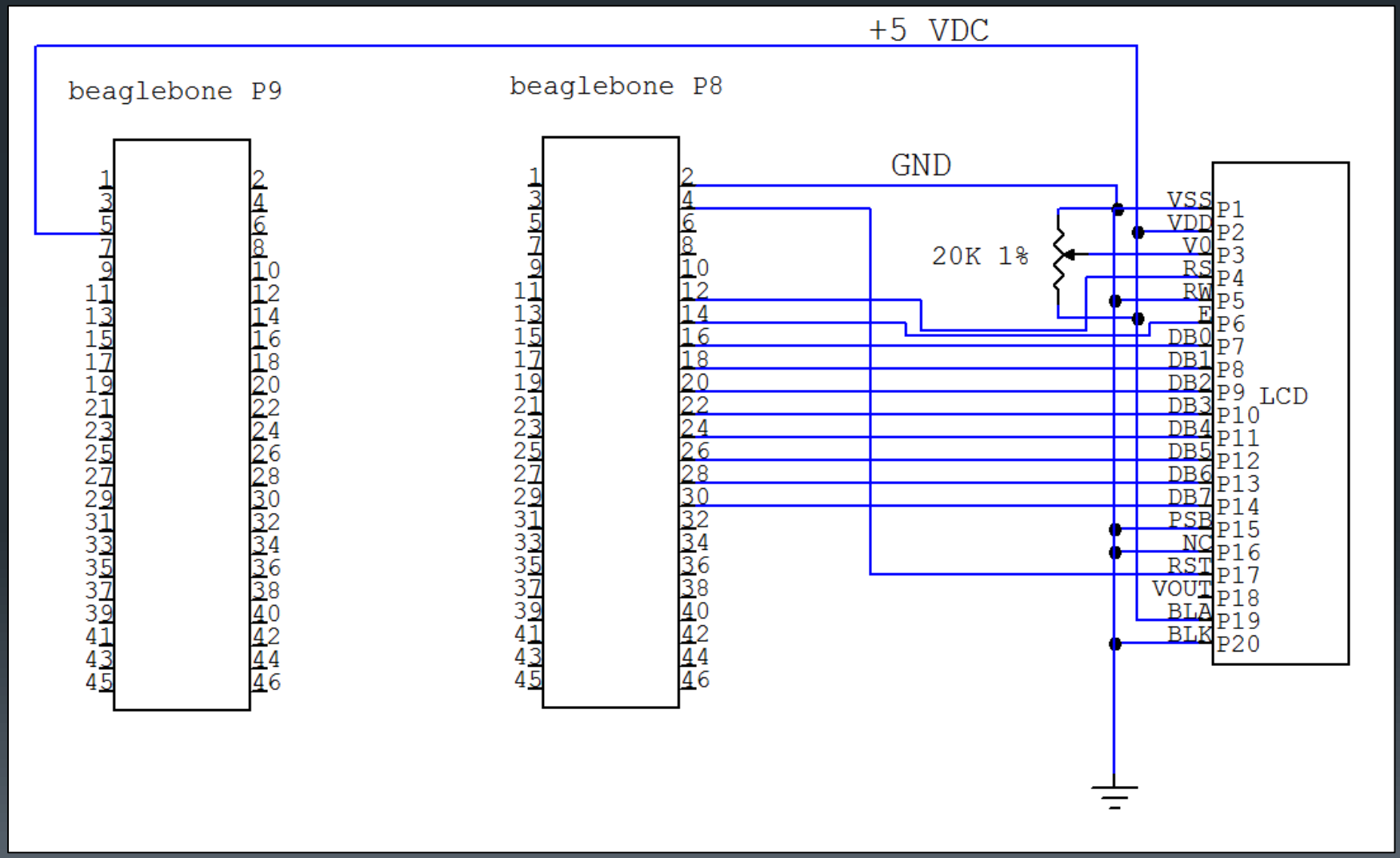


Graphical LCD , 128x64

- 10 pin Parallel Connection
  - 8 Data, RS, Enable, RW tied to ground
- 5 V Power
- 3.3 V Operation Voltage
- Display System Status

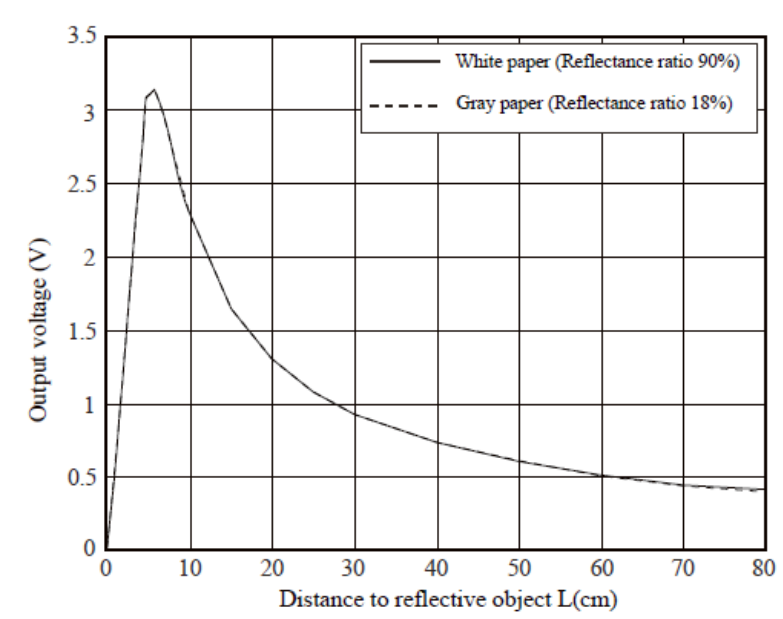


LCD Interface Circuit

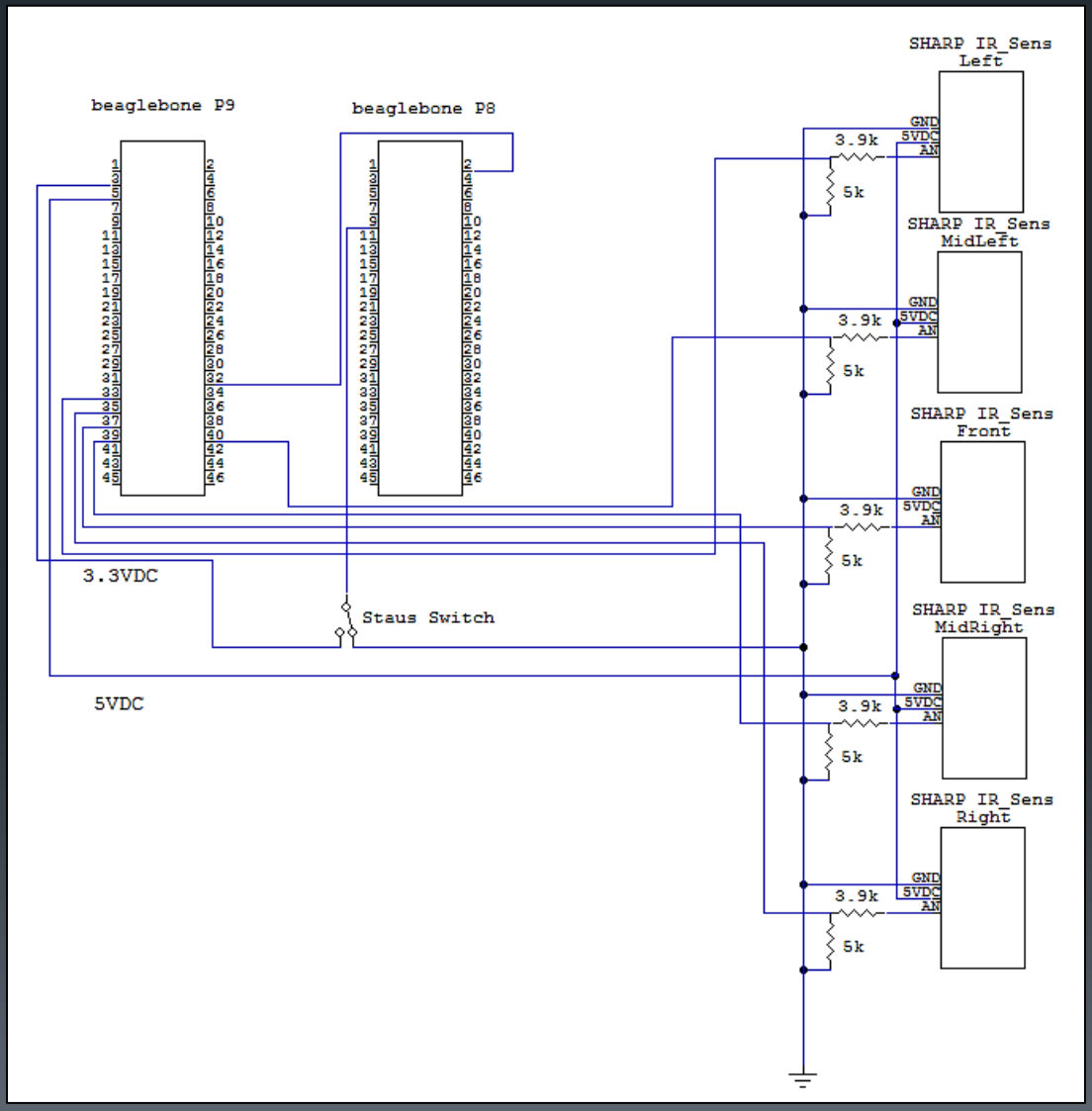


Infrared Proximity Sensors

- 5 – Sharp IR Sensor SEN-08959
  - Power: 4.5-5.5 V (recommended) at 30 mA (typical)
  - Range: 10cm-80cm (outputs 2.15 V – 1.65 V)
  - Resolution: 1 cm (from tests)

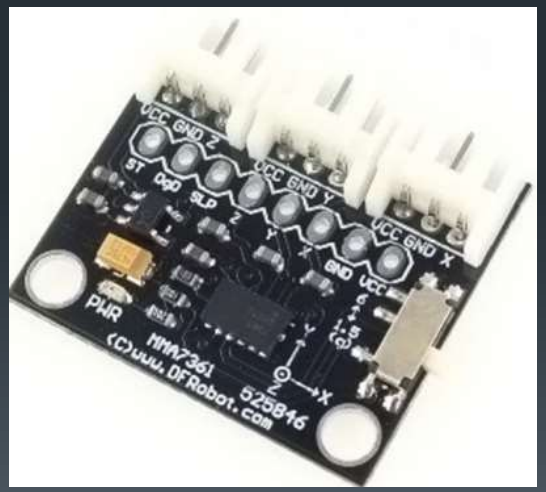


IR Sensor Interface

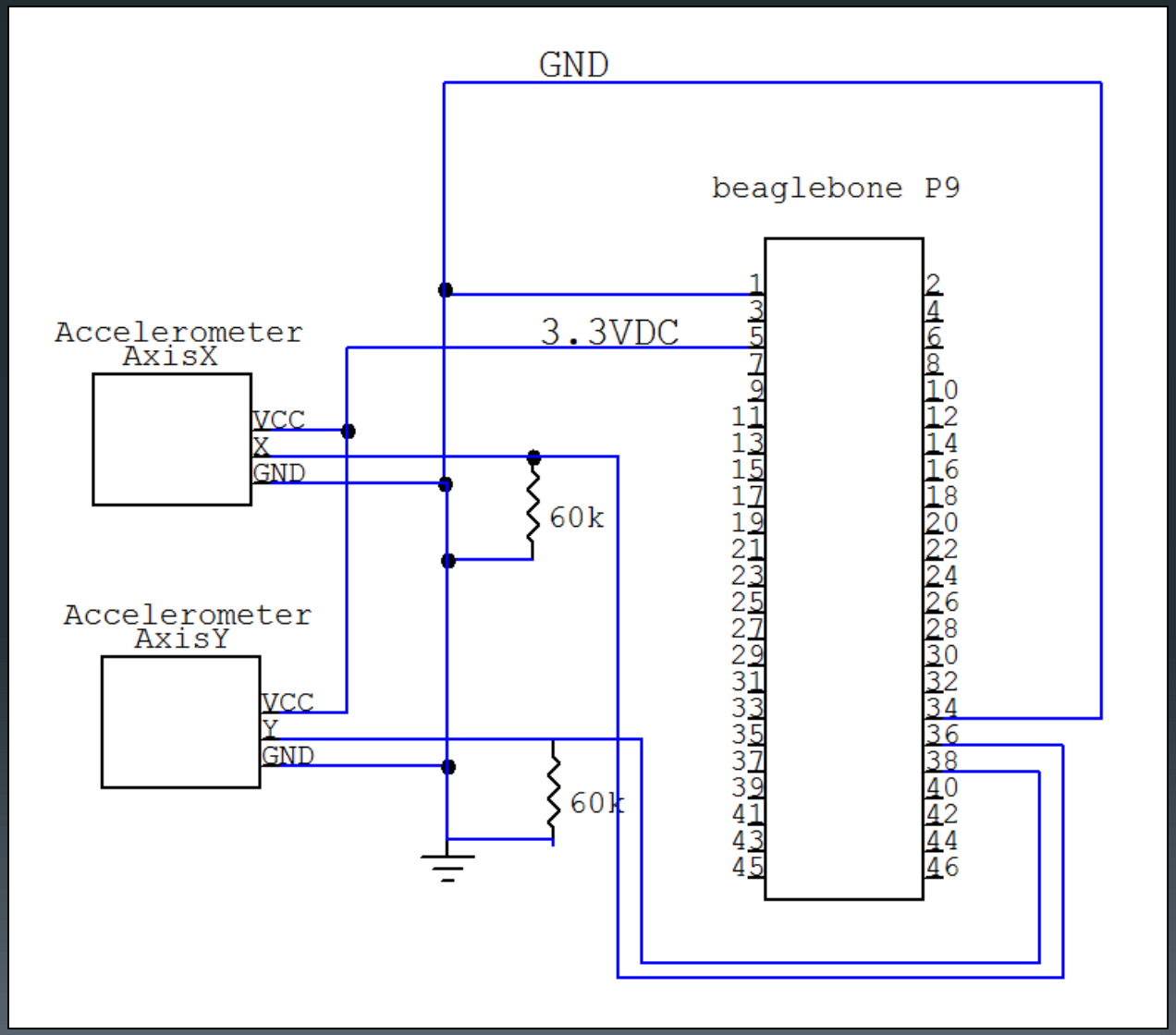


Accelerometer

- 3-Axis, Analog Output
- Supply Voltage: 5 V (typical)
- MMA7260QT Micromachined Accel.
  - Voltage Operation: 2.2 – 3.3 V
  - 0.5 V = -90°
  - 1.6 V = 0°
  - 2.5 V = +90°



Accelerometer Interface



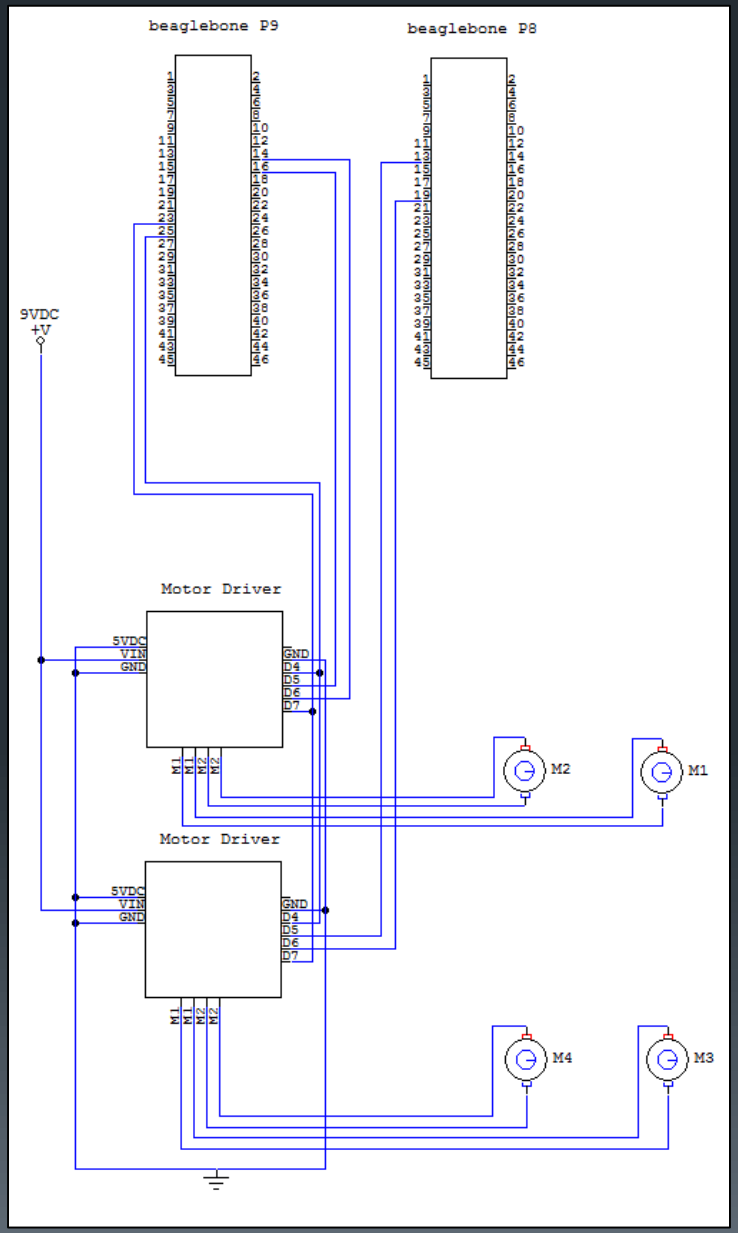
1A Motor Controller (Dual Channels)

- Logic Supply – 3.3 or 5 V
- Motor Supply Voltage – 36 V max
- PWM control (max 7 V)
  - Input High – 2.3 V (min) 100 µA (max)
  - Input Low – 1.5 V (max) -10 µA (max)
- Push-Pull 4 Channel Driver
  - L293B
- 2 AND Gates
- LED’s for motor direction/activation

Motor Controller Interface

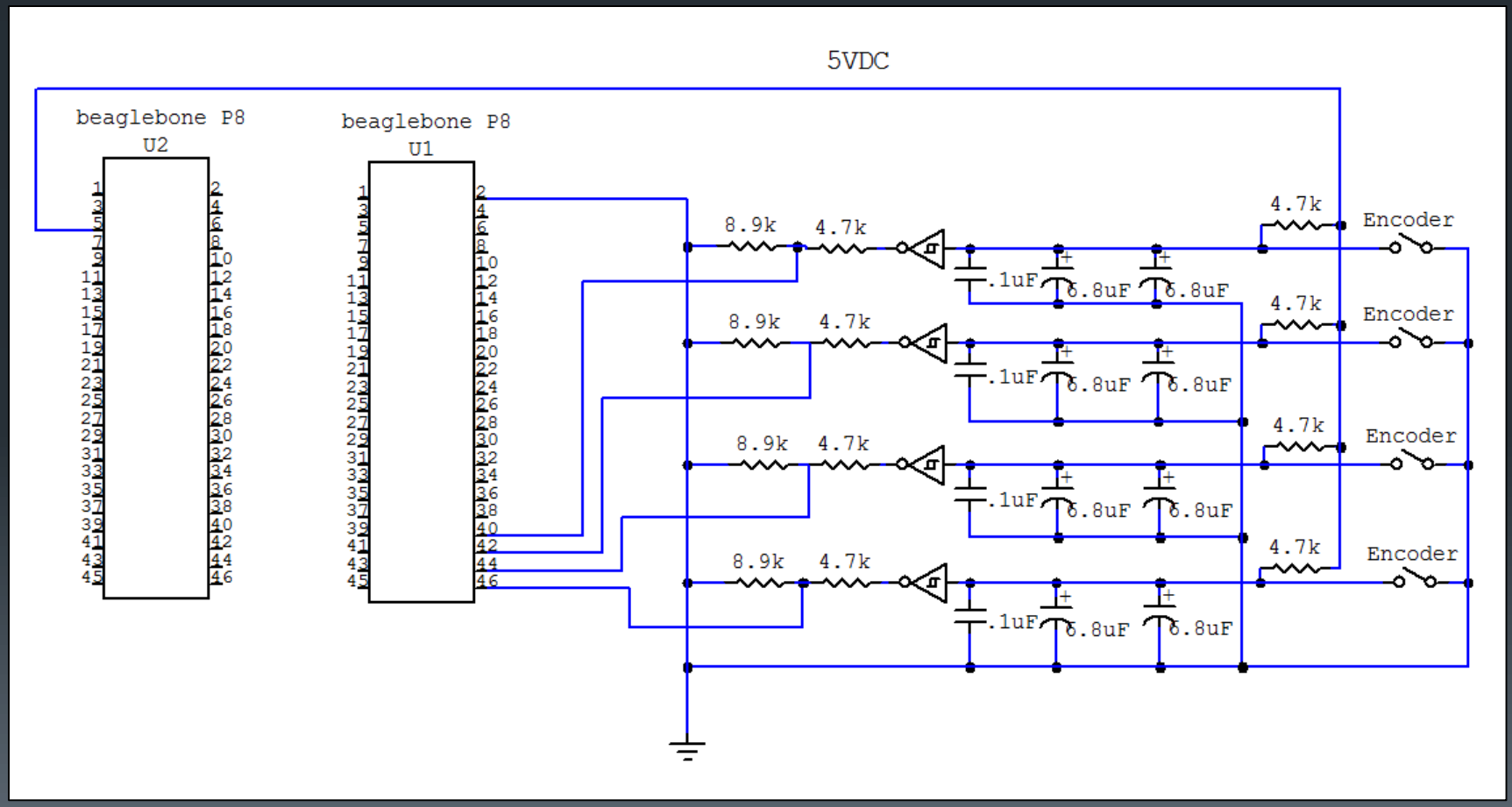
- Power Supply

  9 V, 1.5 A



Whisker Shaft Encoder

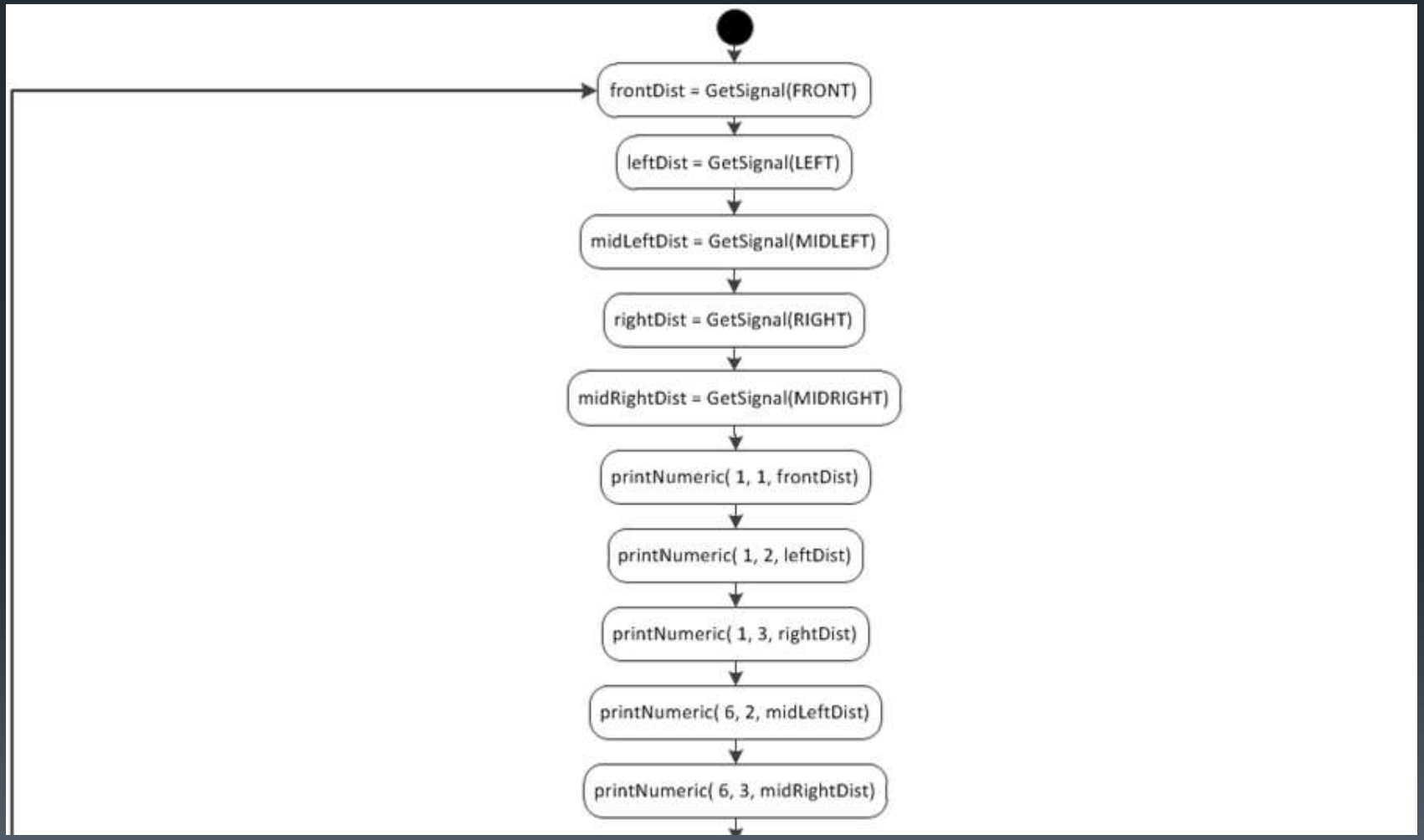
- 5 V input, 3.3 V Output
- Output based on Wheel Clicks



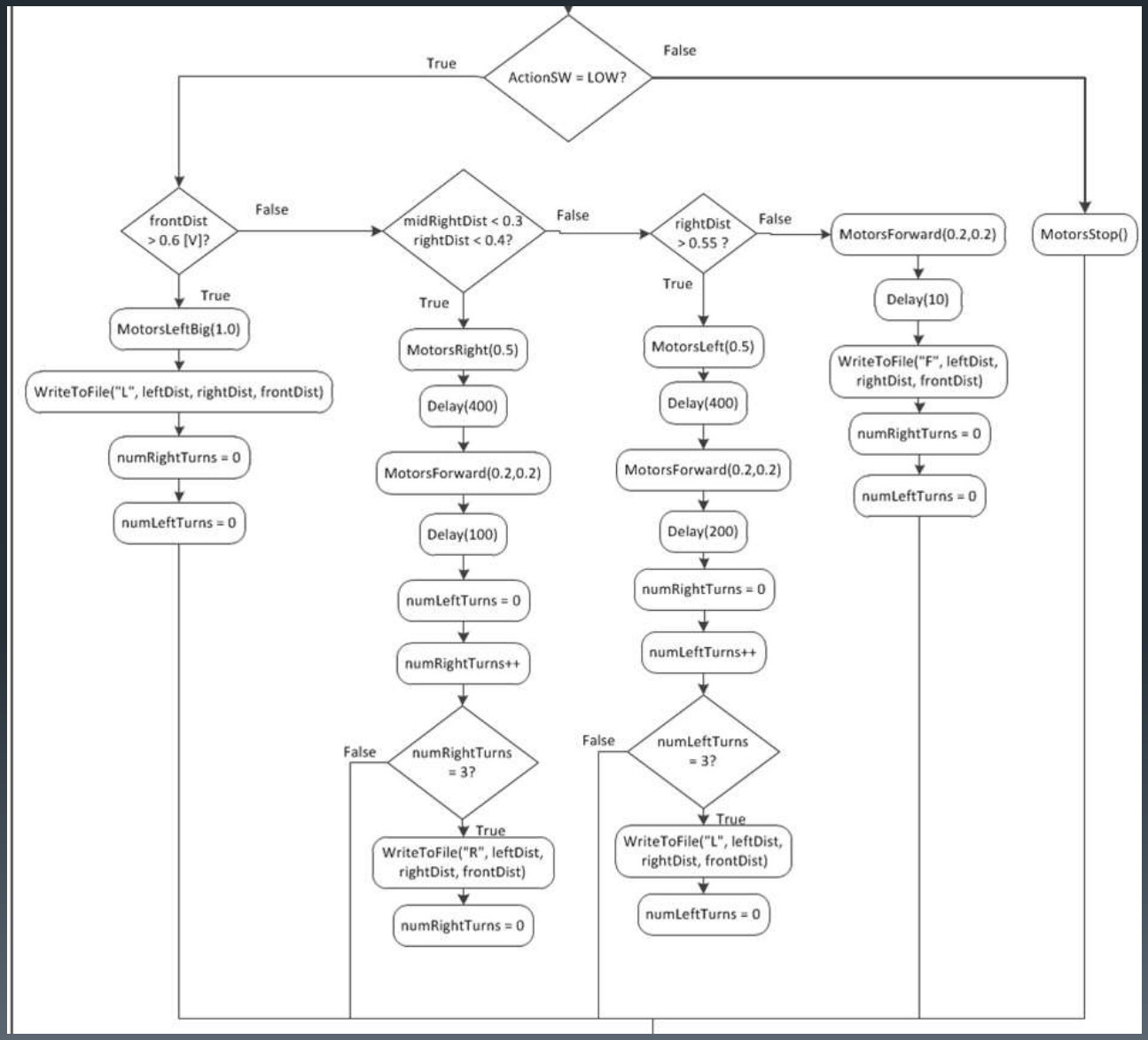
Vehicle Platform

- 1 – Makeblock Ultimate Robot Kit
  - 4 - 6-12 V motors

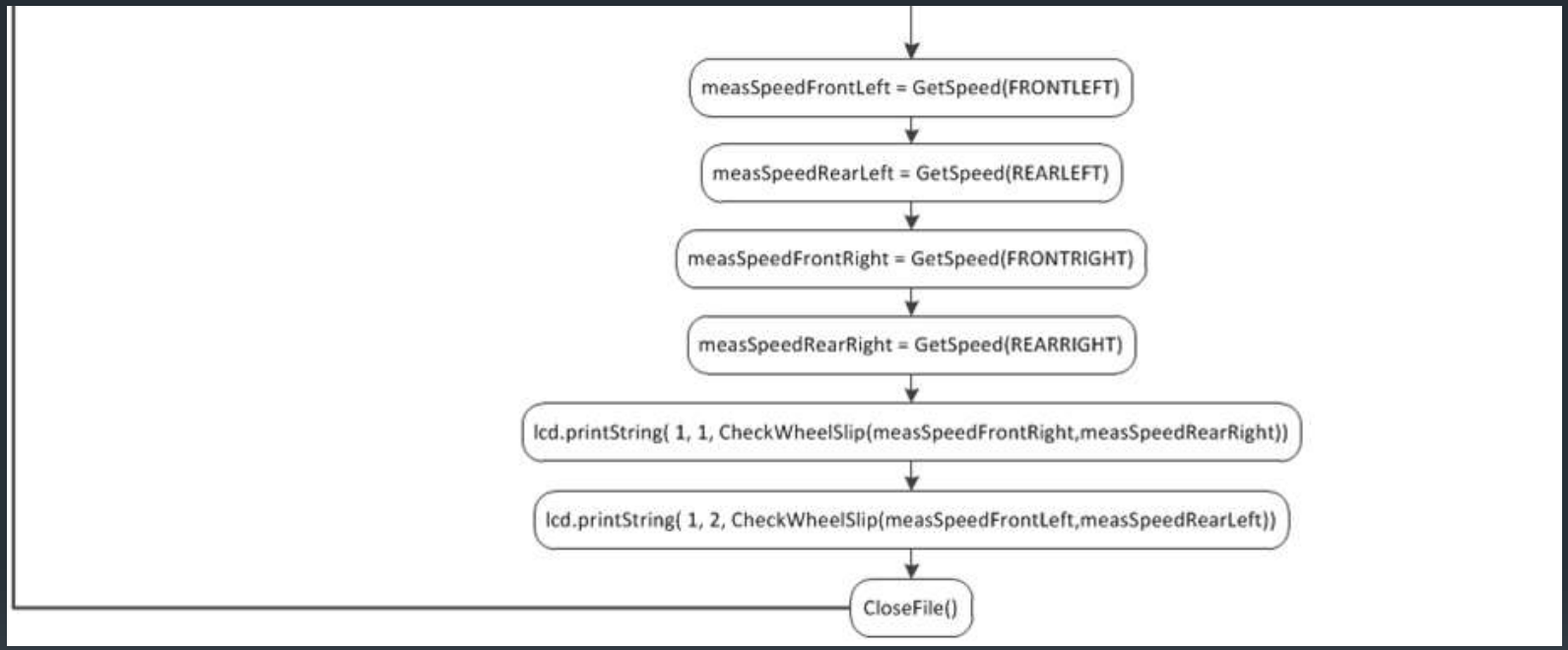
UML Diagram – Main 1



UML Diagram – Main 2



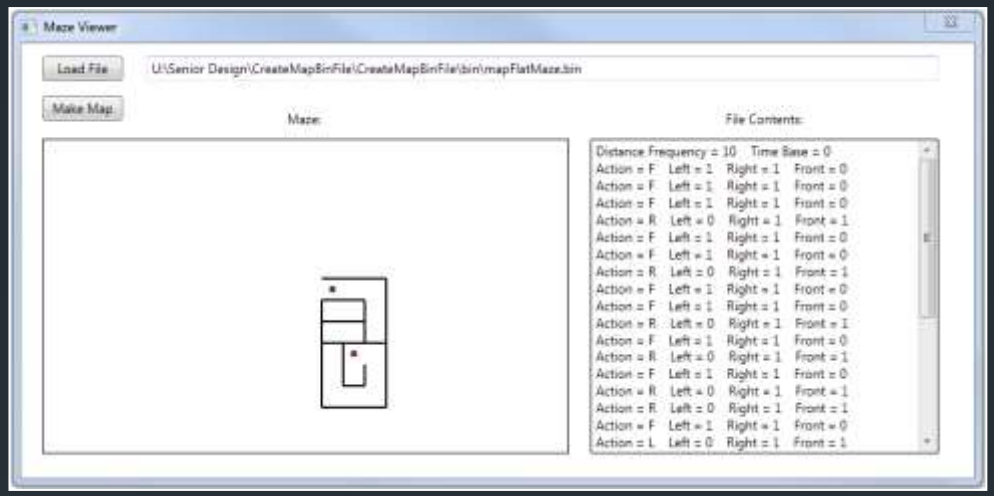
UML Diagram – Main 3



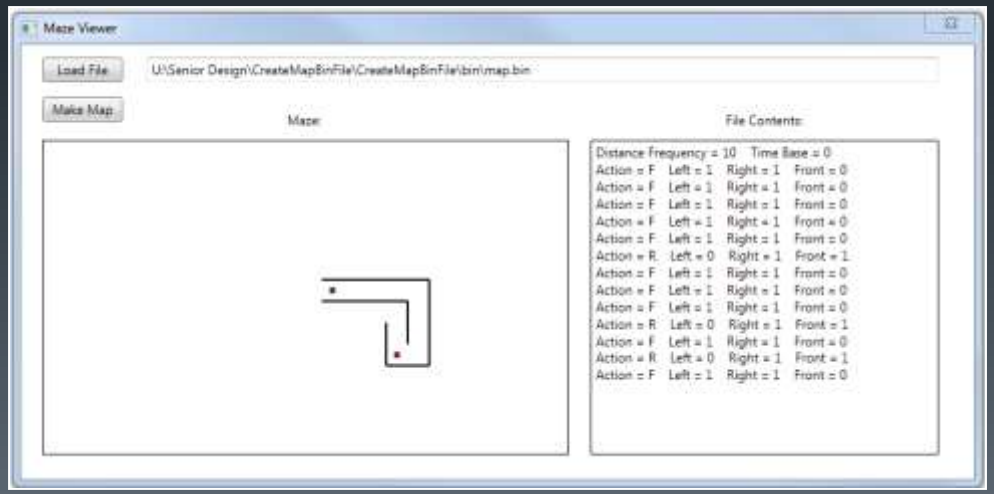
Map Maker Application

- Loads the map file (.bin) from the Beaglebone

Flat Maze:



Rugged Maze:

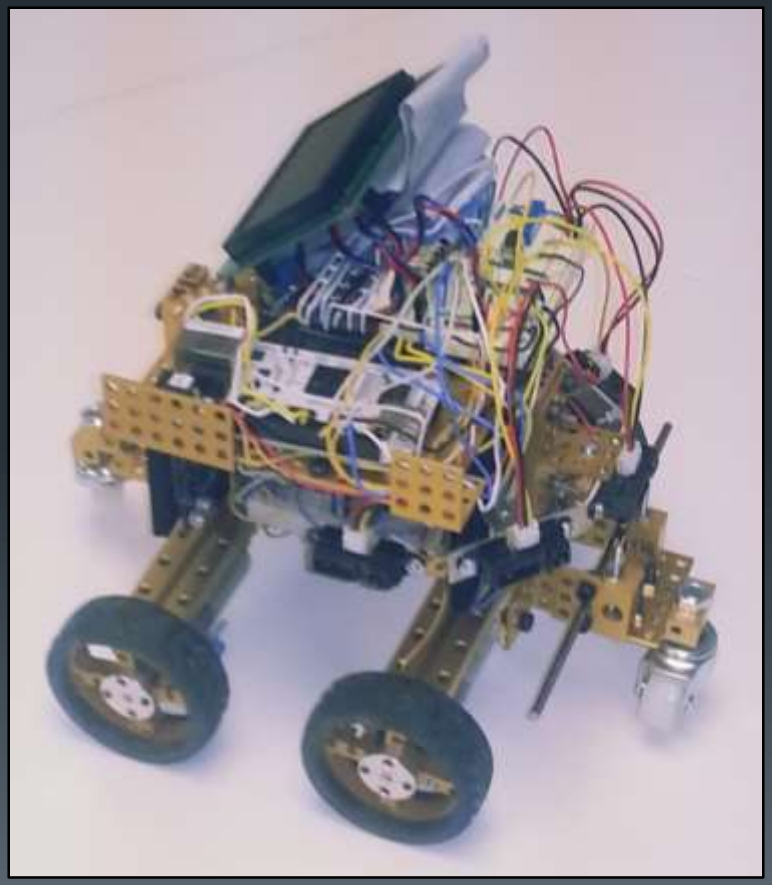


Costs

Component	Price	Qty.	Note
BeagleBone	$89.00	1	Donated by TI
Graphical LCD	$18.00	1	Donated by DFRobot
Triple Axis Accelerometer	$16.00	1	Donated by DFRobot
1A Motor Shield	$14.00	2	Donated by DFRobot
Sharp SEN-08959 IR Sensor	$13.95	5	Donated by Dr. Barrett
Makeblock Ultimate Robot Kit	$210.00	1	Donated by Epic Tinker
Total	**$430.75**		

Results

- Flat Maze
  - 100% Successful without wall collision
- Rugged Maze
  - Unable to pass 60° grade



Problems Encountered

- Ultrasonic Sensors
- Logic Level Converters
- Access to Internal Clock
- Interrupts

Questions?