LINE FOLLOWER- SESSION 1

3RD & 4TH OCT 2011

THE ELECTRONICS CLUB- IITB

-SAMPATH SATTI

-ADWAIT DONGARE

STAB

Electronics Club
Get Electrified!

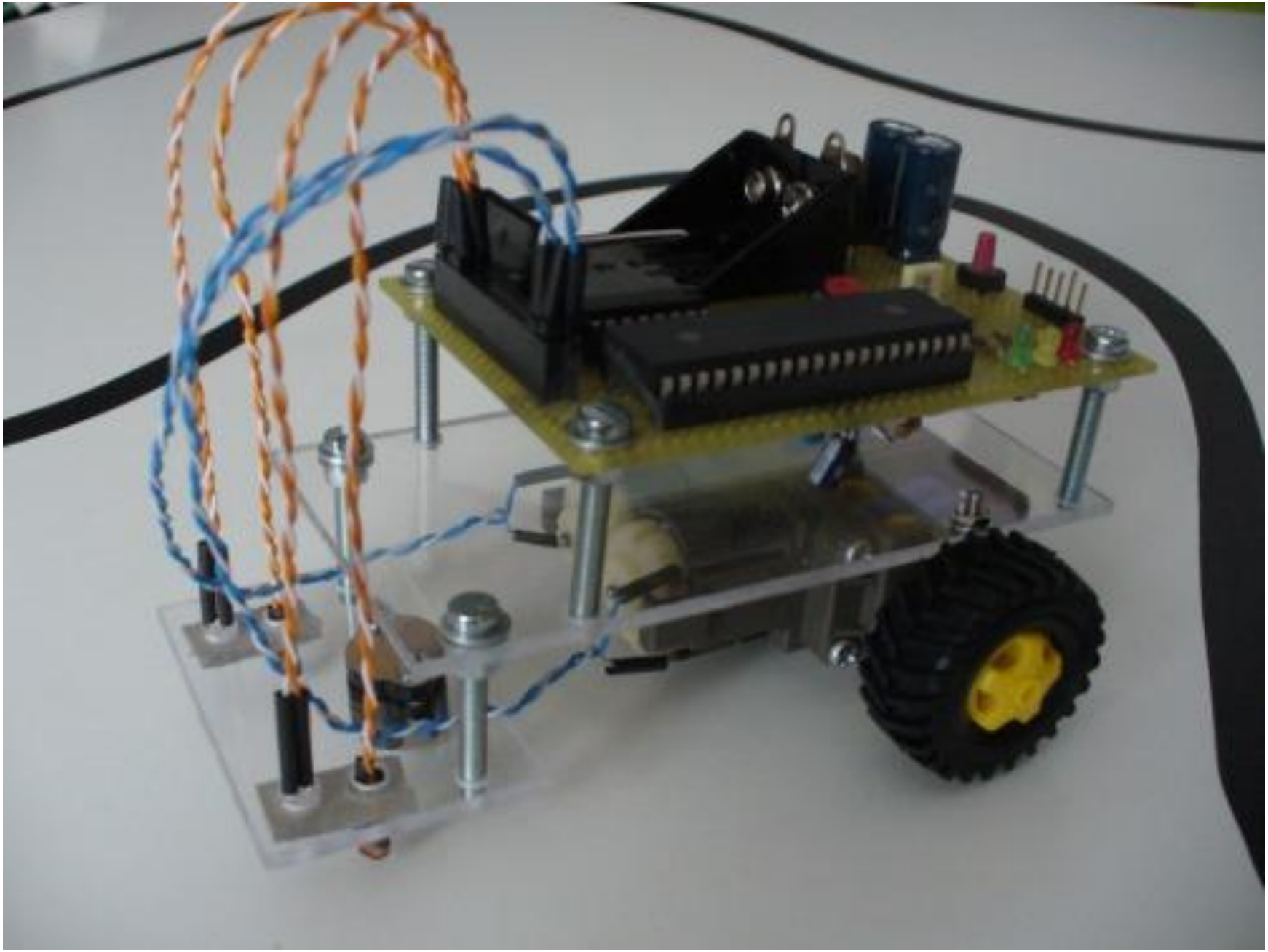
THE BASICS

What is a line follower?
Line follower is a machine that can follow a path. The path can be visible like a black line on a white surface (or vice-versa) or it can be invisible like a magnetic field.

Why build a line follower?
Sensing a line and maneuvering the robot to stay on course, while constantly correcting wrong moves using feedback mechanism forms a simple yet effective autonomous system. As a programmer you 'teach' the robot how to follow the line thus giving it a human-like property of responding to stimulus.

Practical applications of a line follower : Automated cars running on special roads; guidance system for industrial robots moving on shop floor etc. Book keeping in a library.


http://www.youtube.com/watch?v=kEFZJnqaXXw



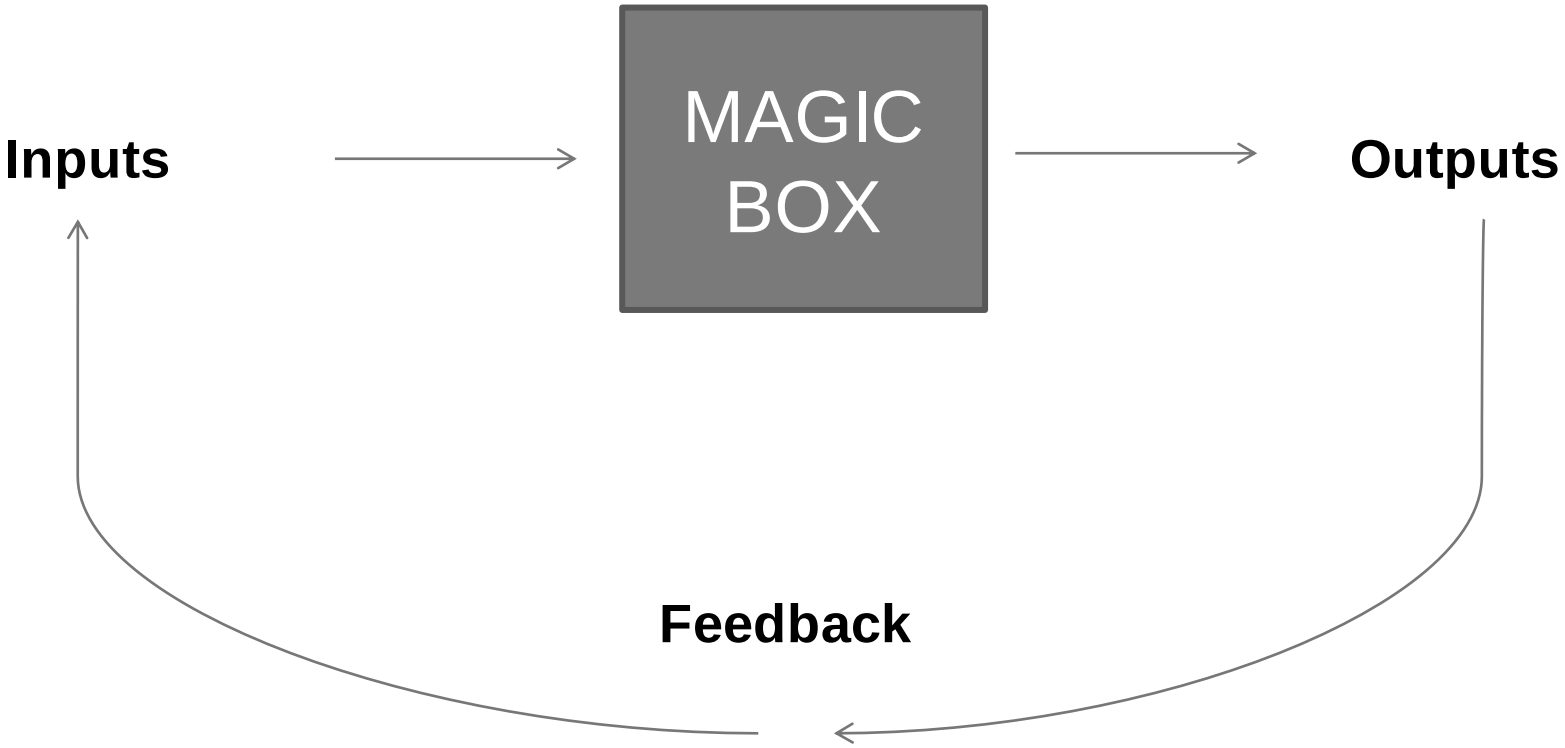
THE BASICS

What can we do?

THE BASICS

Are the outputs & inputs related?

YES!



WHAT IS WHAT?

INPUT	MAGIC BOX	OUTPUT
Sensors	Digital Logic OR Microcontroller	Motors

THE BASICS- SENSING

- **What is changing?**

  Our position on the line.

- **What is the change?**

  Change in the amount of Black & White below the bot.

- **Differentiating Black & White?**

  Black absorbs more of the light that is thrown on it.

- **What can we sense using circuits?**

  A change in some electrical signal.

- **What do we need?**

  Some way to connect light absorbed by the the surface below to an electrical signal.

THE BASICS- MOTORS

- **How do we move the bot properly?**

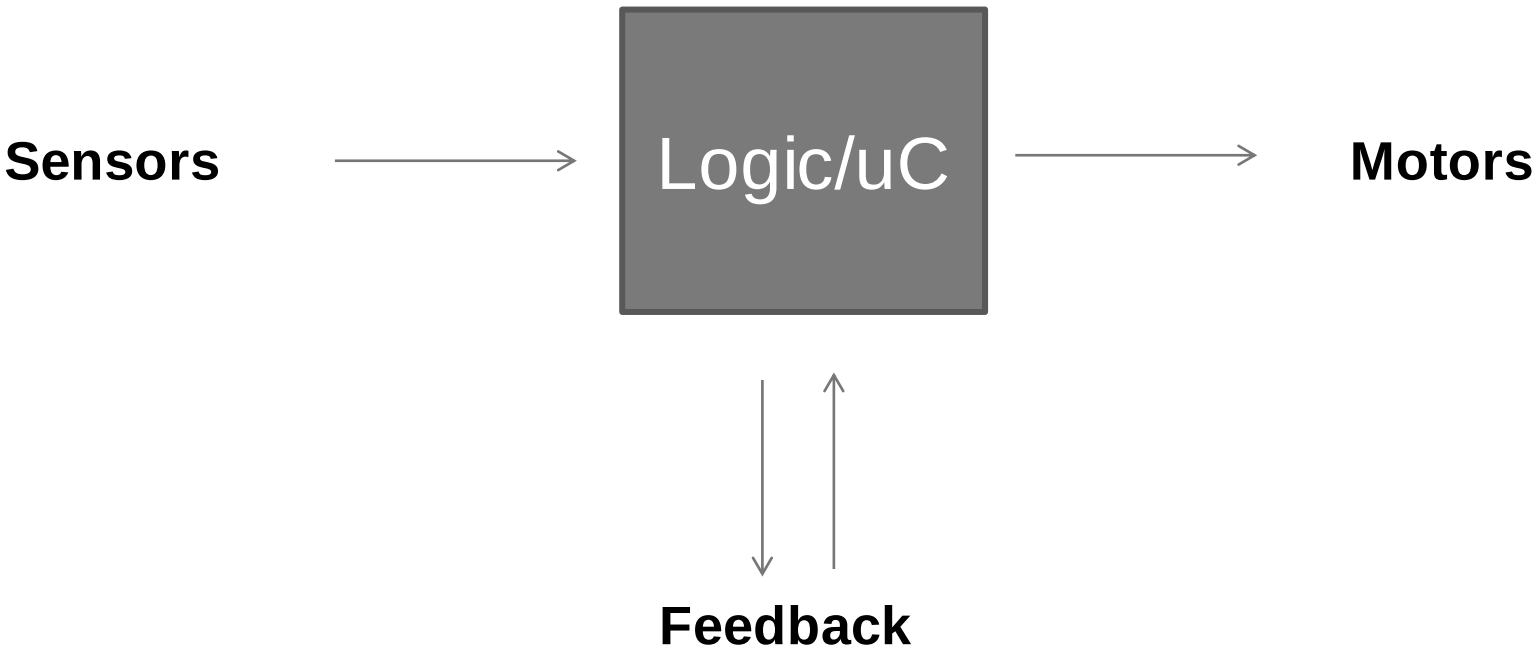
  Finer controller of motors.

- **Moving Left & Right? How to rotate by a given angle?**

- **How to ensure it does not overshoot?**

  Devise proper logic.

BLOCK DIAGRAM



SENSORS

Infra-red sensors

IR PhotoDiode
(Senses light)

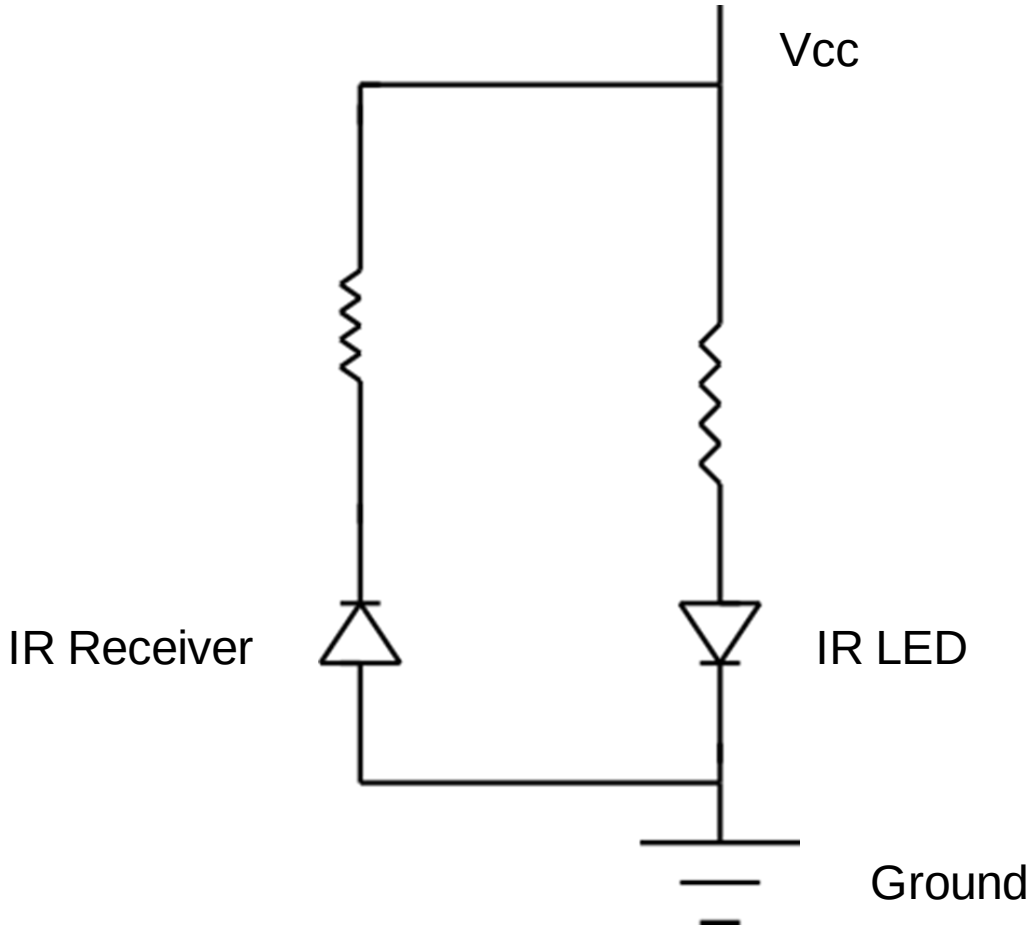
IR LED (Emits IR light)

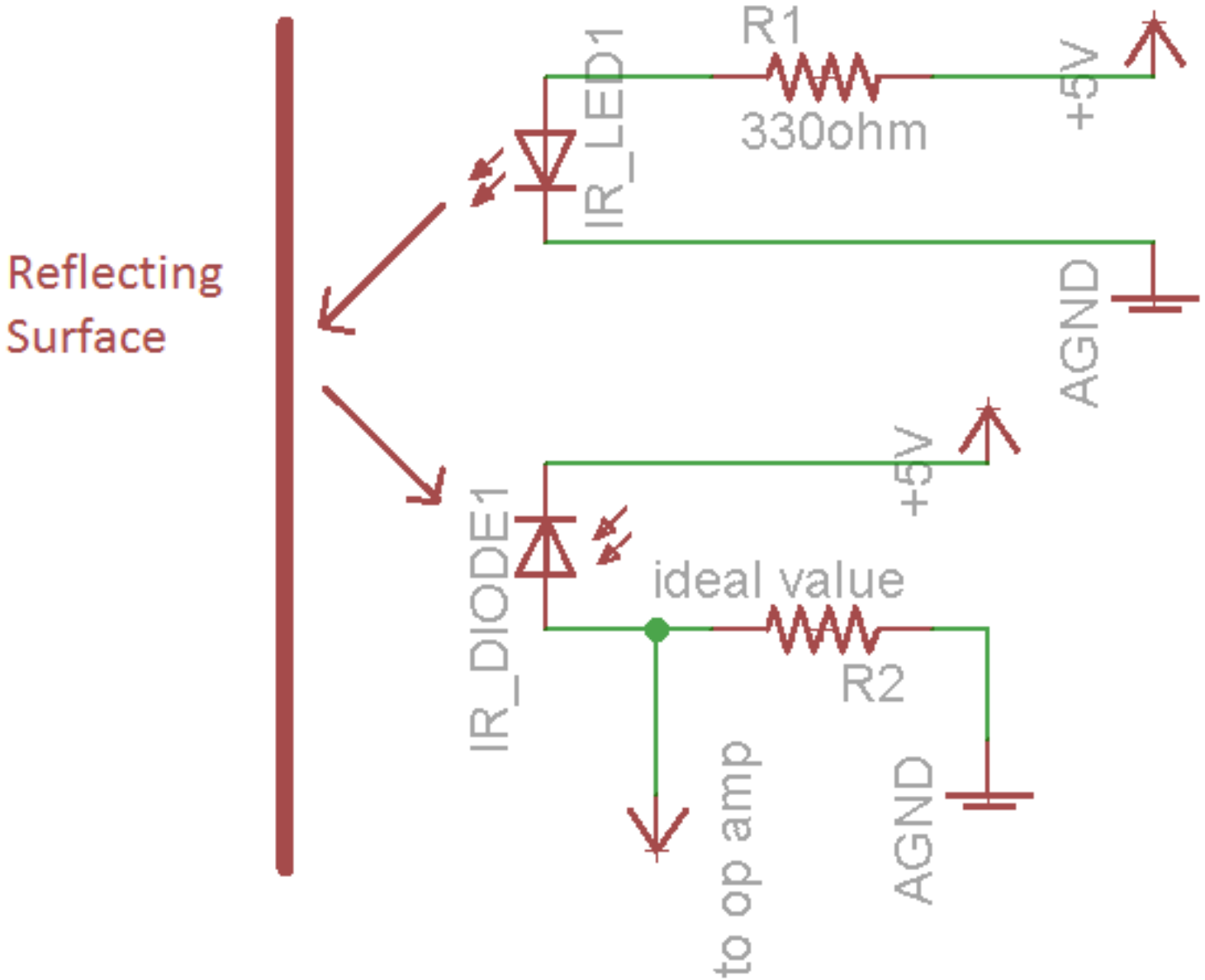
[May not always look like this]

An IR sensor array

No, you don’t need to make one this complicated =)

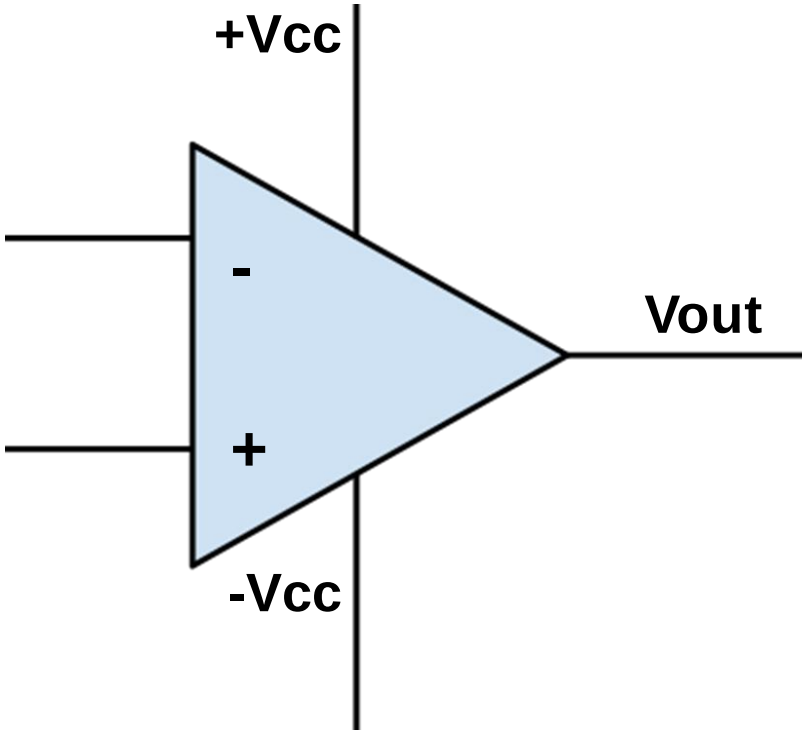
A VERY SIMPLE SENSOR CIRCUIT



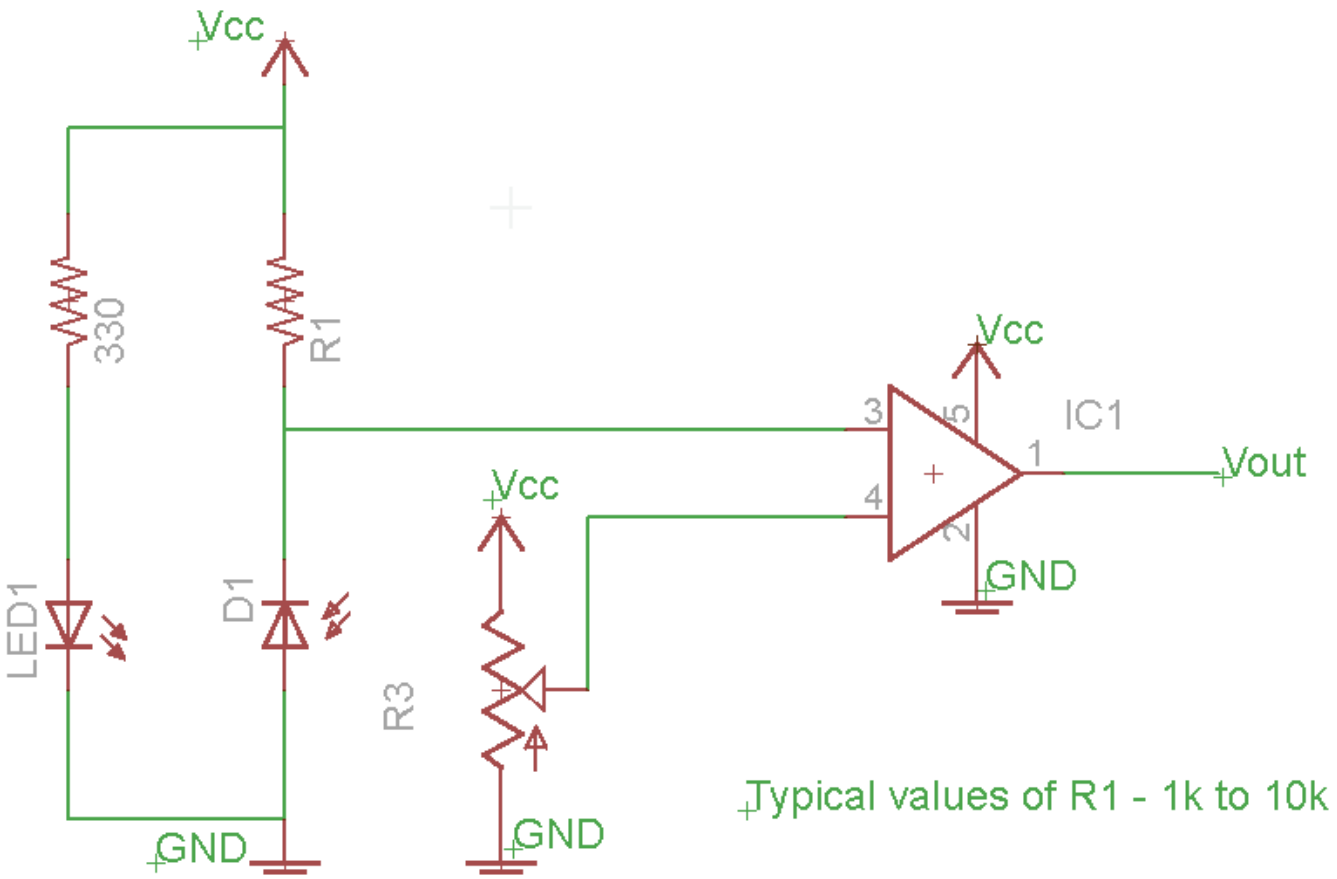

Reflecting Surface
R1
330ohm
IR_LED1
+5V
AGND
+5V
IR_DIODE1
ideal value
R2
AGND
to op amp

OP-AMP FOR COMPARISON

If V+ > V- , Vout becomes +Vcc
If V- > V+ , Vout becomes -Vcc



CIRCUIT WITH COMPARATOR

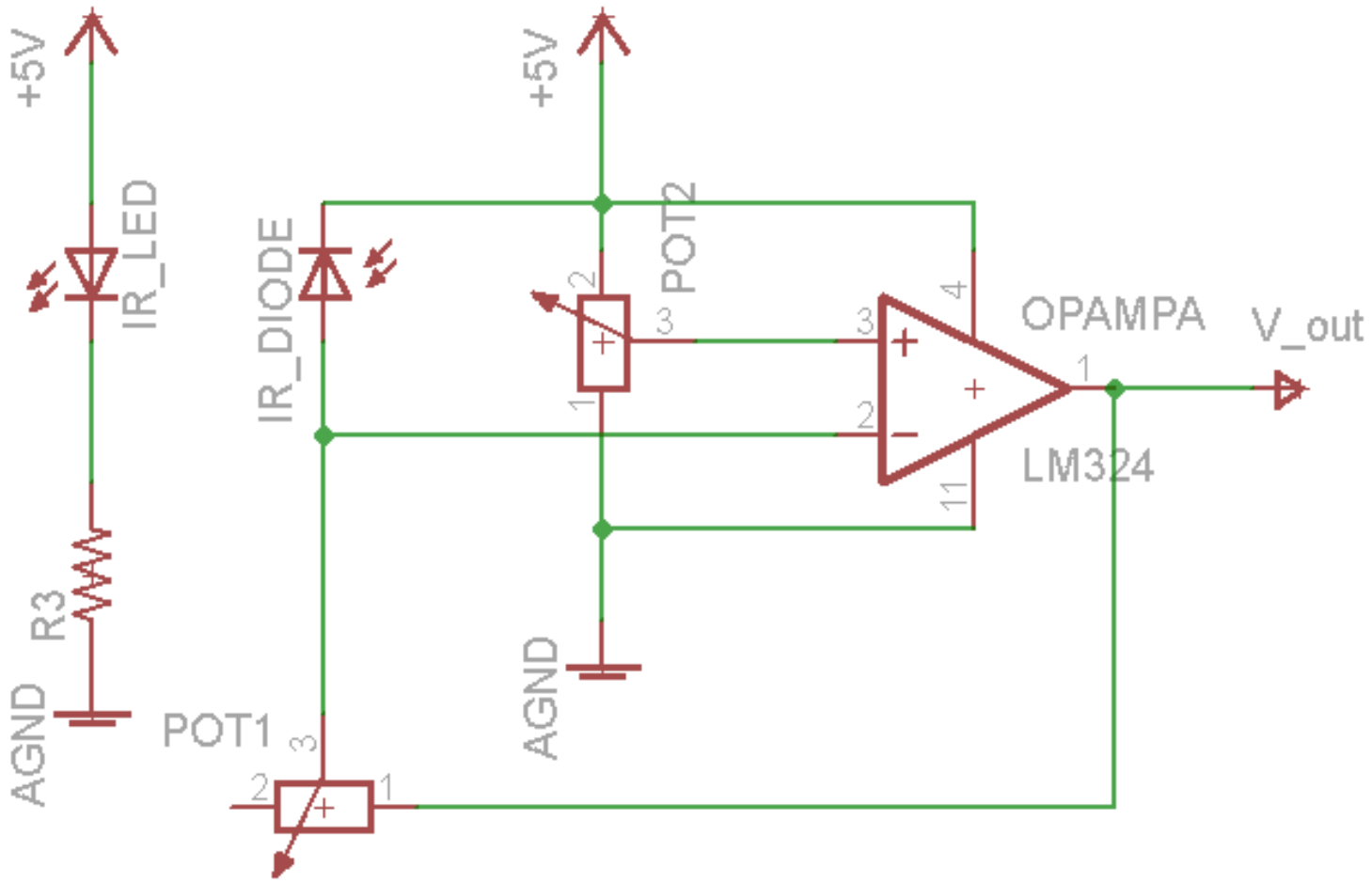


INTRODUCING THE OP-AMP

Why do we use an op-amp?

- **Using an Op-Amp**
  - Comparator - we convert analog output voltage of sensor to digital (HIGH or LOW) as in above case
  - Current (I) to Voltage (V) Converter – Or we can use it as an amplifier as shown in the slightly more advanced circuit in the next slide

CIRCUIT FOR A SINGLE SENSOR – OP AMP AS I TO V CONVERTER



In the simple circuit, the voltage across the IR diode is changing based on the current flowing through it.

The op-amp in the amplifier circuit keeps the voltage across the diode constant, regardless of the current.

The op-amp is NOT NECESSARY, but gives better inputs if used.

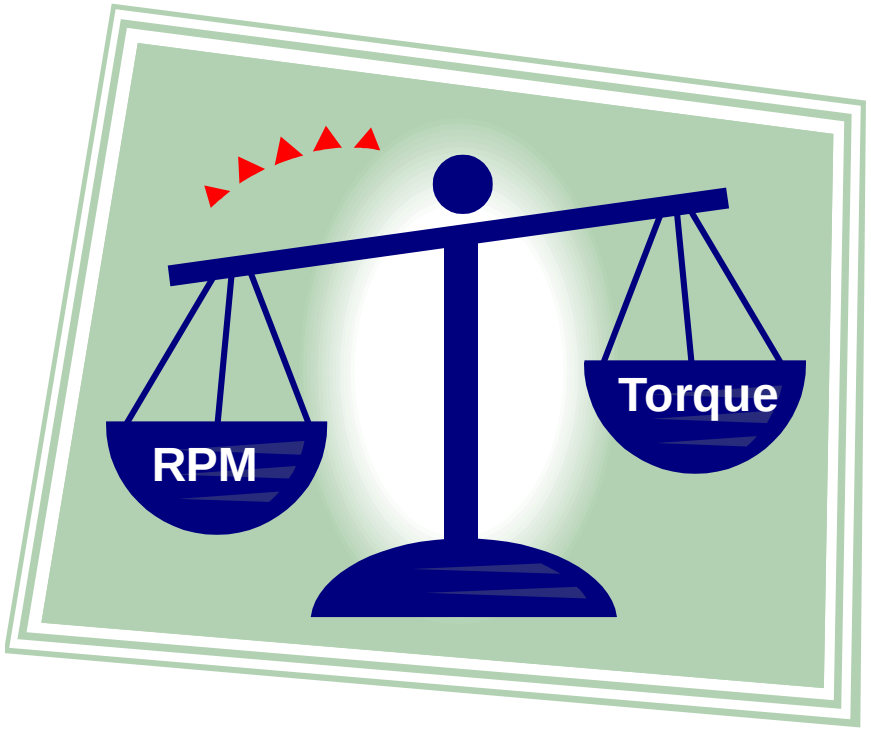
WHAT OP-AMPS CAN YOU USE?

LM324 is the easiest to use for IR sensors on a bot. It works on 5V Vcc.

741 is better but more for lab usage due to its voltage requirements. It needs a dual power supply of +15V and -15V (not possible on our line follower bot)

MOTORS

- **RPM & TORQUE**



MOTORS

High Torque motors:

Give more torque & Higher RPM.

Larger, Heavier & Expensive

Consume more power.

MOTORS

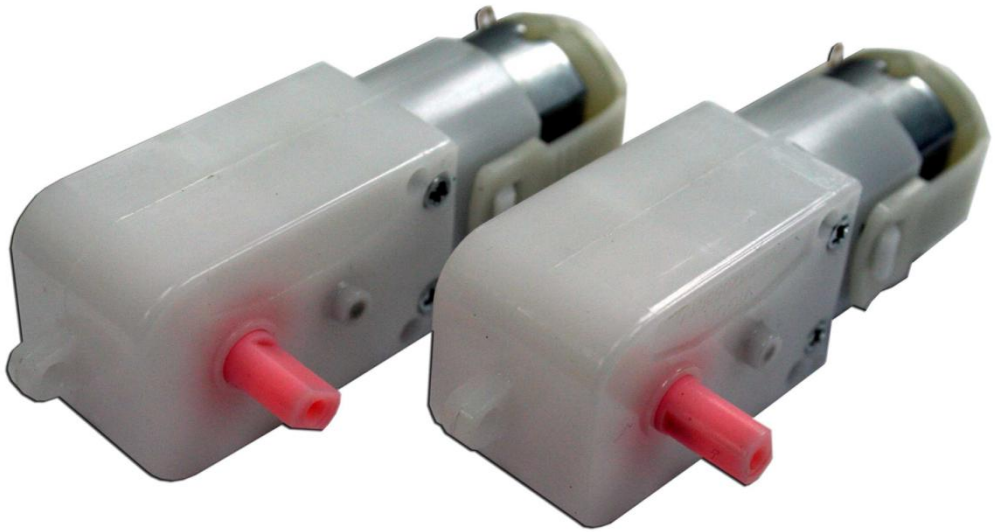
BO motors:

provide lesser Torque.

Smaller, highly efficient packing.

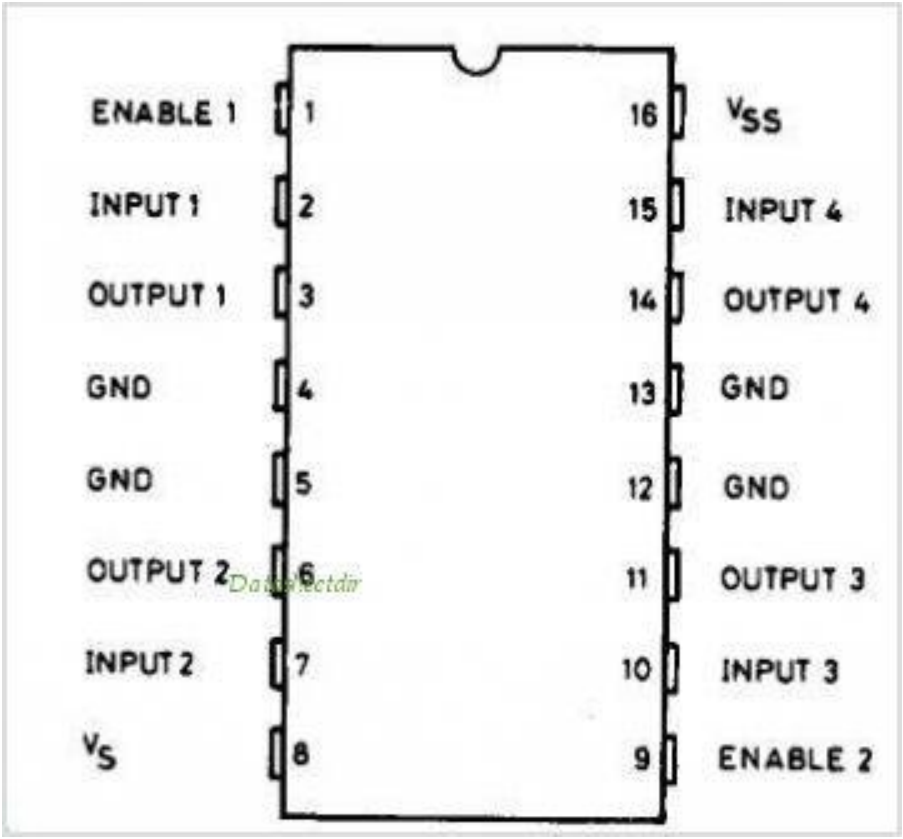
Lighter, Cheaper.

Consume less power than High-Torque ones.



HOW TO DRIVE MOTORS?

Remember L293D?



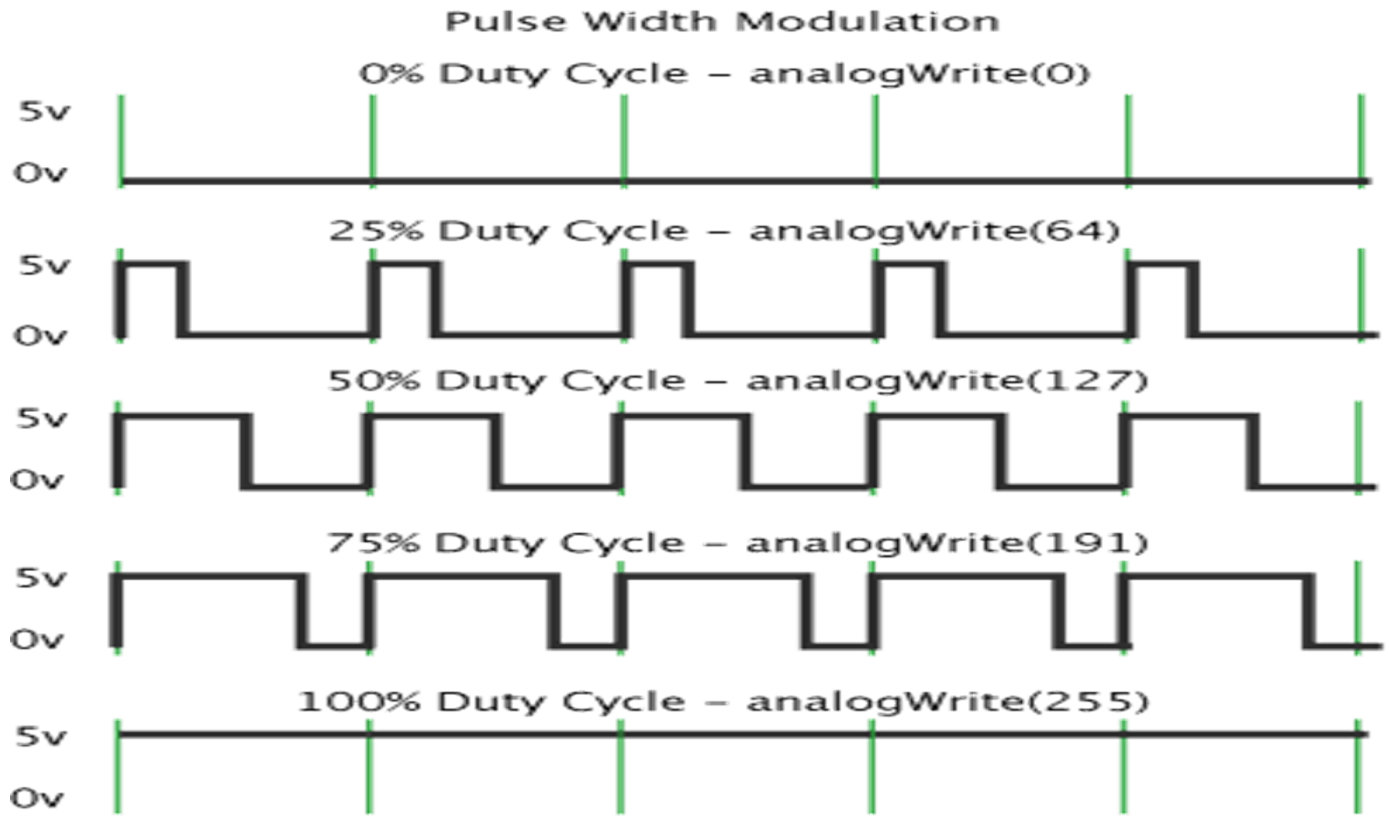
MOTORS (ADDITIONAL INFO!)

How to make motors of a given RPM work at different speeds?

(Hint: giving some voltage across the motor turns it on, while 0 voltage turns it off.)

PULSE WIDTH MODULATION

In a given time, change the amount of time for which the motor is on.

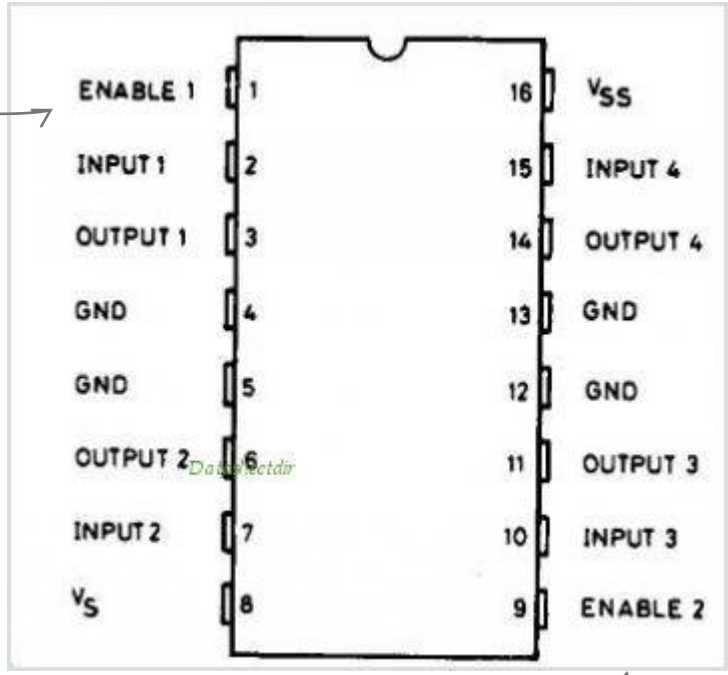


PULSE WIDTH MODULATION

How do you implement it?

What gives the control signal?
The uC or some Logic circuit

Remember the Enable pins on the L293D motor driver?



Enable Pins

DESIGN CONSIDERATIONS

- **Weight**
  affects everything

- **Height of the centre of mass**
  you don’t want it to topple while braking or accelerating

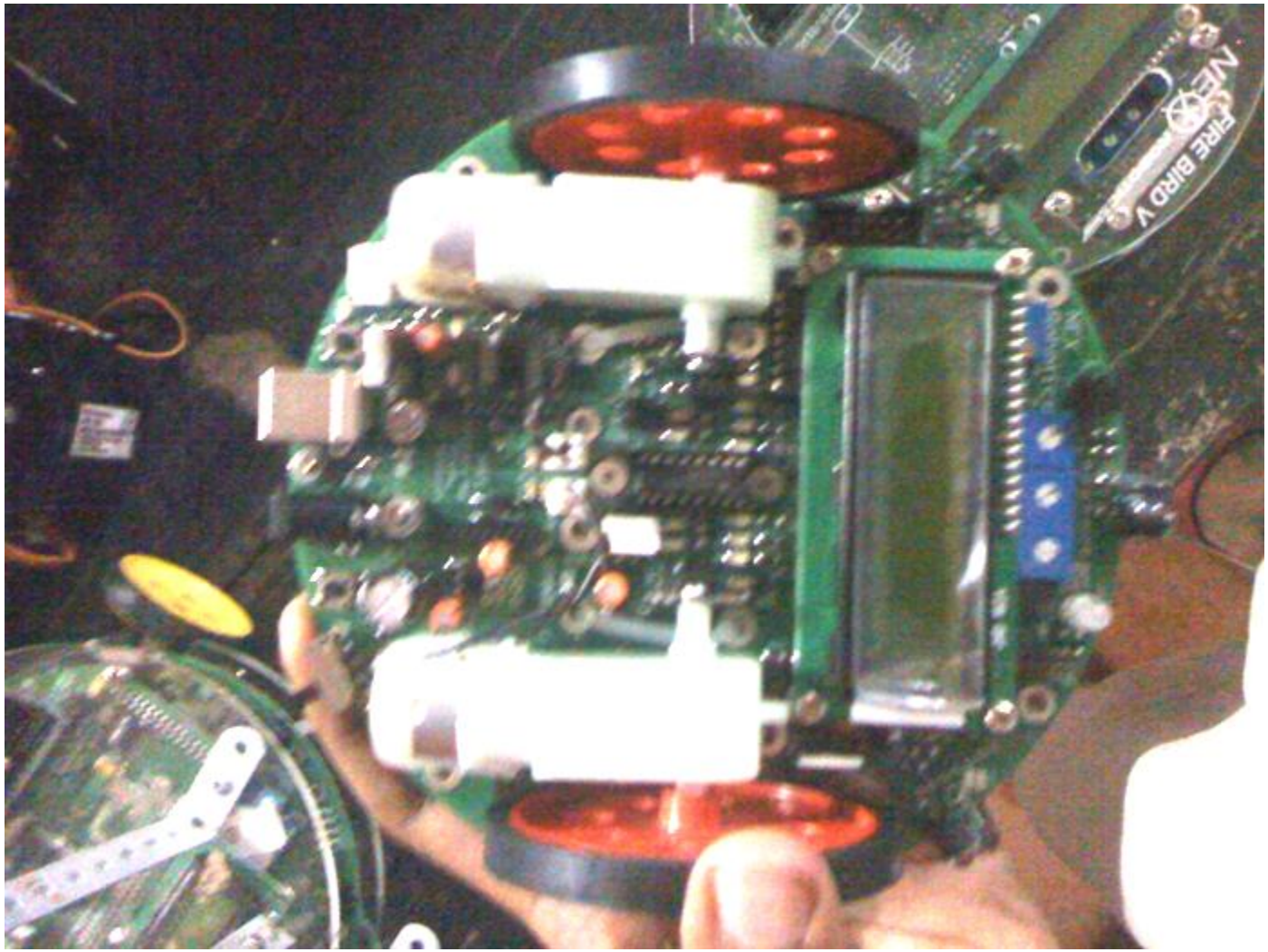
- **Moment of inertia**
  quick turns

CHASSIS

Simple tiffin box =)

CHASSIS

Complicated but has everything



BATTERIES

Lead-Acid vs Ni-Cd vs Li-ion/ Li-polymer

BATTERIES

Lead acid have more capacity, but are heavier.

Lithium based batteries are expensive & difficult to charge.

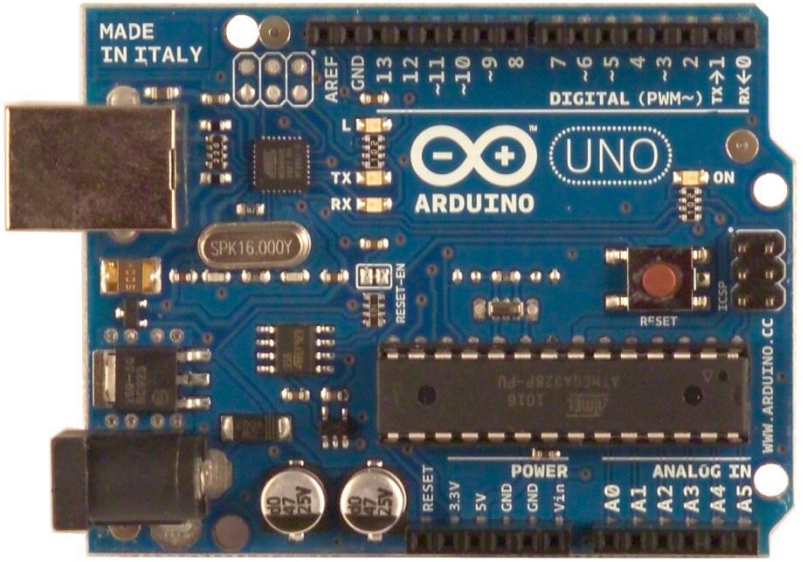
Nickel based batteries have low capacity.

LOGIC CIRCUIT

What do we use as our magic box?

Self made circuit

OR



Arduino Uno

More on these in the next sessions…

LOGIC?

Suppose sensor outputs HIGH when over a white line and LOW when over a black surface

Number of sensors? Your choice – 2, 3, 4 or more!

Increasing number of sensors, accuracy increases – but so does the logic complexity!

LOGIC?

For two sensors,

- **When bot is to the left of the line –**
  - Left sensor – 0, Right sensor – 1
  - Turn right (Left Motor – 1, Right Motor – 0)
- **When bot is to the right of the line –**
  - Left sensor – 1, Right sensor – 0
  - Turn left (Left Motor – 0, Right Motor – 1)
- **When exactly on line –**
  - Left sensor – 0, Right sensor – 0
  - Keep going straight (Left Motor – 1, Right Motor – 1)

Generate this logic –

Using Basic Logic Gates! (Your custom circuit with AND, OR and NOT gates!)

OR

Program the logic into a microcontroller

(More on this in the upcoming sessions)

READING DATASHEETS

Is a skill & getting important stuff from them is even more important.

Datasheets have all the information about a specific part/IC- the shape, pin diagram, range of values over which it works etc. & they are freely available on the net.

Check the datasheets for (even if you don't understand much of it):

L293D (the motor driver)

LM324 (the op-amp)

TIMELINE

Big projects must have timelines!

- Till 9th Oct: Get your Sensor circuit, Motor driver circuit, Chassis ready
- Up next: Programming the microcontroller/ designing the digital logic
- Integration & debugging
- Oct 15th & 16th : Competition
- Stay updated! bit.ly/line-follower

NOTE: Line follower & Robocon qualifiers are the same.

C/C++ SESSION

If you don't know programming, don't worry!!

We will help you with C/C++ in another session.

6th Oct, Thursday, 8.30-10.30pm. Further details on the hostel notice boards.