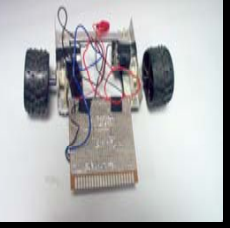
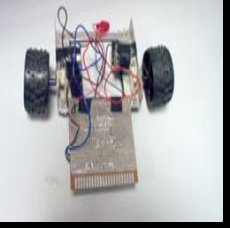
Line Following Robot

Adarsh K (ME00362)
Prashanth S (ME00370)
Radha Malini M G (ME00371)



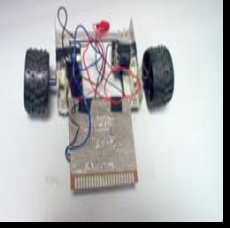
Navigation Principles

- **Externally Guided**
  - **Laser**
    - Similar to the principle of Laser guided missiles.
  - **GPS Based**
    - Most modern method in Exploratory robots.
    - Can estimate its own location within meters
- **Self Guided**
  - **CCD Camera**
    - Can detect using machine vision.
    - Uses contrast to detect edges.
  - **Proximity Sensor**



Navigation Principles

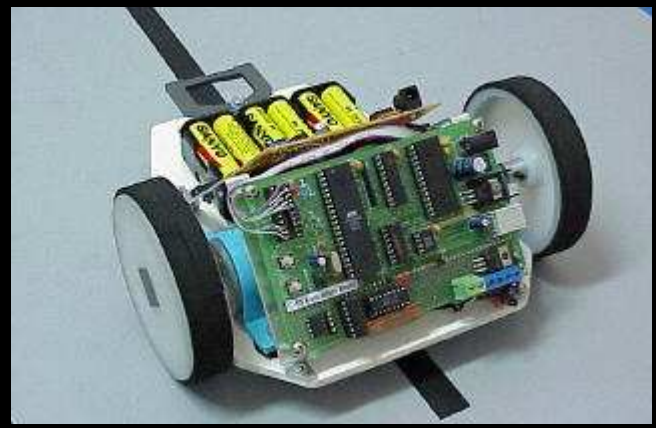
- **Collision Avoidance**
  - Combination of sensors and path finding Techniques.
  - Can be
    - Preprogrammed – Static.
    - Adaptive – Dynamic.
- **Line Following**
  - Used in manufacturing .
    - Delivering parts between stations.
  - Possible to use different colored lines.
- **Microprocessor Controlled**
  - Can be programmed to handle different conditions.
- **Electronic Controlled**
  - Hard Wired.
  - Cheap and simple.
  - Manual switching for handling different conditions.



Line Following Robots

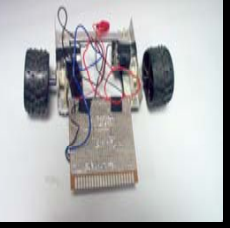
Sandwich

Sweet



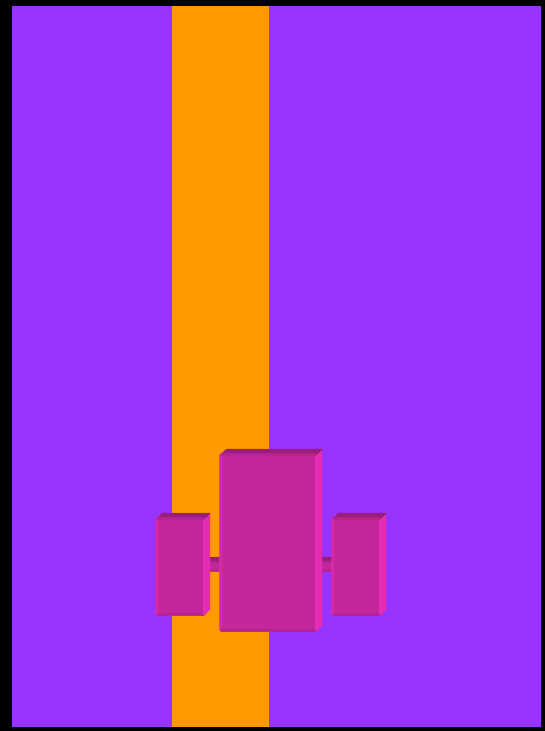
Kabo

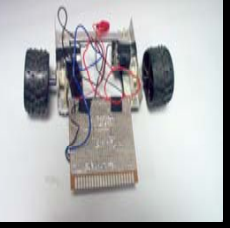
Line Following Principle



Single Sensor

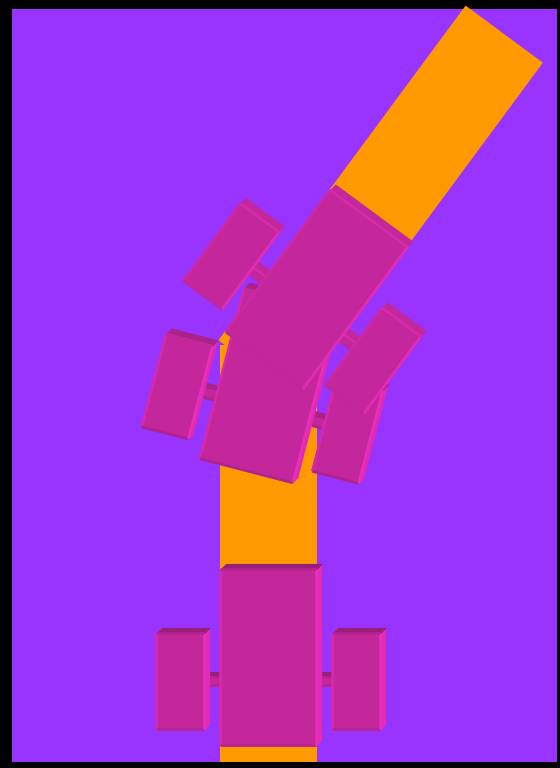
- Detects edge.
- Directs Power alternately to two motors.
- Advantages
  - Single sensor.
  - Suitable for sharp curves.
- Disadvantages
  - Jerky motion.
  - If robot leaves path
    - Turns 180’ and moves in opposite direction



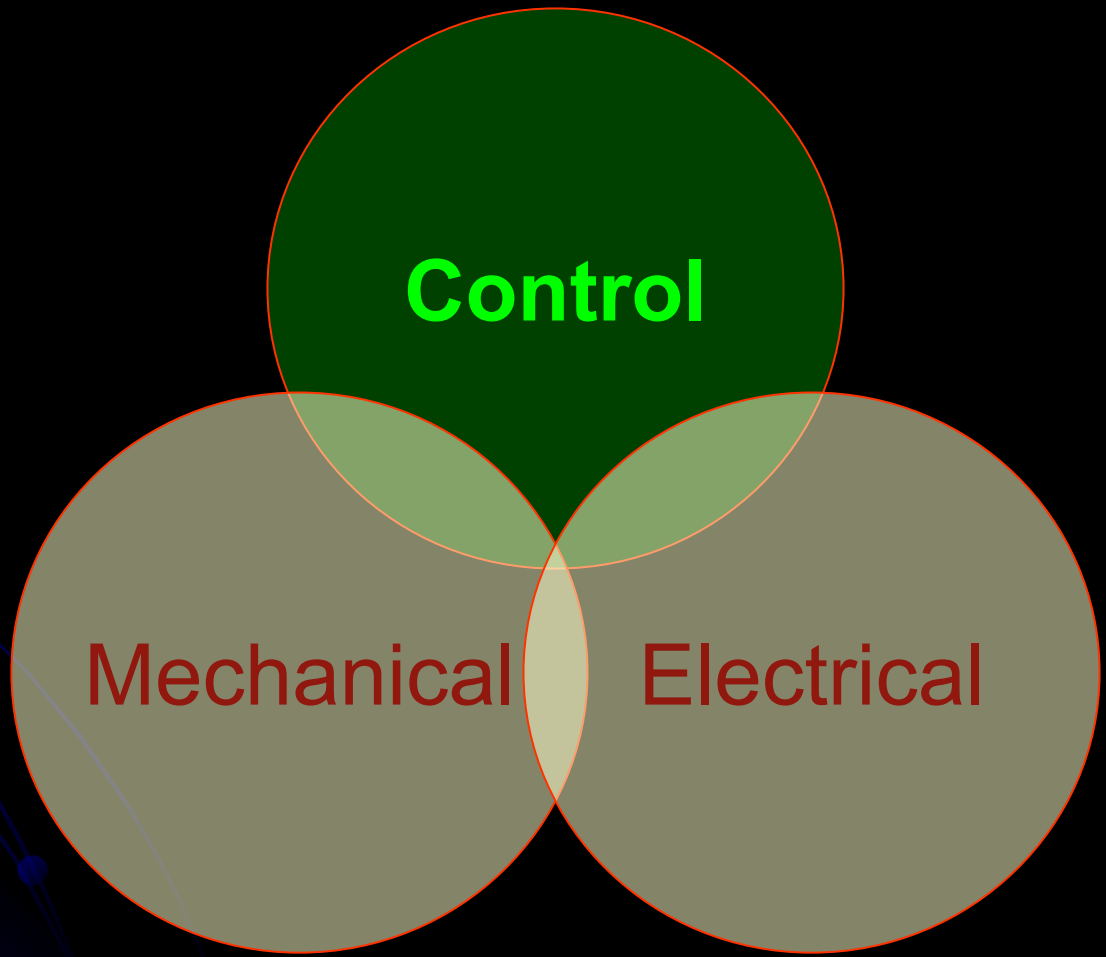


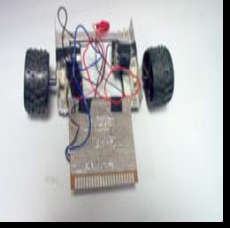
Dual Sensor

- Two LDR's.
- Each sensor controls one motor.
  - Left sensor controls right motor and vice versa
- Advantages
  - Smooth motion on straight line
- Disadvantages
  - Two Sensors
  - Two motors should be synchronized



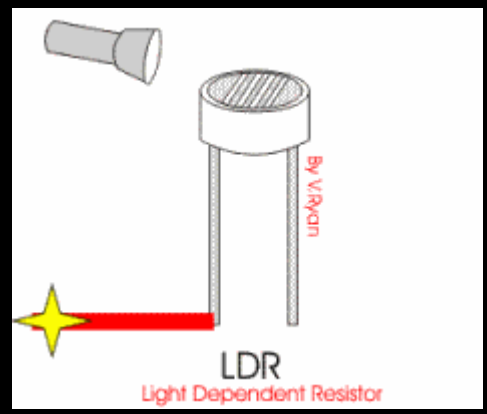
Components

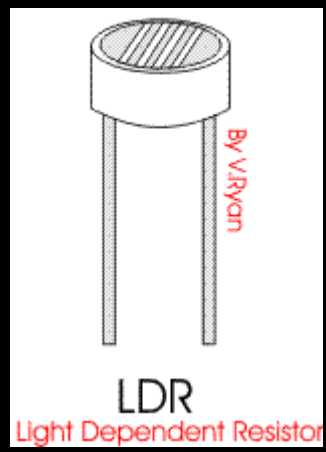


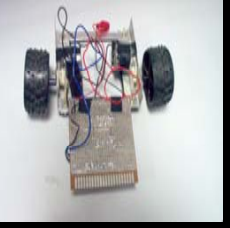


Light Dependent Resistor

- **Light dependent resistors**
  - Electronic components where the resistance of the device varies with light intensity.
  - Also called LDRs, photoresistors or photoconductors.
  - Used to detect Presence of Light.
  - Normally the resistance of an LDR is very high(1 MΩ).
  - When illuminated with light resistance drops dramatically.

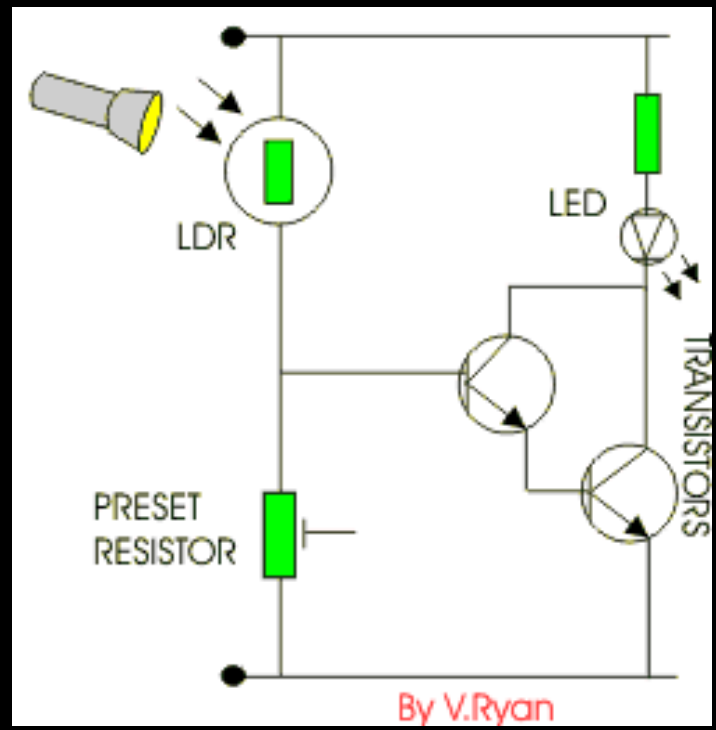


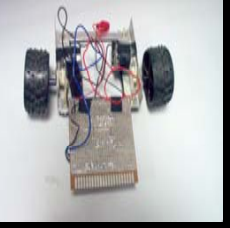




Light Dependent Resistor

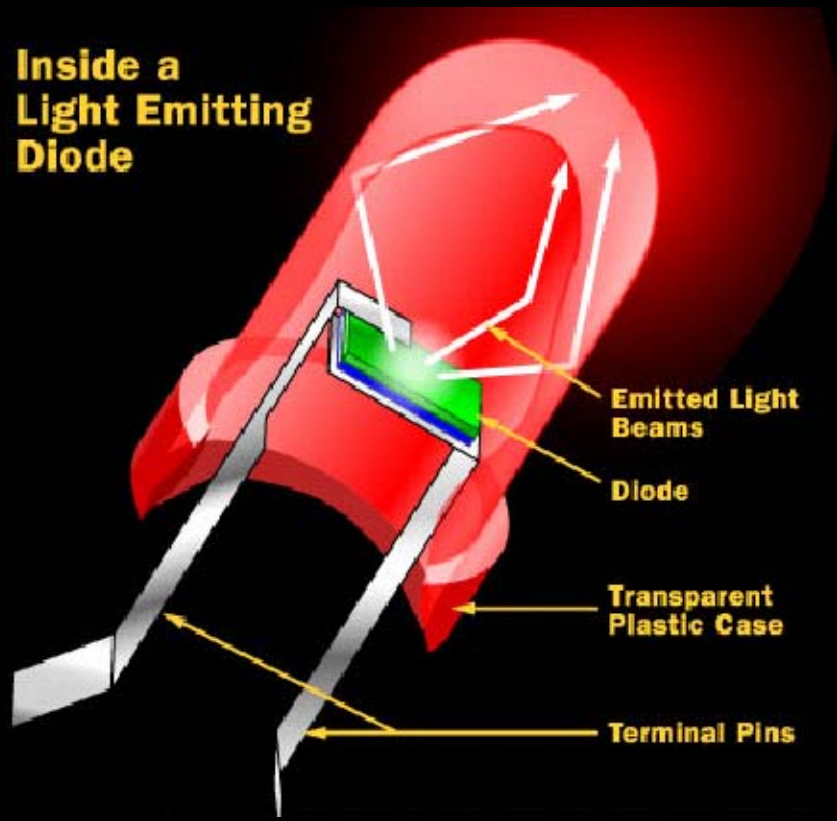
- **Working**
  - **Made of a high resistance semiconductor.**
  - **Photons are absorbed by the semiconductor.**
    - Bound electrons jump into the conduction band.
    - The resulting free electron (and its hole partner) conduct electricity, thereby lowering resistance.
- **Types**
  - **Cadmium sulfide (CdS) LDRs**
    - Camera light meters, clock radios, security alarms and street lights.
  - **Ge:Cu photoconductors**
    - Far-infrared detectors.
    - Used for infrared astronomy and infrared spectroscopy.

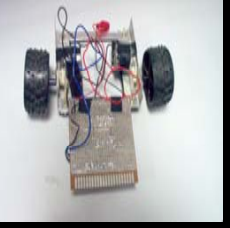




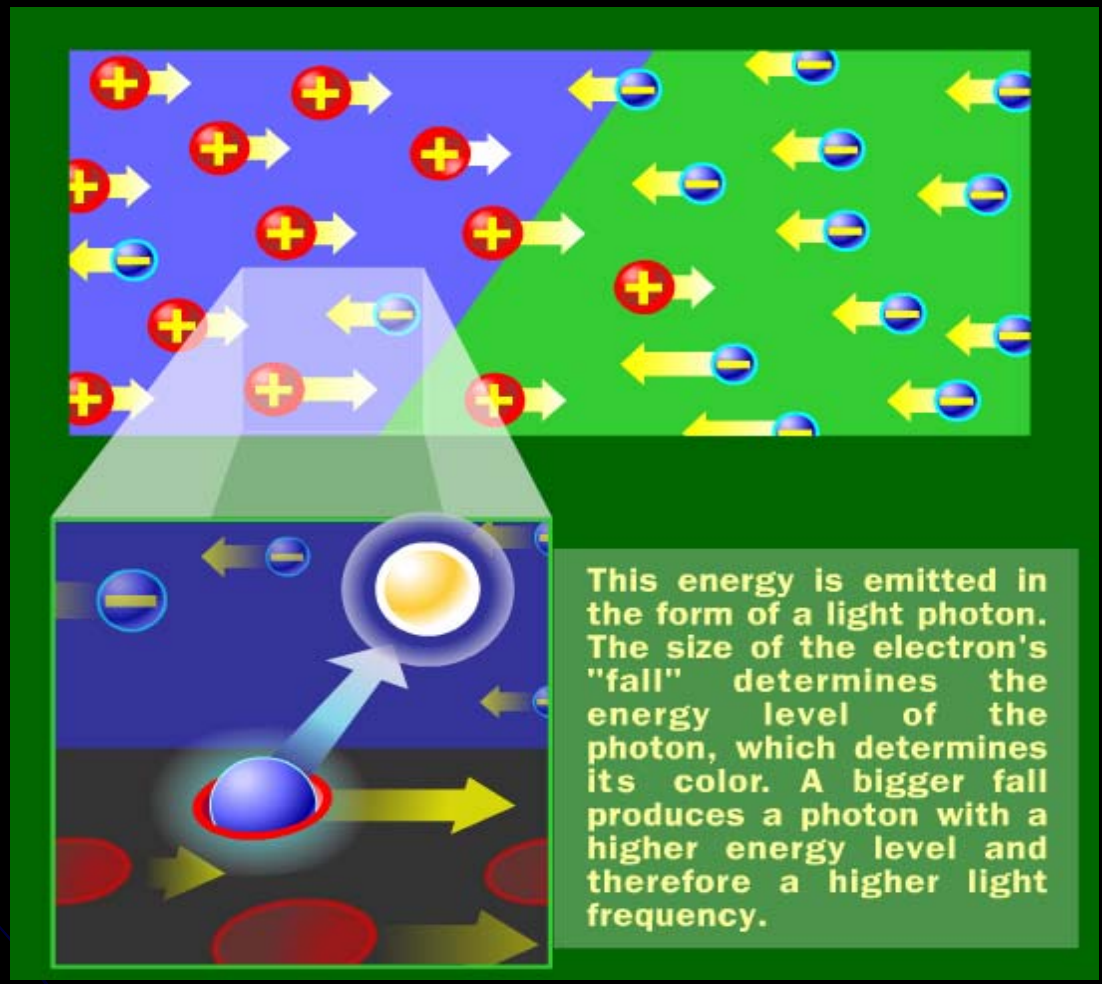
Light Emitting Diode

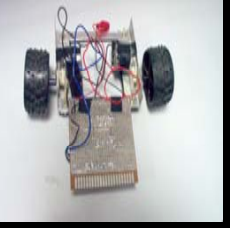
- Usually made of Aluminum-Gallium-Arsenide (AlGaAs).
- Pure aluminum-gallium-arsenide.
  - All of the atoms bond perfectly to their neighbors.
  - No free electrons to conduct electric current.
- In doped material.
  - Additional atoms change the balance, either adding free electrons or creating holes where electrons can go.
  - Makes the material more conductive.
- The interaction between electrons and holes generates light.





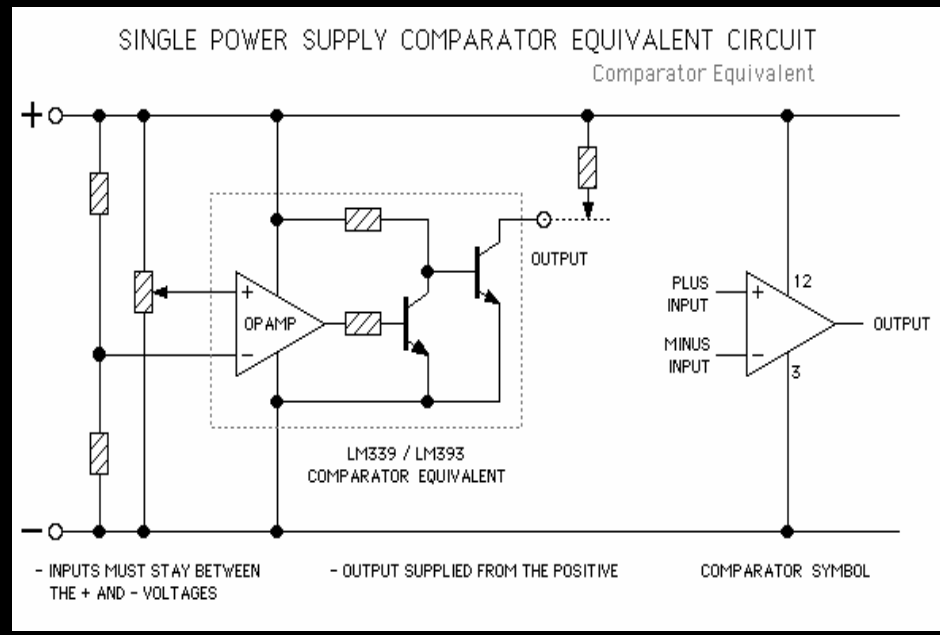
Working

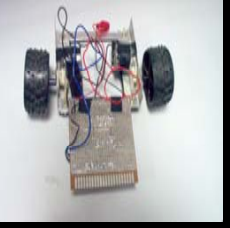

This energy is emitted in the form of a light photon. The size of the electron's "fall" determines the energy level of the photon, which determines its color. A bigger fall produces a photon with a higher energy level and therefore a higher light frequency.



Voltage Comparator

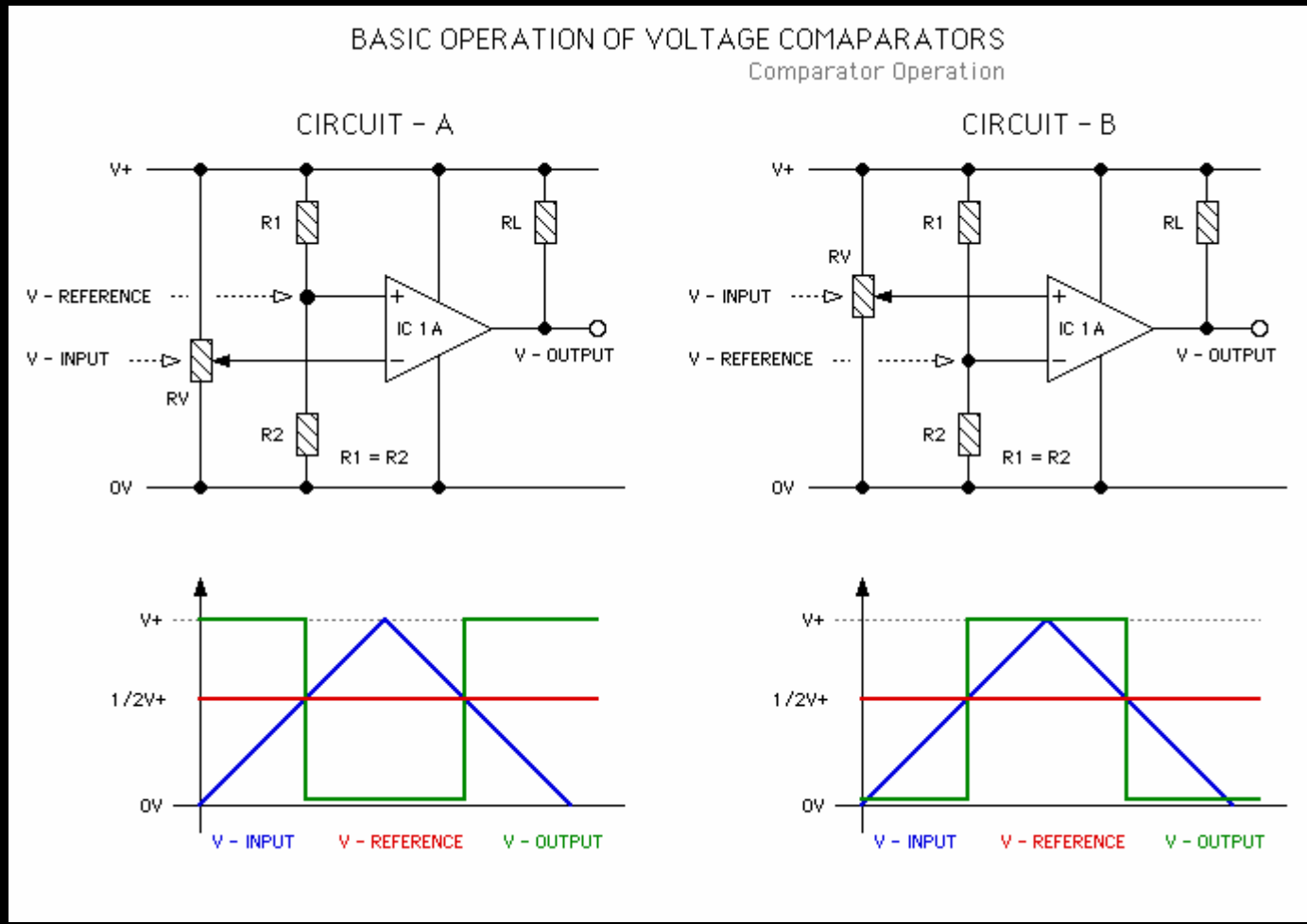
- Compares two voltage signals and determines which one is greater.
- The result is indicated by the output voltage.
  - If the output is saturated in the positive direction.
    - Noninverting input (+) is a greater than the inverting input (-).
  - If the output voltage is near the negative supply voltage.
    - Inverting input (-) has a greater voltage applied to it than the noninverting input (+).
  - All voltages measured with respect to ground.

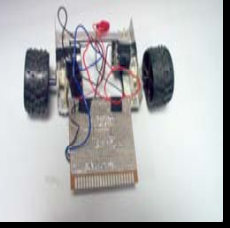




Operation

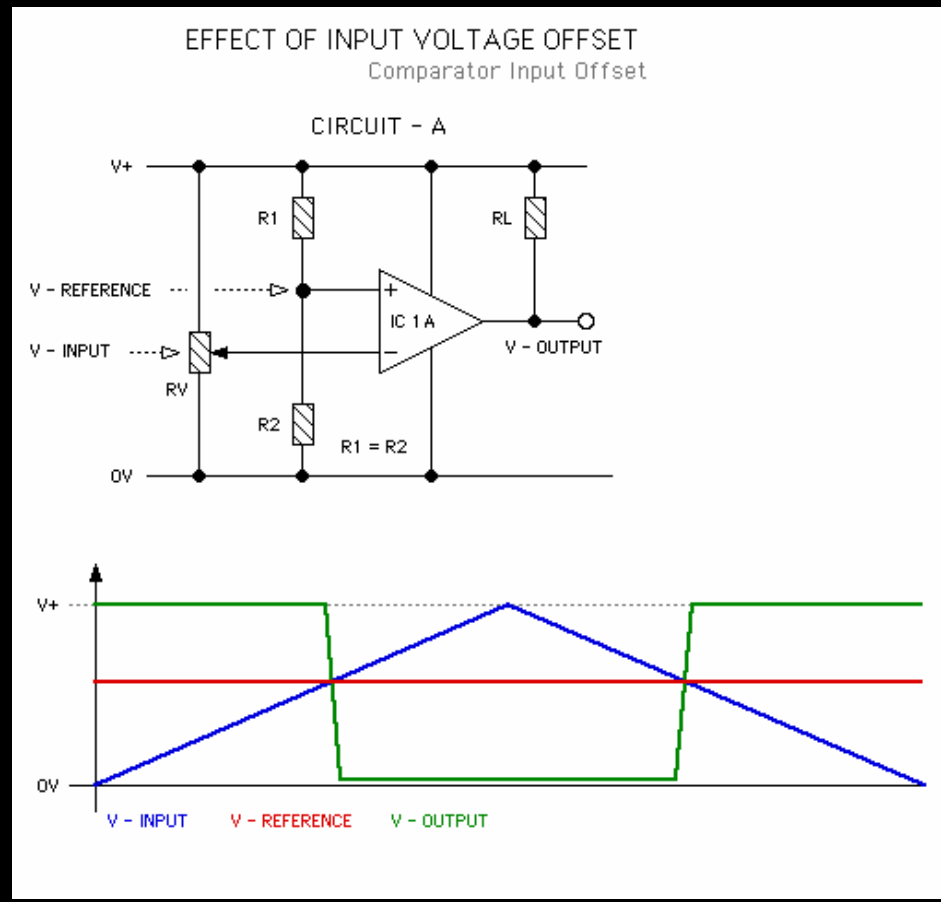
- Reference voltage
  - One-half of the supply voltage
- Input voltage
  - Variable from zero to the supply voltage. .

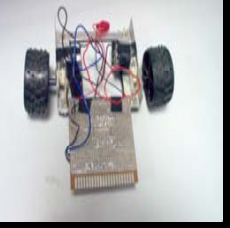




Actual and Ideal Comparator

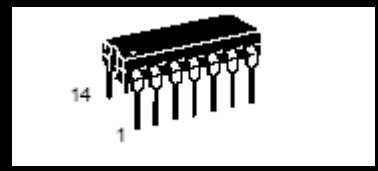
- Voltage comparators are not perfect devices.
- Input Offset Voltage.
  - This problem occurs when the Input voltage changes very slowly.
  - Result of the Input Offset Voltage
    - Output transistor does not fully turn on or off when the input voltage is close to the reference voltage.
  - Keeping the value of RL high will help reduce the problem.

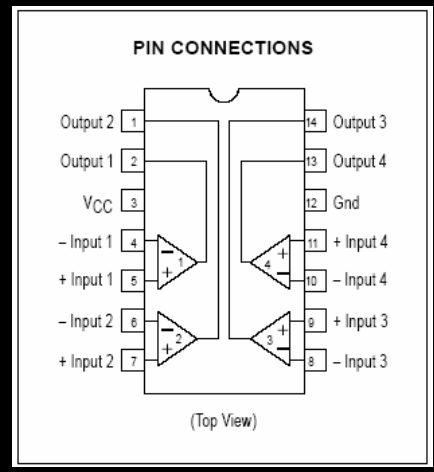


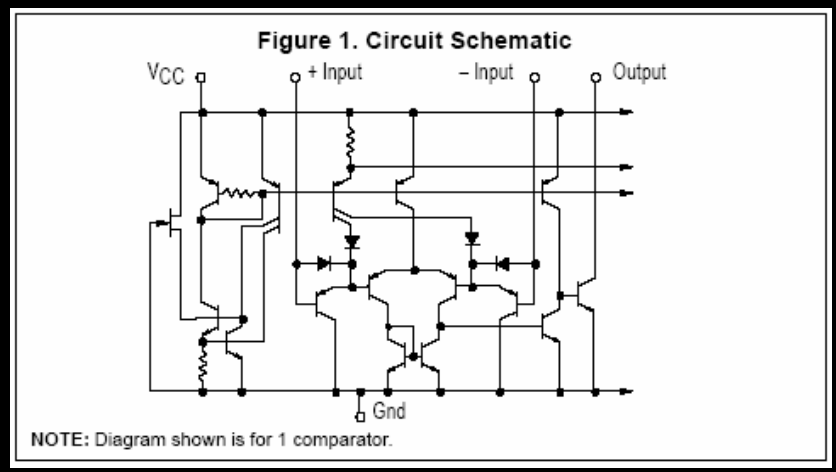


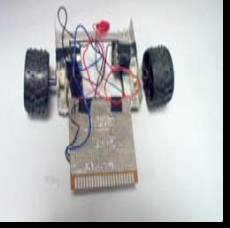
LM339 Comparator IC

- **Features.**
  - High gain.
  - Wide Bandwidth.
- **Application**
  - Limit comparators.
  - Simple analog to Digital converters.
  - Pulse, square wave and time delay generators.
  - Clock timers.
  - Multivibrators.
  - High voltage digital logic gates.
- **Advantages**
  - High precision comparators.
  - Reduced V_{OS} drift over temperature.
  - Eliminates need for dual supplies.
  - Allows sensing near GND.
  - Compatible with all forms of logic.
  - Power drain suitable for battery operation.



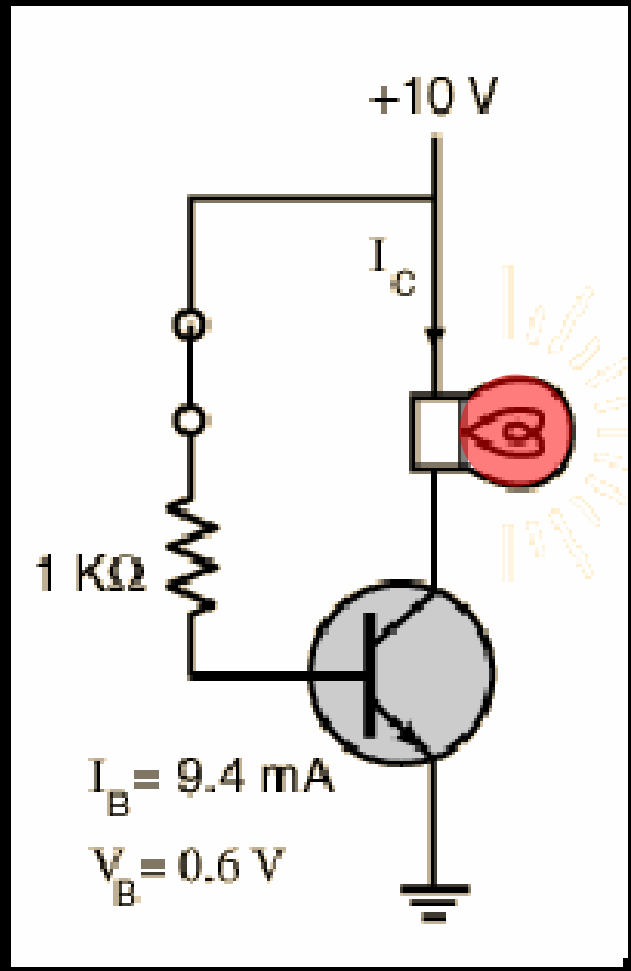




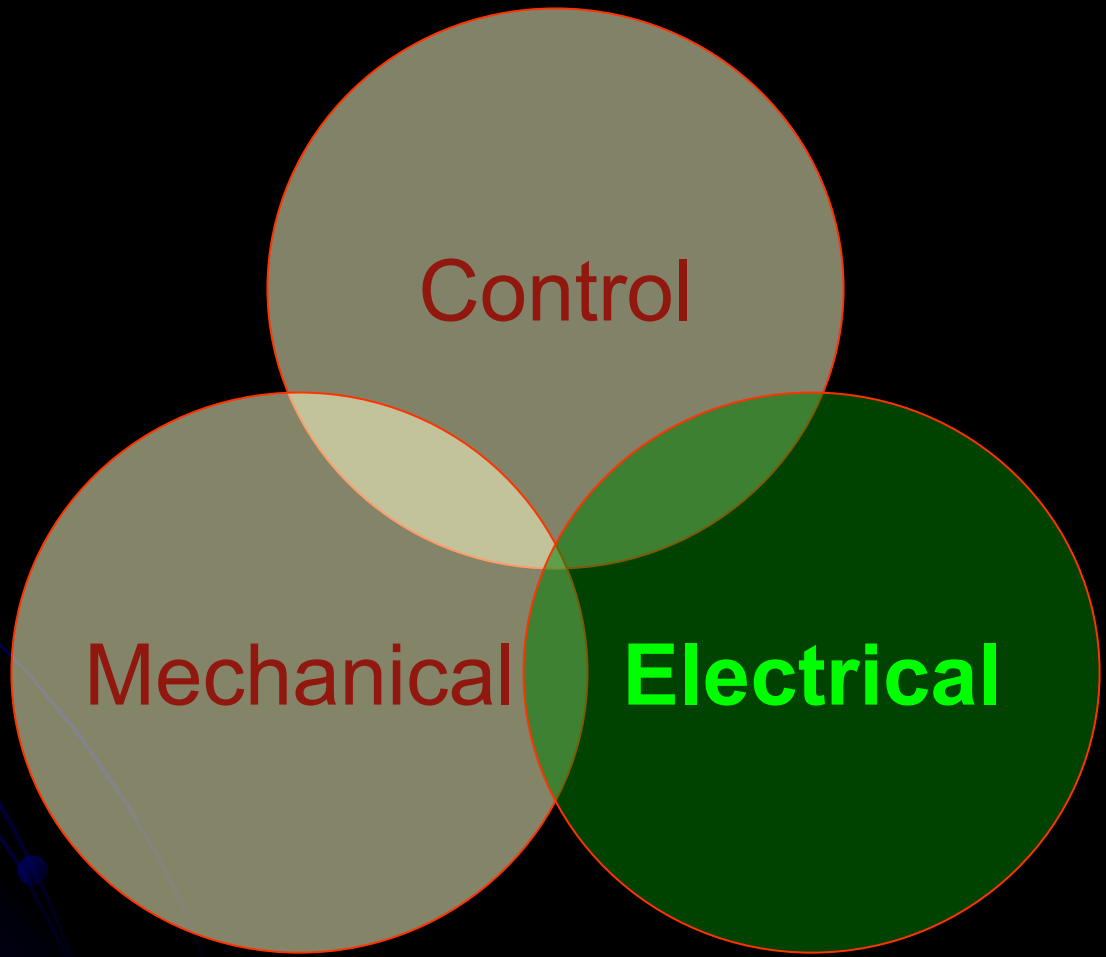


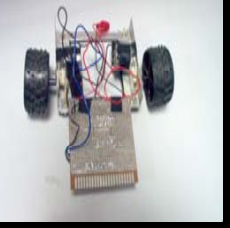
Transistor Switch

- **Switch open.**
  - No base current flows.
  - No collector current can flow.
  - The transistor is said to be CUT OFF.
- **Switch closed.**
  - Base current flows causing collector current to flow.
  - The battery voltage is dropped across the lamp causing the collector voltage to fall to a very low value.
  - The transistor is said to be SATURATED.

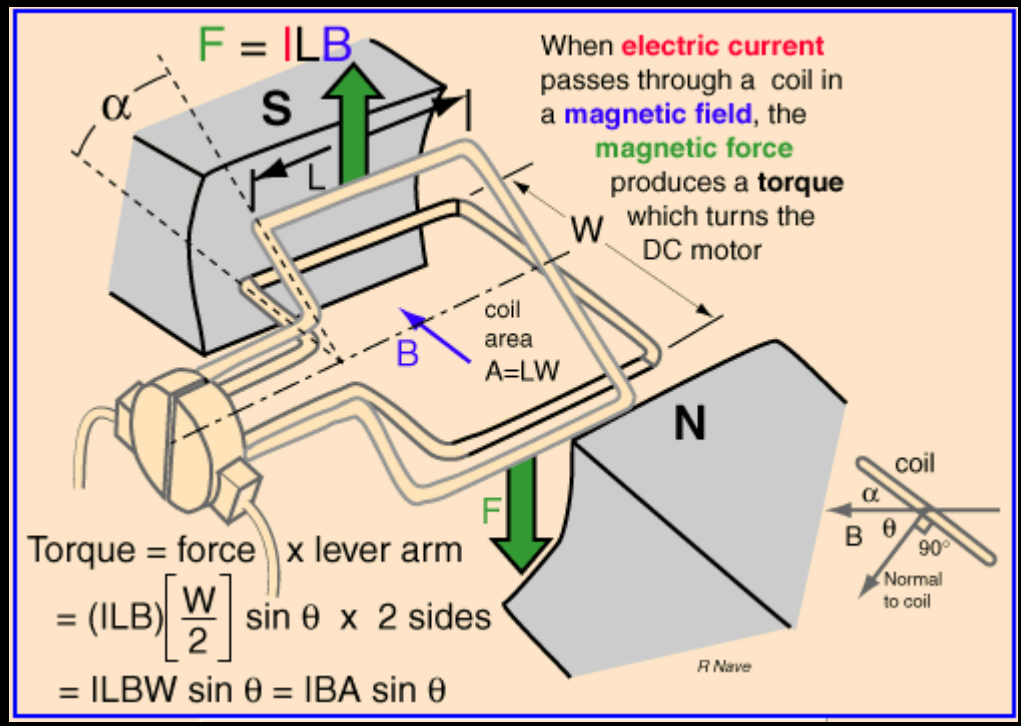


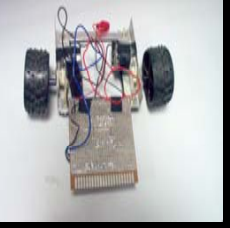
Components



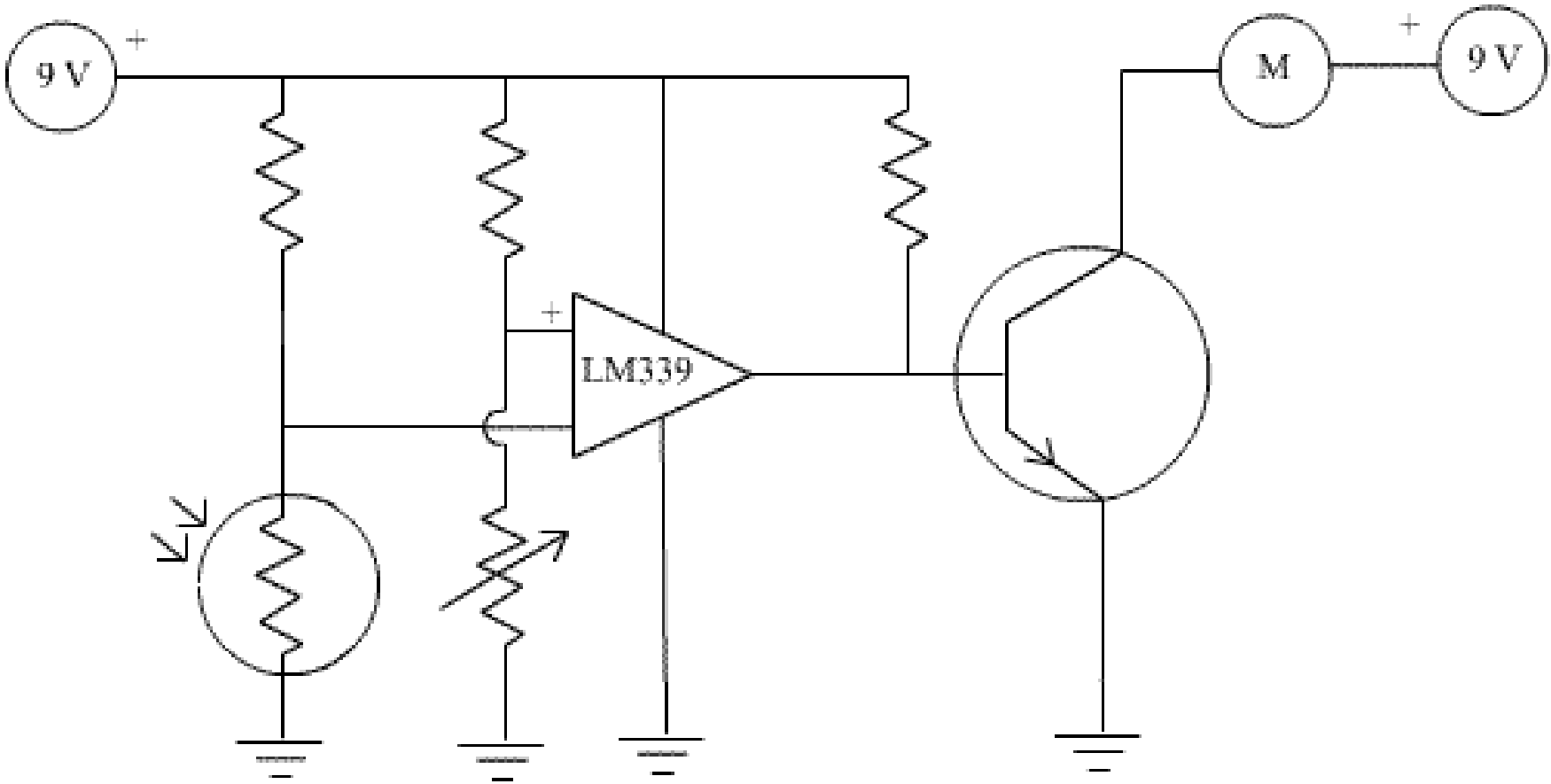


DC Motor

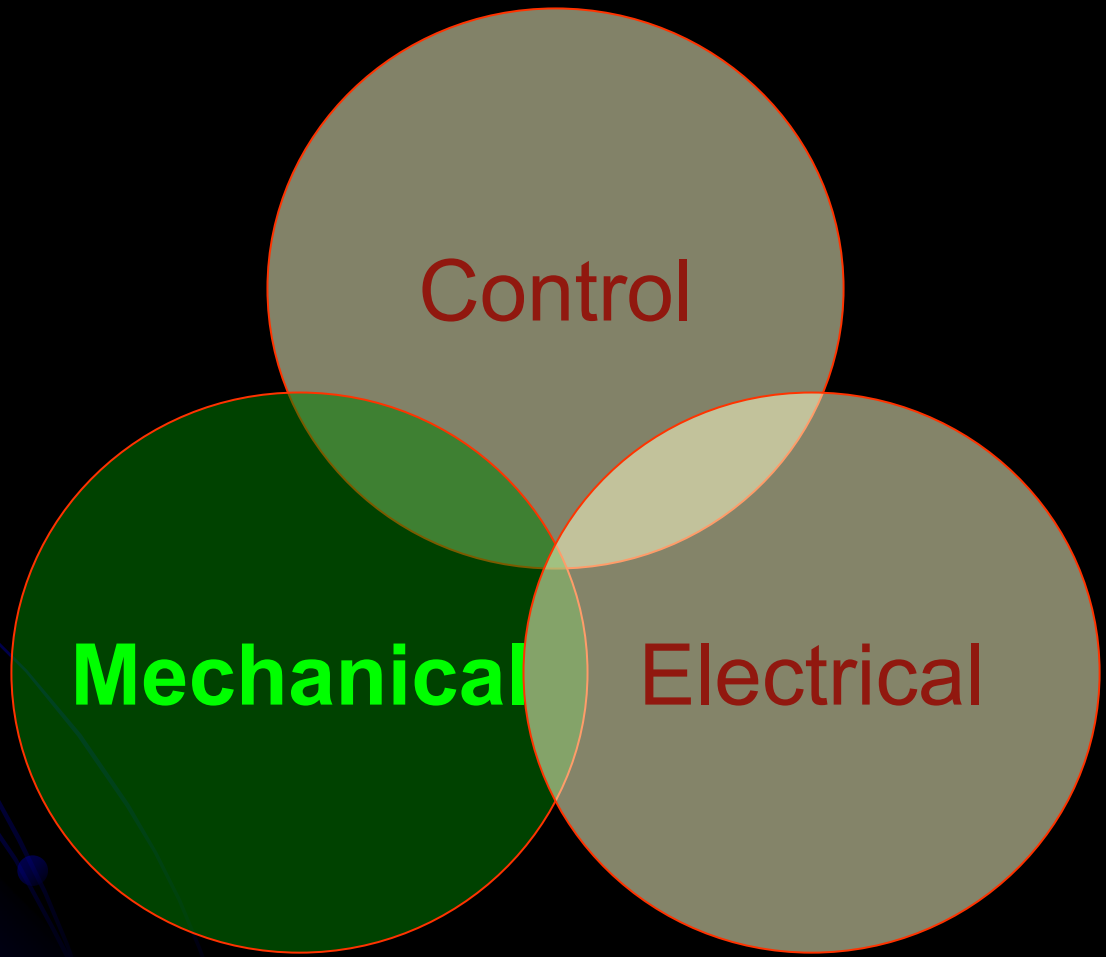

F = ILB
α
S
L
W
When electric current passes through a coil in a magnetic field, the magnetic force produces a torque which turns the DC motor
B
coil area A=LW
N
F
coil
α
B
θ
90°
Normal to coil
Torque = force x lever arm
= (ILB)[W/2] sin θ x 2 sides
= ILBW sin θ = IBA sin θ
R Nave

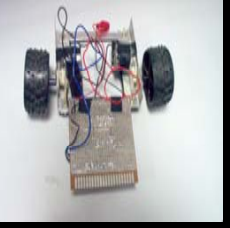


Complete Circuit



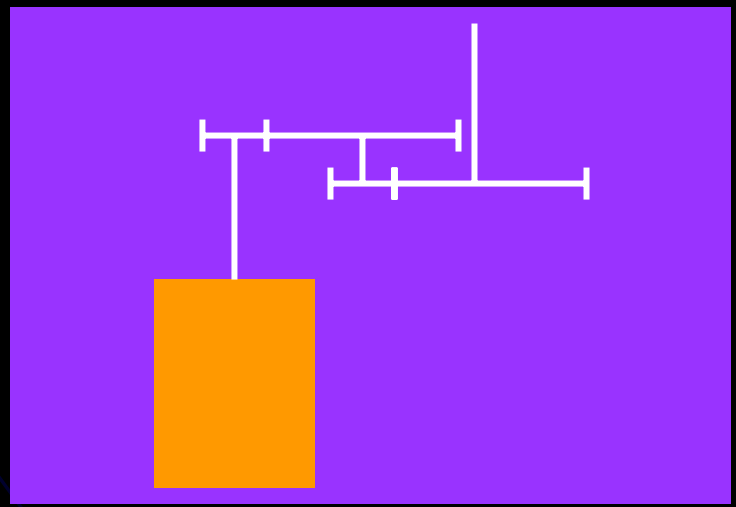
Components



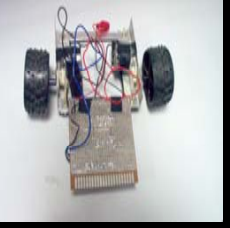


Gear Assembly

- To improve the torque.
- Speed of DC Motor gets reduced.
- Ideal for Locomotion.
- 1:36 Gear reduction used.

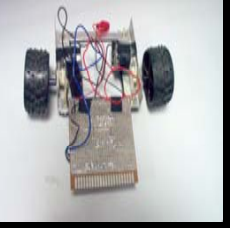


Practical Problems

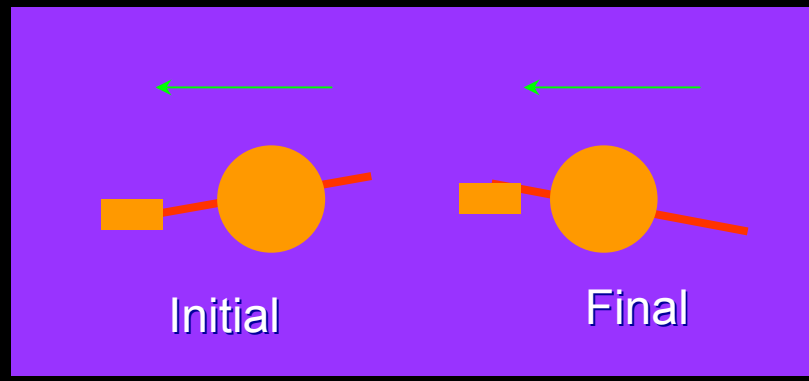


Electronic Problems

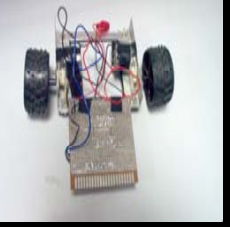
- **LDR**
  - **LDR Initially used had very high resistance (in MΩ).**
  - **New LDR's were not exactly the same.**
    - One was 3 KΩ, Other was 10 KΩ.
    - Had to tune each circuit differently.
- **LED**
  - **The two LED's had different light intensity.**
  - **Separating the two LED's**
- **Transistor**
  - **Initially BC107 used**
    - Amperage rating was not high enough.
    - Gave rise to heating problems.
    - Replaced it with BDX530 which has a Heat sink.



Mechanical Problems

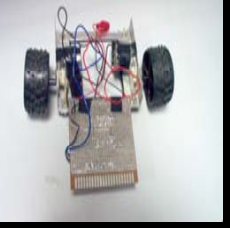


- **Gear Assembly**
  - Was not very rigid.
- **Direction of Motion**
  - Power not enough to push robot.
  - Changed Motor position to pull the Robot.
- **Friction**
  - High due to lack of third wheel.
  - Teflon Tape helped to reduce friction.
- **Height of Sensor.**
  - Circuit to be calibrated based on height of Sensor from the ground.



Possible Improvements

- Have separate power source for Control circuit and Motor.
- Improve mechanical drive train.
- Include
  - Microprocessor.
  - Collision and obstacle avoidance.
  - Multiple AGV.



References

- Robot Room.
  - Line following Robots
- How Stuff Works Website.
- Sarjoun Skaffet. et.al, Inertial Navigation and Visual Line Following for a Dynamic Hexapod Robot.IEEE, 2003.