P-BOT R2

INTERFACE MODULE

Technical Manual Rev 2r0

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The P-BOT R2 Interface Module is a general robot interface board that in addition contains a set of electronics subsystems so as to enable you to construct mobile robots with no difficulty. It has a 2-channel DC motor driver, 3-channel collision sensor, and a 3-channel analog comparator that works flawlessly with line sensor array or the same sensors. It is a user-friendly educational platform that enables direct programming on the board itself.

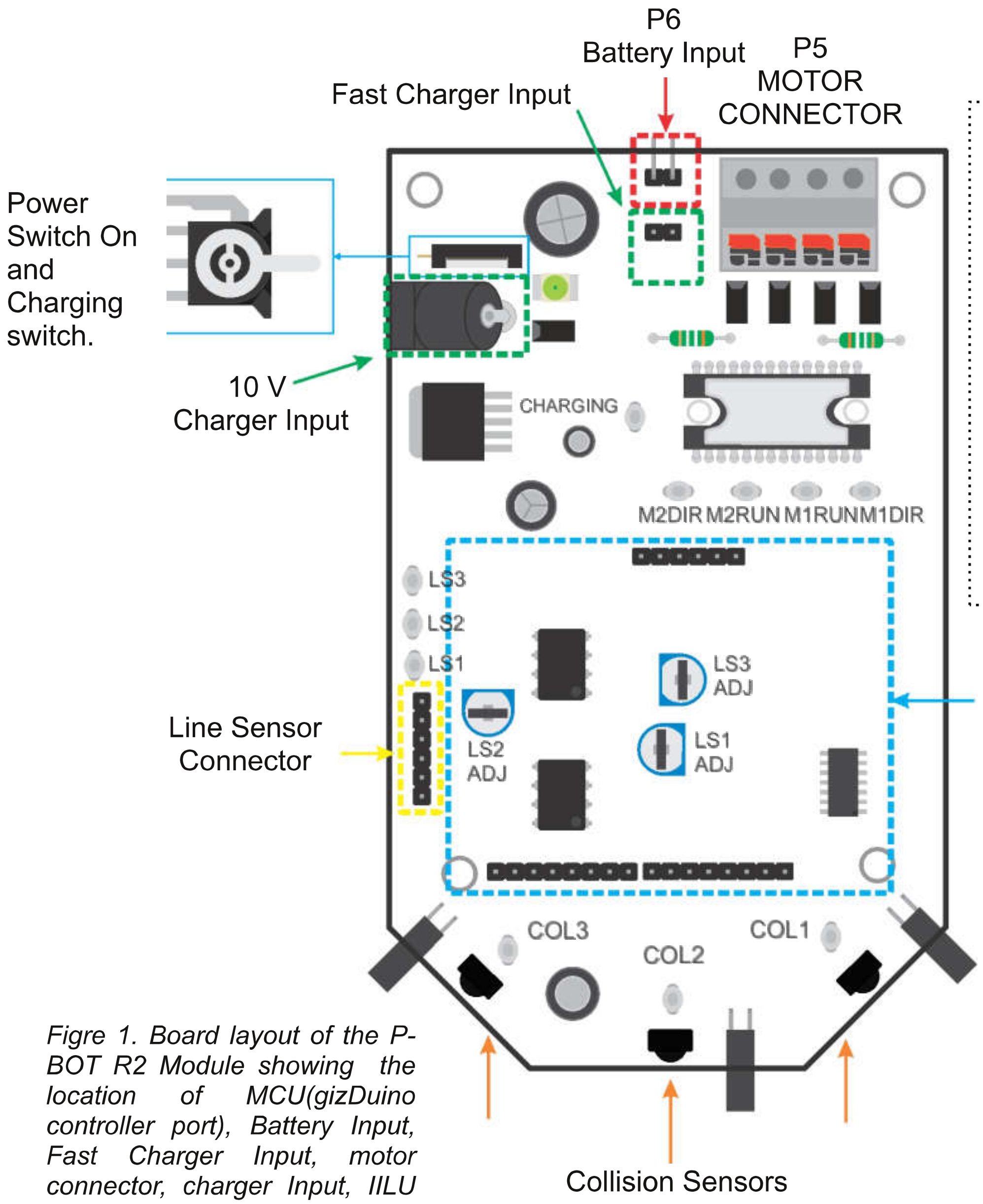
It has a 7.2 V 800mAh Ni-MH rechargeable batteries as its power supply. Later on in this manual, the wiring diagram shall be shown with two options to recharge your battery.

One of the minor revisions of the P-BOT is its power switch and MCU port orientation. The power switch is still a two state switch for charging and on-state. The orientation of the MCU port is intended for allowing the user to see the motor LED indicators that show whether the mobile robot is turning left, right, forward or backward for easier programming and troubleshooting.

This robot kit is absolutely for students, hobbyists, and for researchers that would like to learn basic MCU programming. It is based on the old mobile robot project used by students in their experiments to explain how sensors and an MCU work.

This mobile robot kit is still available disassembled and assembled depending on the purpose of the buyer.

Despite the revisions, the P-BOT R2 is still compatible for MCU boards such as the e-Gizmo Gizduino, Gizduino + or X, Pinguino, and Z8duino.



Figre 1. Board layout of the P-BOT R2 Module showing the location of MCU(gizDuino controller port), Battery Input, Fast Charger Input, motor connector, charger Input, IILU switch, and line sensor connector.

Toggle the switch as shown in this figure.

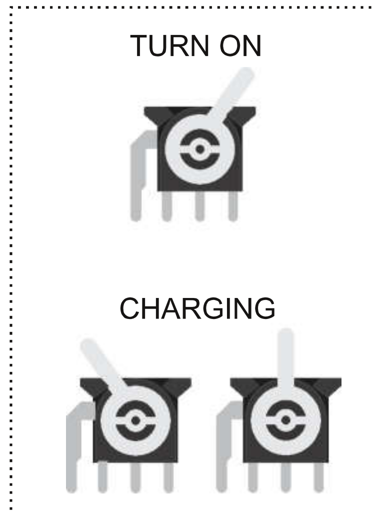


Figure 2. ILLU switch Illustrations:

PIN I.D	Descriptions
P5	Connections for Motor Drivers
P6	Battery Input and Charger Input (Fast Charger - approx. 1 hour)
P8	gizDuino Controller Port
P9	Connections for Line Sensors
SW1	Power and charging Switch
10 V Charger	Charger Input (10V Charger Adaptor - approx. 6 hours)

Table 1. Pin connections and descriptions.

LED INDICATORS

Table 2. LED indicators and Descriptions.

LED	PIN I.D	Descriptions
D1	COL3	Collison Sensor 3 (LOW-on state)
D2	COL2	Collision Sensor 2 (LOW-on state)
D3	COl1	Collision Sensor 1 (LOW-on state)
D7	LS1	Line Sensor 1:(Analog Comparator1) LOW-on state
D8	LS2	Line Sensor 2: (Analog Comparator 2) LOW-on state
D9	LS3	Line Sensor 3: (Analog Comparator 3) LOW-on state
D10	M1DIR	Motor Driver1 Direction (Forward/Reverse)
D11	M1RUN	Motor Driver 1 Run
D12	M2RUN	Motor Driver 2 Run
D13	M2DIR	Motor Driver 2 Direction (Forward/Reverse)
D18	-	Power Indicator
D21	CHARGING	Charging Indicator

LINE SENSOR ADJUSTMENTS

Table 3. Line Sensor Adjustments

COMP	PIN I.D	Descriptions
RV1	LS1 ADJ	Line Sensor 1 Adj
RV2	LS2 ADJ	Line Sensor 2 Adj
RV3	LS3 ADJ	Line Sensor 3 Adj

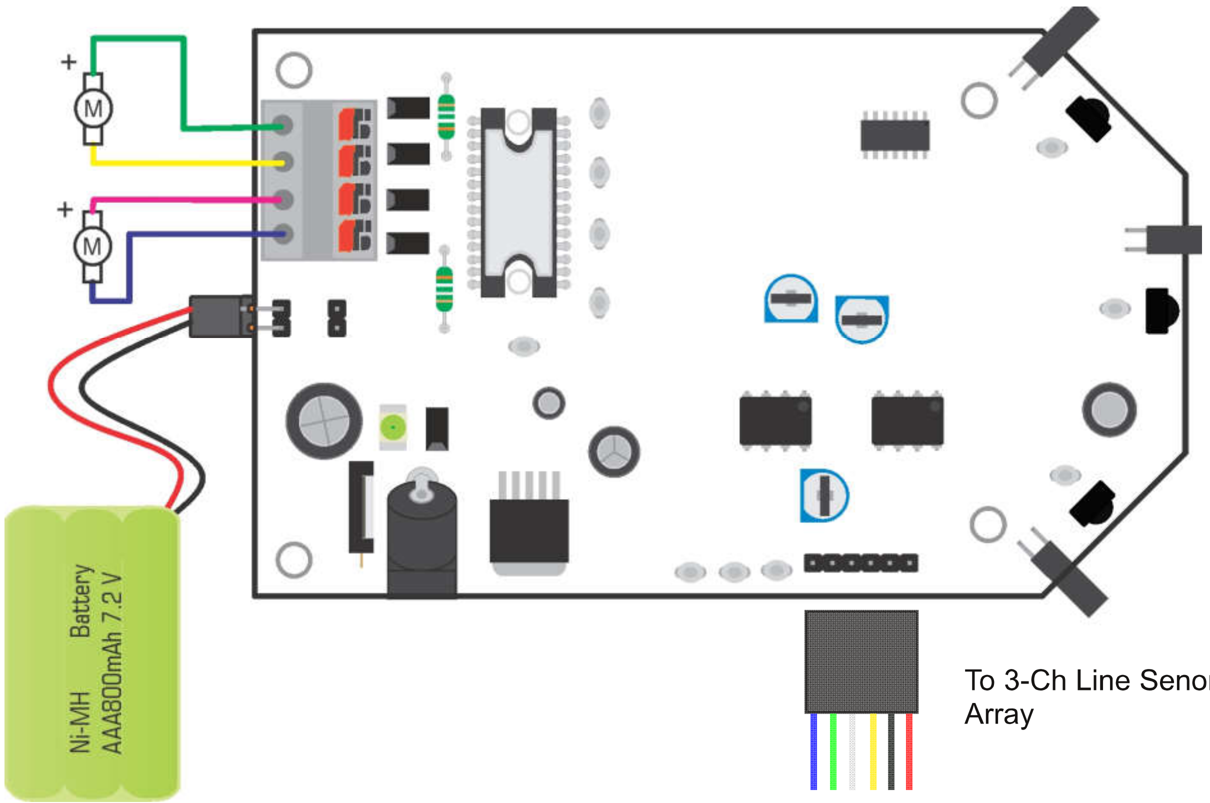


Figure 3. Motor and Battery Wiring Diagram along with the line sensor array connection illustration

Similar to the P-BOT rev 1r0, the P-BOT rev 2r0 have the same motor and battery connections. The line sensor connection is shown in Fig.3 wherein the input supply of the sensor array is indicated as the red wire on the 6-pin female connector of the line sensor array. The polarity of the battery port is also shown to avoid short circuits but due to the revision, the board essentially have a short-circuit proof configuration to avoid batteries blowing up.

A system block diagram of P-BOT R2 module is shown in Figure 4. It consists of a 3-analog comparator for line sensors, 3 channel collision sensor circuit, motor driver circuit.

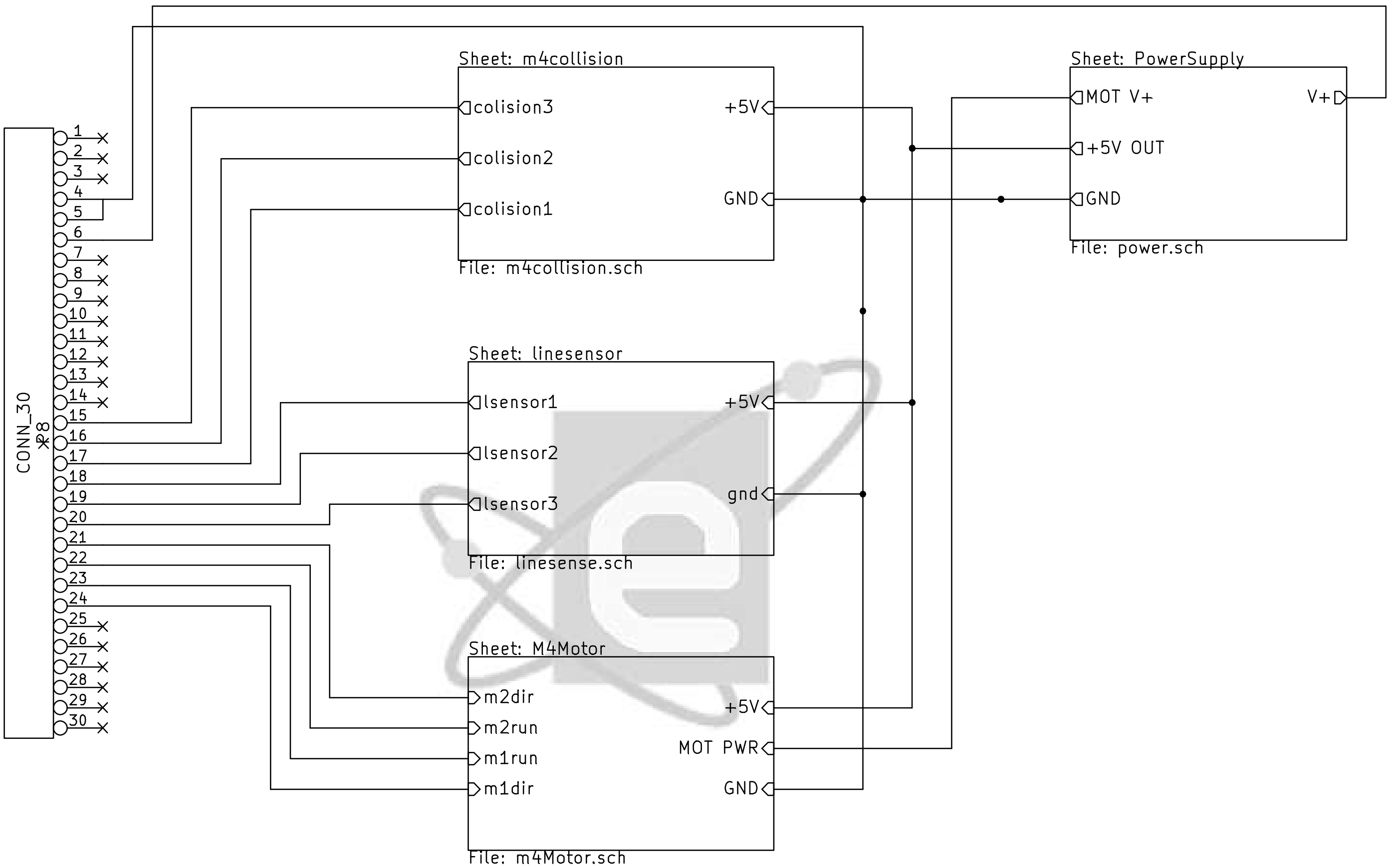


Figure 4. System Block Diagram of P-BOT R2 module.

The concept of each circuit block shall be shown on the next three pages along with sample applications and explanations.

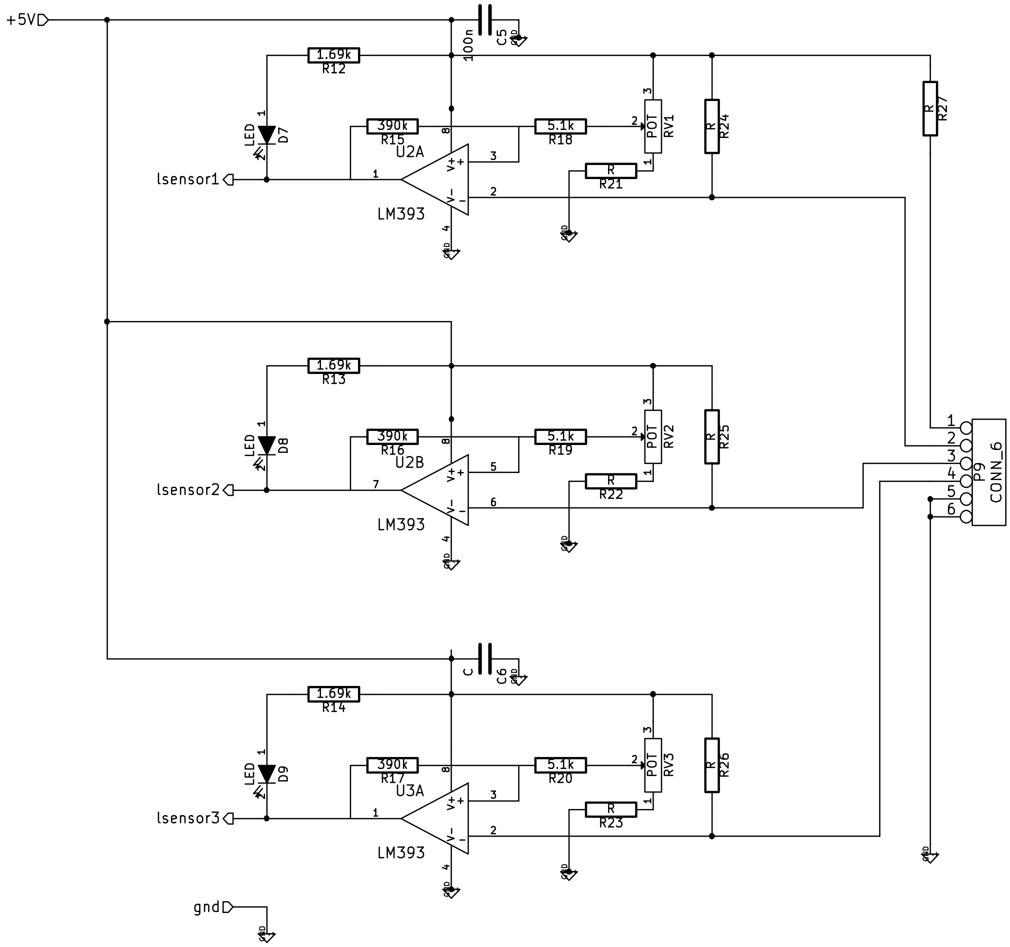
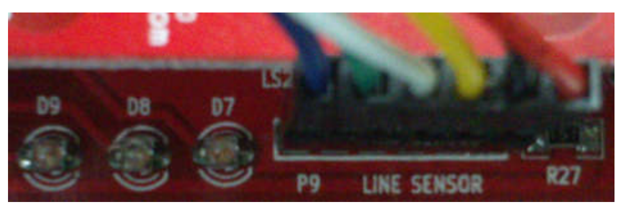


Figure 5. 3-channel analog comparator circuit schematic diagram.



Analog comparator mostly converts analog voltage appear at its input into a single bit digital logic signal.

The process is trouble-free and straightforward. The reference voltage is fed to the positive(+) input of the comparator. Then If the analog input fed through the – input exceeds the reference voltage, the comparator output switches to logic low. Or else, it assumes a logic HIGH state. (figure 3).

The sensitivity of the three comparators can be separately set by adjusting their reference voltage through their corresponding adjust trimmers (See Table 3. Line Sensor Adjustments descriptions).

3-channel analog comparator is a common analog interface circuit. It can be used as well with other sensors with 0-5VDC output range functioning as a single bit analog to digital converter(ADC).

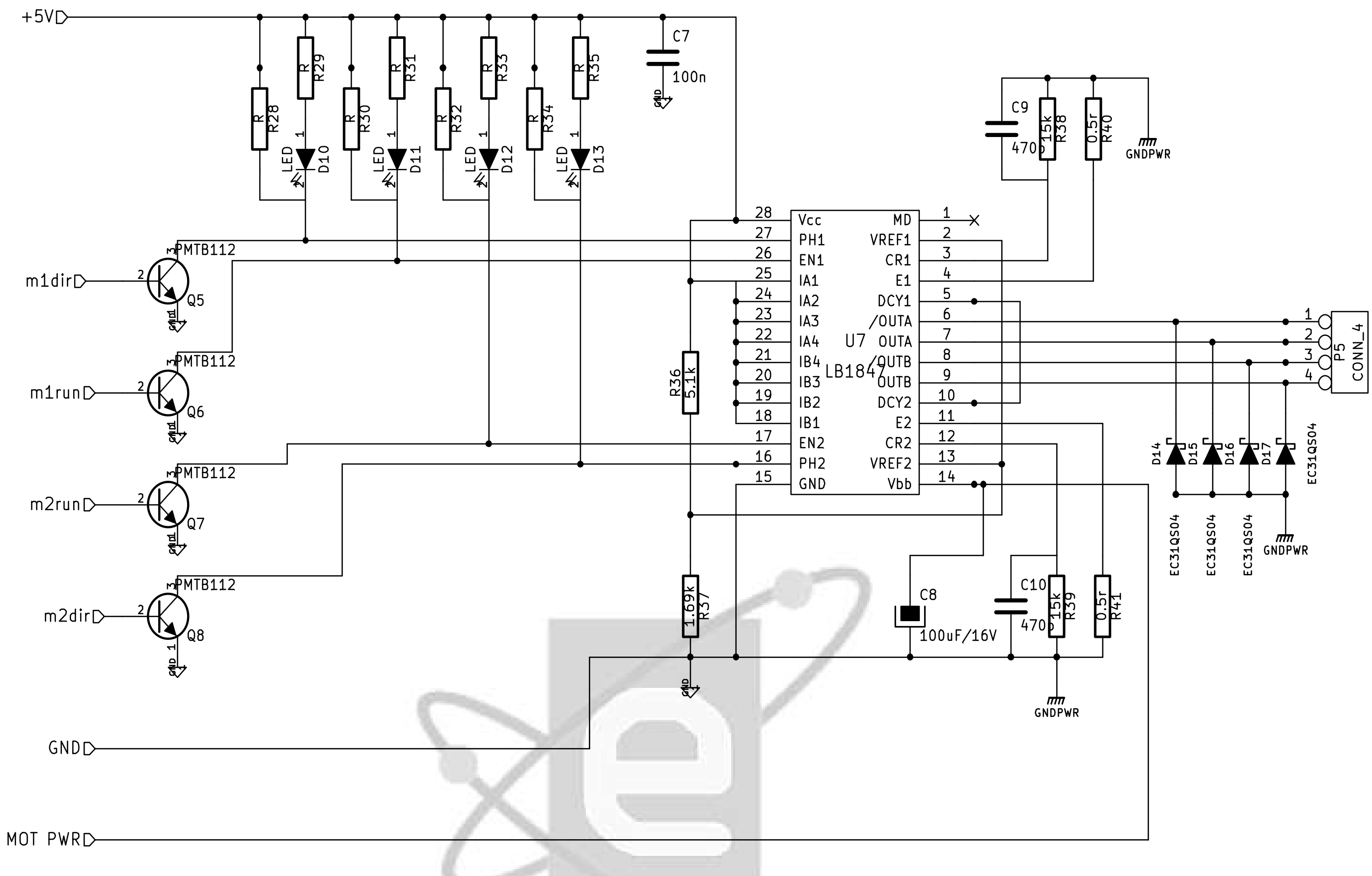


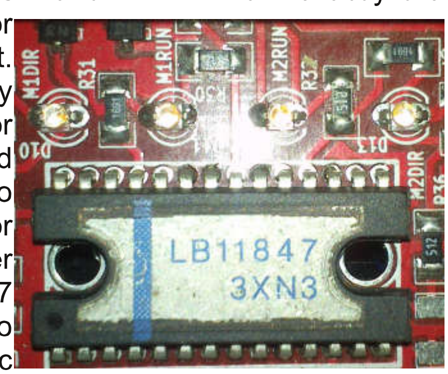
Figure 6. Schematic Diagram of Motor Driver circuit

The U7 motor driver circuit is the connection circuit between your controller and the motor. The controller can scheme the operation of the motor through a series of simple logic output combinations through this circuit.

The motor drivercircuit U7 is the bridge circuit between your controller and the motor. Through this circuit, the controller can orchestrate the operation of the motor through a series of simple logic output combinations.

For illustration, turn on Motor 1 (M1), then set the M1RUN input to logic HIGH. To change the motor rotation direction (forward/reverse), change the logic state of M1DIR accordingly. Note the forward or reverse rotation will depend on the polarity of your motor connection. If the motor run in the opposite direction that you expected in a particular M1DIR state (e.g. Logic High), simply swap the motor1 connections at the motor output terminals. If you want to change the speed of rotation, you can simply do so by PWM control of M1RUN input.

The M2RUN and M2DIR work exactly the same way for motor2 output. The U7 is actually a stepper motor driver configured to function as two channel DC motor driver. Buffer circuits Q5 to Q7 are added to ensure logic compatibility with the installed controller. D10 (M1DIR), D11 (M1RUN), D12 (M2RUN), and D13 (M2DIR) present a visual state indicator of the motor driver control inputs.



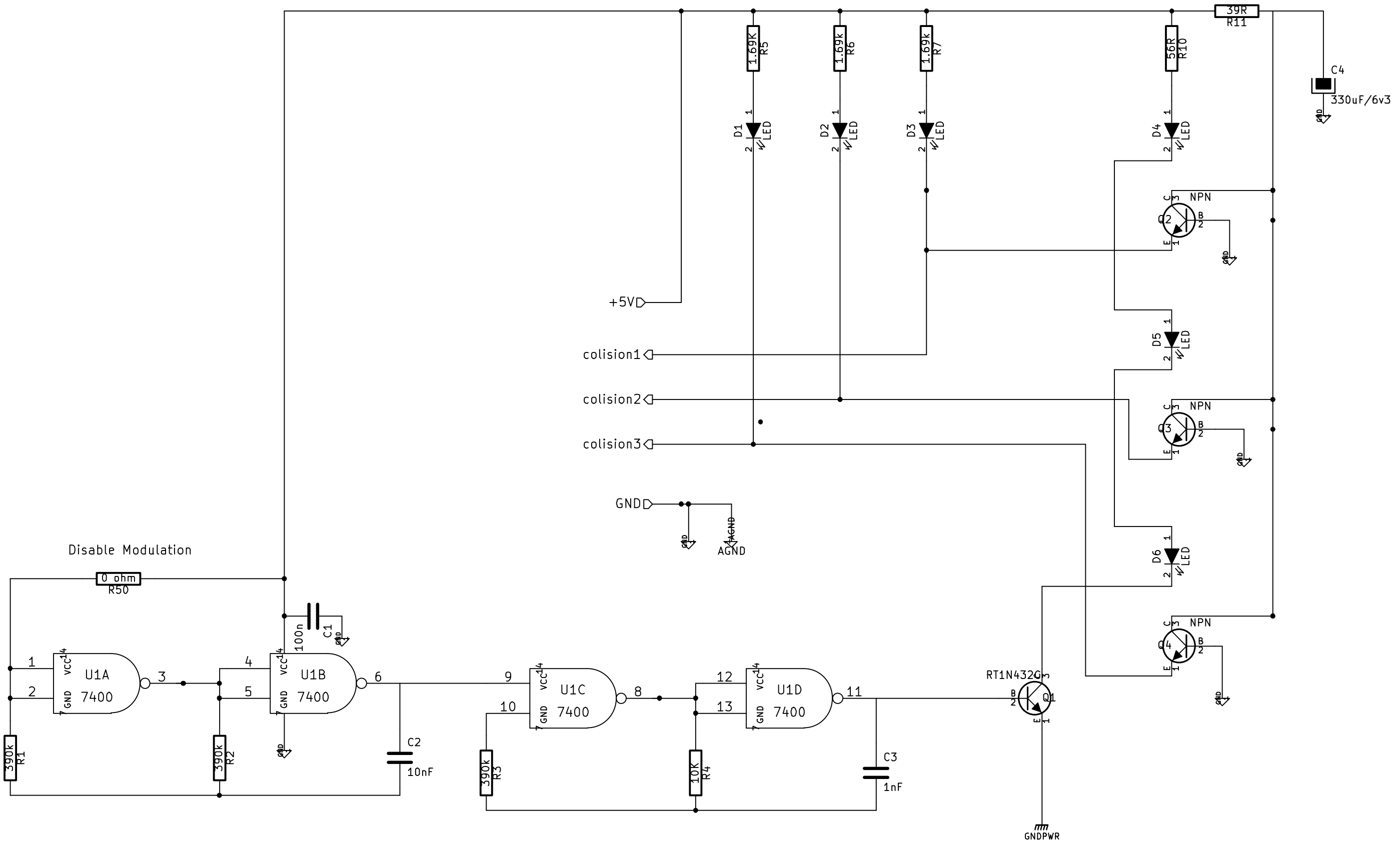
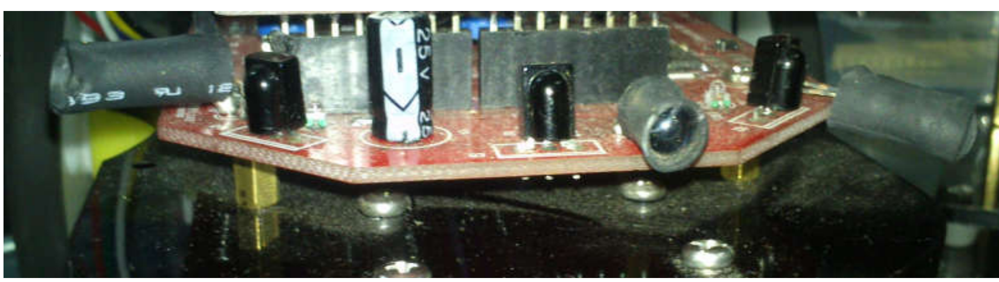


Figure 7. Schematic of three channel collision detector.

The collision detector detects object by sniff for any reflected beam send by an array infrared emitter. Some object that crosses the beam will reflect back a minute portion of the beam send by the emitters. If the object comes close as much as necessary as well as within the sensor detection view, the beam it reflects back is enough to trigger the detector, annunciating detection.



The collision sensor is an Infrared IR reflection sensor that is able of detecting up to 20 centimetres (cm) away from the sensor tip. Detection distance is a bit dependent on the colour of the reflecting surface. Dark and dull surface generally results in shorter detection range. In some testing, detection distance drops to as low as 5cm with objects that has black and dull surface.

Q2 to Q4 is the IR detector array and D4 to D6 forms the emitter array. The IR detectors will respond only to IR beams that are chopped at a 40 kHz rate. The U1C and U1D circuit, buffered by Q1, performs this chopping function. U1A and U1B can be activated for special applications where additional modulation of the chopping circuit may be desirable. This part of the circuit is disabled by default with the installation of R50. To enable this function, remove R50 and install (solder) R1, R2, and C2.

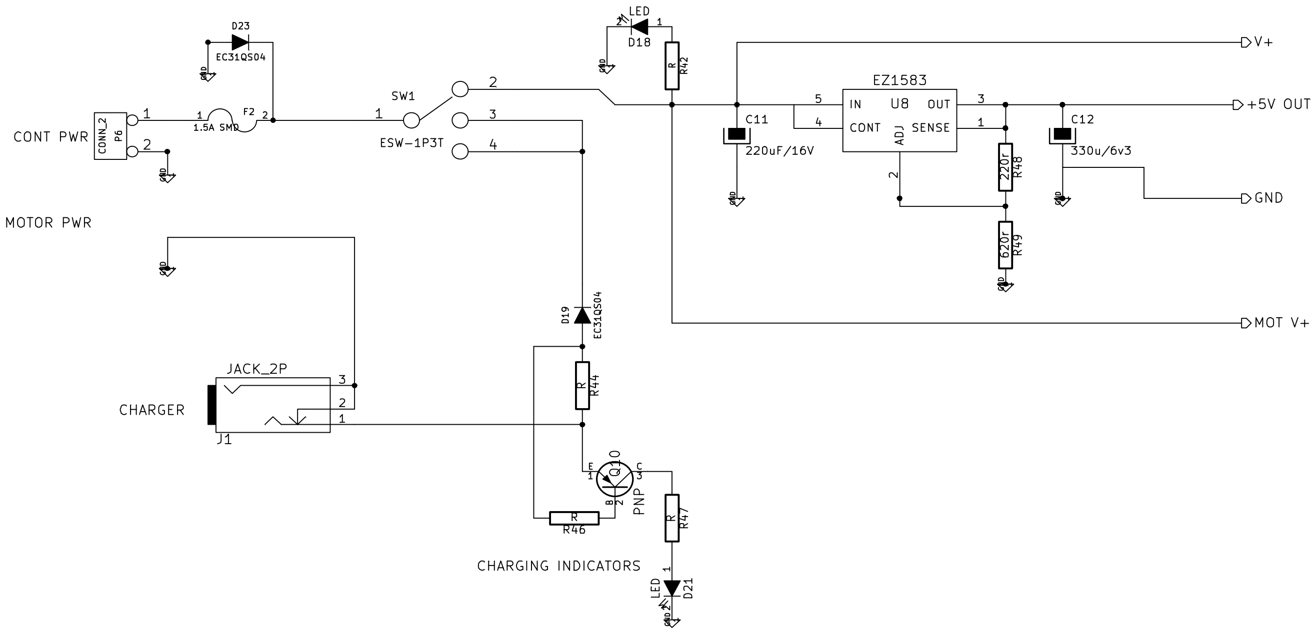


Figure 8.Power distribution and charger indicators. D23 protects the rest of the circuit in the event the power supply polarity is connected the wrong way by quickly blowing Fuse 2.

Power to the logic circuit is fed through terminal P6. A low dropout voltage regulator conditions the power from the battery into a stable 5V for distribution to the rest of the logic circuit.

The power input terminal fitted with fuse (F2) and reverse protection diode (D23).These components will keep the power from getting through if it is connected in reverse polarity by blowing the corresponding fuse.

The power switch is a three position switch with two charging position if the switch is not in turn on position. The charger circuit is activated by switching the switch in 'CHARGE' position. An external regulated 10V, 500mA or greater, power source must supply the charging power through the 10 V Charger Input. Q10 and associated components forms a charge monitor circuit for the motor battery. This circuit will turn ON the charging indicator (D21) LED if the charging current goes in excess of 100mA.

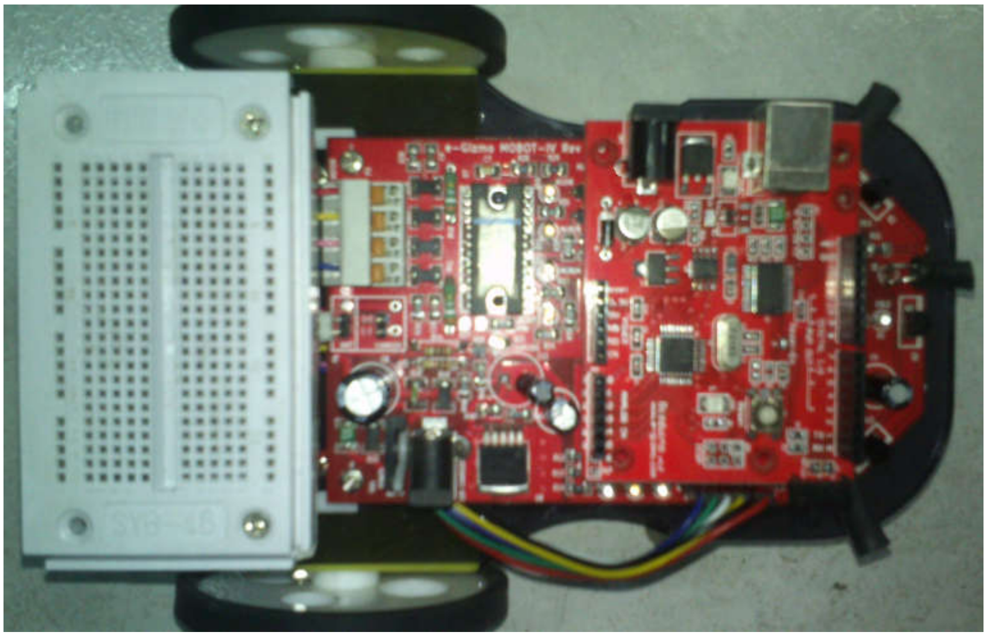


Figure 10. P-BOT R2 with breadboard add-on

Along with technical revisions, the spoiler of the new P-BOT R2 chassis has certain screw holes for the user to at least incorporate a breadboard for educational and prototyping purposes. It will enable the user to have a mini digital trainer placed above the mobile robot kit so that other sensors or peripherals may be added and tried out by the user. Please take note of the occupied pins of the P-BOT board since it can't be used for other applications.

Occupied pins:

COL1 (Left) = Digital pin 4
COL2 (Center) = Digital pin 3
COL3 (Right) = Digital pin 2
LS1 (Left) = Digital pin 7
LS2 (Center) = Digital pin 6
LS3 (Right) = Digital pin 5
M1DIR (Left) = Digital pin 11
M1RUN = Digital pin 10
M2RUN = Digital pin 9
M2DIR (Right) = Digital pin 8

Free pins:

Digital pin 0 & 1 = For Serial Communication
Digital pin 12 = Free pin
Digital pin 13 = Reset/LED Indicator

Analog pin A0-A3 = Analog I/O/Digital I/O
Analog pin A4-A5 = SCL and SDA (for I2C)

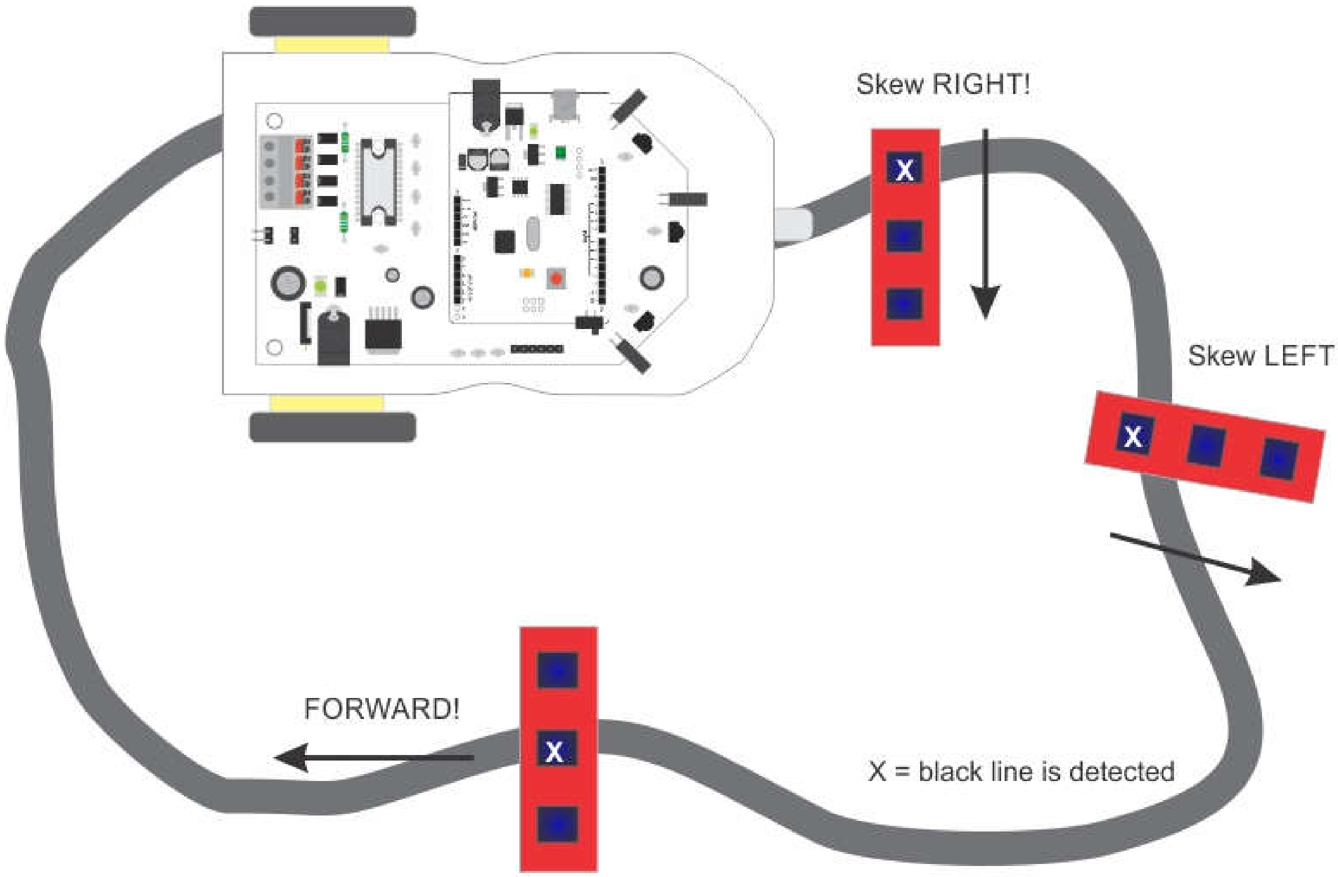


Figure 11. P-BOT R2 basic line follower logic

Line followers are one of the basic mobile robot designs used by hobbyists and educators. This simple application makes use of line sensors and motor logic applying conditional statement applications such as if-statements, while-statements, etc.

This application makes use of infrared sensors. From basic optics, the infrared transmitter (IR LED) outputs infrared light like a typical LED and is thus received by an infrared receiver (IRDA). Each time the receiver senses the bounced back infrared light, a certain amount of voltage is fed as output to the comparator, thus gives a digital output.

As shown in figure 11, this is the simplest line following logic for a line follower mobile robot. The program is very simple, each time a black line is detected, the mobile robot should turn to a certain direction. For example, if the left line sensor is triggered, the mobile robot should turn right and vice versa. However, if the center line sensor is triggered, the mobile robot should not hesitate to go forward and continue line tracking. For other situations, the sample program contained in the folder "P-BOT Sample Programs" should contain the sketch on how does the line-follower completely work.

Sensors applied:
- 3-Ch line sensor (infrared based)

Other applications:
- Doodle robots
- Cleaning robots
- Line follower racing robots

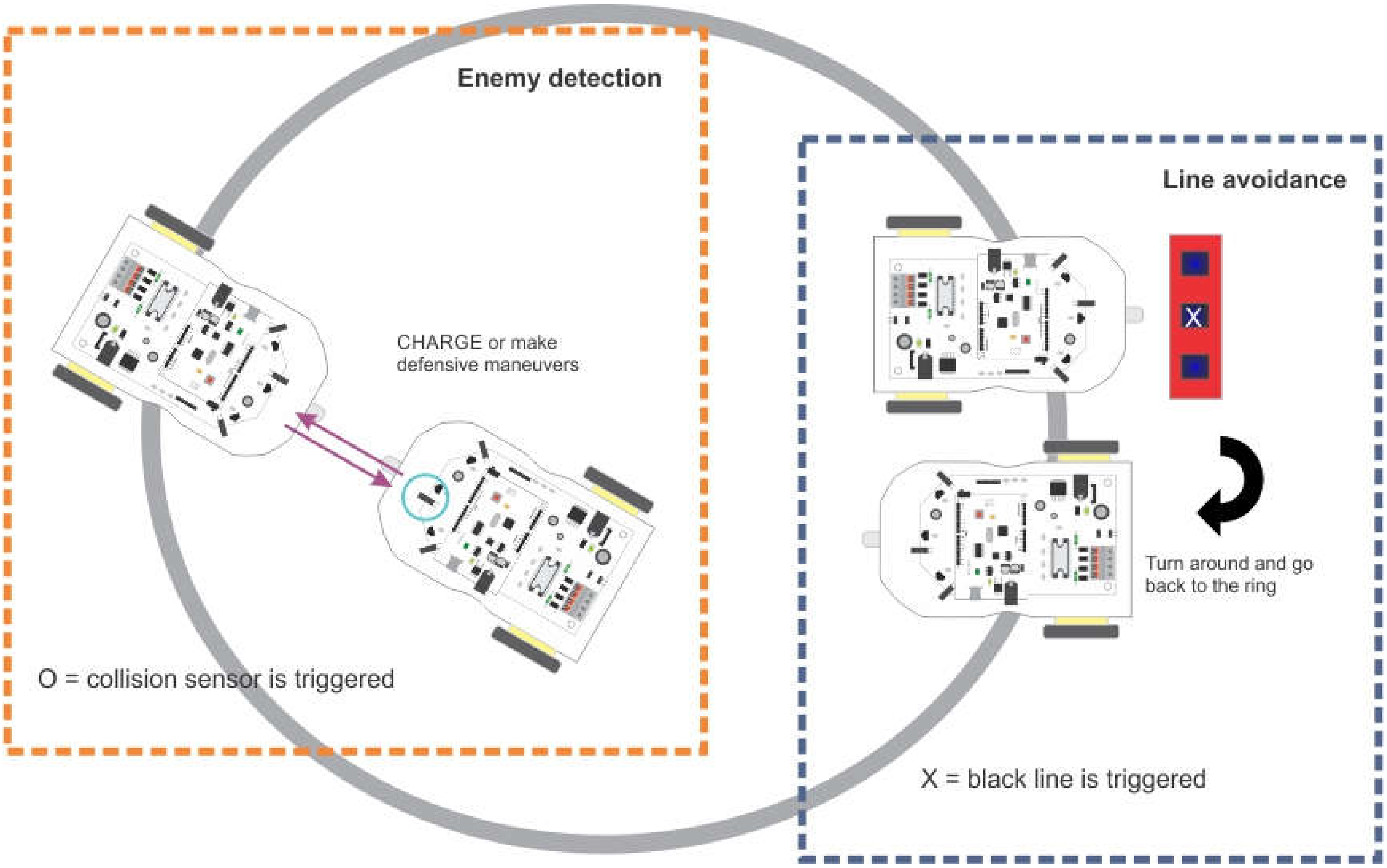


Figure 12. P-BOT R2 basic sumobot logic

A sumobot is technically a mobile robot programmed to be like a sumo wrestler. Its basic logic is to move away the target out of the ring while avoiding getting out of the ring itself. The trend of sumobots started as collision sensors were incorporated on mobile robots as a kind of sport or game. Some would also organize sumobot competitions wherein hobbyists can show off their DIY robots and their progamming skills.

The theory behind the sumobot is the use of infared transmitters and receivers. Similar to the line sensor, a certain voltage output is fed to logic gates to identify digital logic. In other words, when an object is detected, a "HIGH" logic level will be fed to the MCU wherein conditions may be applied.

For a sumobot, the collision sensor may trigger the mobile robots maneuvers wherein the robot may turn around and avoid an enemy or ram the enemy directly so that its enemy is thrown away from the ring.

Again, sample codes are provided on the same folder as this technical manual as a demo program for the said application.

Sensors applied:
- Line sensors
- Collision sensors

Other applications:
- Fall avoiding robot
- Robot wrestling

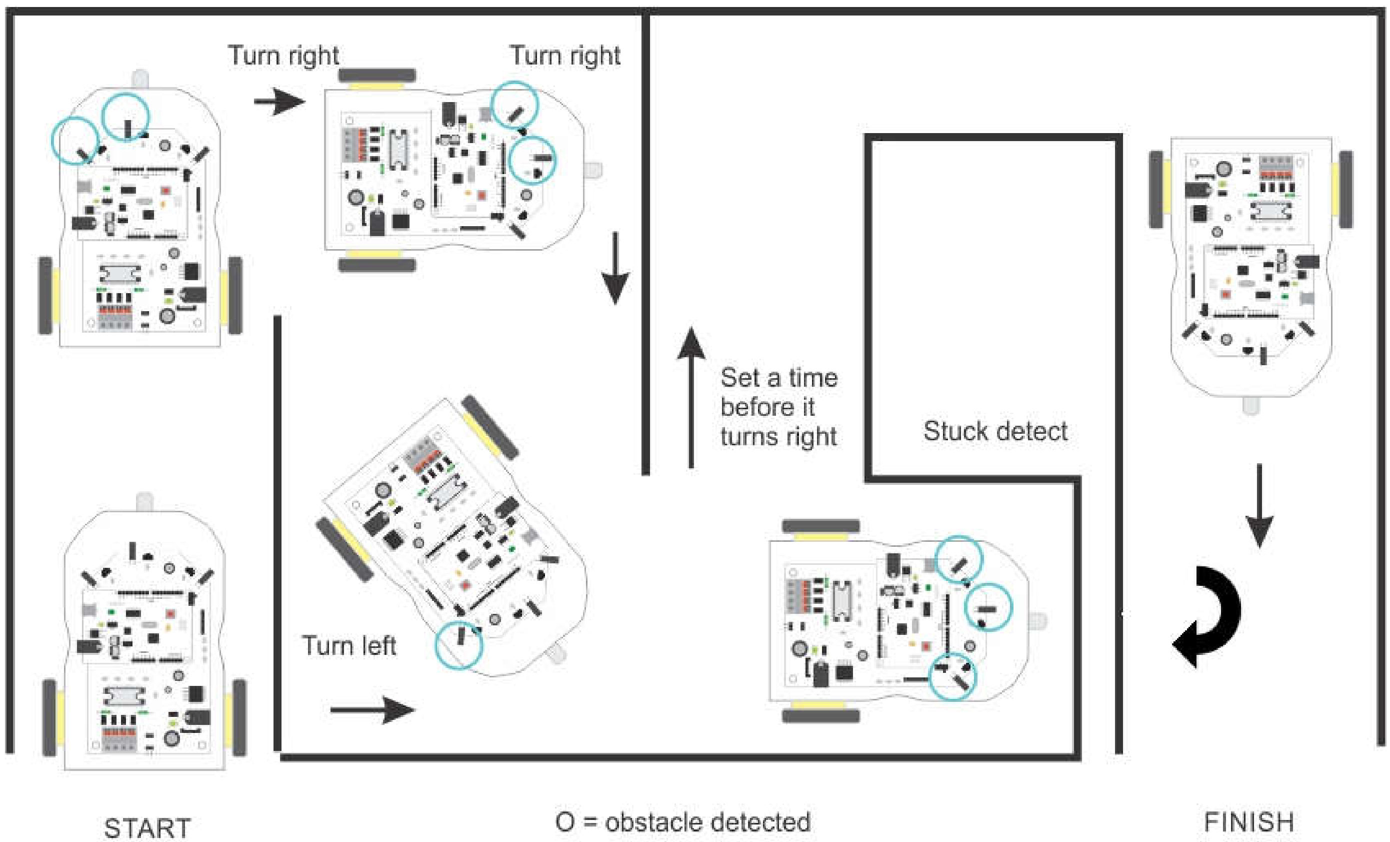


Figure 13. P-BOT R2 basic mazebot logic

The mazebot or maze solver is also one of the famous progams for an obstacle detecting robot. It's goal is simple, to solve the maze, but the logic is complicated for some beginners. What you need for a good mazebot is the proper timing and conditioning so that your mobile robot can solve a maze fast and accurately. Like sumobots and line followers, competitions are also held for those mazebots that can solve a maze with the least amount of time.

Some tips are to define conditions whenever one or more collision sensors are triggered. For example, obviously if an obstacle to the left of your robot is detected, it should turn right to avoid it. This logic is the same when the right sensor detects an obstacle but the problem is when all of the three are triggered. Some would make a stuck detecting function to allow the robot to turn back and choose a different path. The problem will arise when you need to choose whether after turning back, if you should go left or right as shown on the image above.

Basic sample codes are found on the same folder as the manual and how these problems are solved through basic timing conditions.

Sensors applied:
- Collision sensors

Other applications:
- Navigation robots