CHAPTER ONE

INTRODUCTION

1.1 General Concepts

Nowadays the creations of Line Following Robotic Vehicle (LFRV) model can be found from all over the countries , as it give many advantages in our lives. It works just like a robot as it is able to sense and response to the environment. Considering that, LFRVs should be well developed to optimize it's benefits to our own living. The aim of this project is to build a prototype of an Automated (LFRV) model that can move on a flat surface with its two driving wheels and a free wheel. The prototype is able to follow line on floor with the Arduino-uno as its main brain that control all the navigation and responses to the environment.

The ability to follow line on floor is an advantage of this prototype as it can be further developed to do more complicated task in real life. To follow the line, the Arduino is attached to a sensor that continuously reflecting to the surface condition. Therefore, this project involves of designing and fabrication of the hardware and circuitry. The key study in this project is the algorithm designed in assembly language, embedded in the microcontroller.

1.2 Problem Statement

There are many method used for transportation of production and storage system in factories. Some factories using manual methods such as labers . This will need more time, more consumption reduce the outputs production .
Nowadays, many method used to line following detection. For example using phototransistors, IR sensor or ultrasonic sensor. Each method have their own advantages and disadvantages.

1.3 Objectives

The objectives of the Line Following Robotic vehicle(LFRV) include :

- Moving forward searching for a black line on a white surface .

- Detecting a black line on a white surface .
- Generating control commands to follow a detected black line .

1.4 Methodology

A model of a line following robotic has been done using a controller , LDR sensor and DC motor .

1.5 Project layout

This thesis consists of an abstract and fivechapters - chapter one deals with an introduction that consists of problem statement , objective research and thesis organization .

Chapter two contains the previous studies of literature review and general information's about the robotic systems .

Chapter three include detailed description of the components used in the design ,and the role of each one, with block diagram explaination how all components work together.

Chapter four is about the operation and how the (LFRV) response in the different cases.

Chapter five include the conclusion andrecommendations .

CHAPTER TWO

ROBOTIC SYSTEMS

2.1 Introduction

Robotic is the branch of mechanical engineering, electrical engineering and computer science that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing.

These technologies deal with automated machines that can take the place of humans in dangerous environments or manufacturing processes, or resemble humans in appearance, behavior, and or cognition. Many of today's robots are inspired by nature, contributing to the field of bio-inspired robotics. The concept of creating machines that can operate autonomously dates back to classical times, but research into the functionality and potential uses of robots did not grow substantially until the 20th century. Throughout history, it has been frequently assumed that robots will one day be able to mimic human behavior and manage tasks in a human-like fashion. Today, robotics is a rapidly growing field, as technological advances continue; researching, designing, and building new robots serve various practical purposes, whether domestically, commercially, or militarily. Many robots are built to do jobs that are hazardous to people such as defusing bombs, finding survivors in unstable ruins, and exploring mines and shipwrecks. Robotics is also used in STEM (Science, Technology, Engineering, and Mathematics) as a teaching aid .

- Etymology

The word robotics was derived from the word robot, which was introduced to the public by Czech writer KarelČapek in his play R.U.R. (Rossum's Universal Robots*)*, which was published in 1920. The word robot comes from the Slavic word robota, which means labour. The play begins in a factory that makes artificial people called robots, creatures who can be mistaken for humans – very similar to the modern ideas of androids. KarelČapek himself did not coin the word. He wrote a short letter in reference to an etymology in the Oxford English Dictionary in which he named his brother Josef Čapek as its actual originator.[1]

According to the Oxford English Dictionary, the word *robotics* was first used in print by Isaac Asimov, in his science fiction short story "Liar!", published in May 1941 in Astounding Science Fiction. Asimov was unaware that he was coining the term; since the science and technology of electrical devices is electronics, he assumed robotics already referred to the science and technology of robots. In some of Asimov's other works, he states that the first use of the word robotics was in his short story Runaround (Astounding Science Fiction, March 1942)

- Low Of Robotics

A robot may not injure a human being or, through inaction, allow a human being to come to harm.

A robot must obey the orders it by human beings except where such orders would conflict with the First Law.

A robot must protect its own existence as long as such protection does not conflict with the First or Second Laws

In 1948 Norbert Wiener formulated the principles of cybernetics, the basis of practical robotics .

Fully autonomous only appeared in the second half of the 20th century. The first digitally operated and programmable robot, the Unimate, was installed in 1961 to lift hot pieces of metal from a die casting machine and stack them. Commercial and industrial robots are widespread today and used to perform jobs more cheaply, more accurately and more reliably, than humans. They are also employed in some jobs which are too dirty, dangerous, or dull to be suitable for humans. Robots are widely used in manufacturing, assembly, packing and packaging, transport, earth and space exploration, surgery, weaponry, laboratory research, safety, and the mass production of consumer and industrial goods.

- Robotic aspects

There are many types of robots; they are used in many different environments and for many different uses, although being very diverse in application and form they all share three basic similarities when it comes to their construction

Robots all have some kind of mechanical construction, a frame, form or shape designed to achieve a particular task. For example, a robot designed to travel across heavy dirt or mud, might use caterpillar tracks. The mechanical aspect is mostly the creator's solution to completing the assigned task and dealing with the physics of the environment around it. Form follows function

Robots have electrical components which power and control the machinery. For example, the robot with caterpillar tracks would need some kind of power to move the tracker treads. That power comes in the form of electricity, which will have to travel through a wire and originate from a battery, a basic electrical circuit. Even petrol powered machines that get their power mainly from petrol still require an electric current to start the combustion process which is why most petrol powered machines like cars, have batteries. The electrical aspect of robots is used for movement (through motors), sensing (where electrical signals are used to measure things like heat, sound, position, and energy status) and operation (robots need some level of electrical energy supplied to their motors and sensors in order to activate and perform basic operation

All robots contain some level of computer programming code

A program is how a robot decides when or how to do something. In the caterpillar track example, a robot that needs to move across a muddy road may have the correct mechanical construction, and receive the correct amount of power from its battery, but would not go anywhere without a program telling it to move. Programs are the core essence of a robot, it could have excellent mechanical and electrical construction, but if its program is poorly constructed its performance will be very poor (or it may not perform at all). There are three different types of robotic programs: remote control, artificial intelligence and hybrid. A robot with remote control programing has a preexisting set of commands that it will only perform if and when it receives a signal from a control source, typically a human being with a remote control. It is perhaps more appropriate to view devices controlled primarily by human commands as falling in the discipline of automation rather than robotics. Robots that use artificial intelligence interact with their environment on their own without a control source, and can determine reactions to objects and problems they encounter using their preexisting programming. Hybrid is a form of programming that incorporates both AI and RC functions

2.2 Robotic Construction

Power source At present mostly (lead–acid) batteries are used as a power source. Many different types of batteries can be used as a power source for robots. They range from lead–acid batteries, which are safe and have relatively long shelf lives but are rather heavy compared to silver–cadmium batteries that are much smaller in volume and are currently much more expensive. Designing a battery-powered robot needs to take into account factors such as safety, cycle lifetime and weight. Generators, often some type of internal combustion engine, can also be used. However, such designs are often mechanically complex and need fuel, require heat dissipation and are relatively heavy. A tether connecting the robot to a power supply would remove the power supply from the robot entirely. This has the advantage of saving weight and space by moving all power generation and storage components elsewhere. However, this design does come with the drawback of constantly having a cable connected to the robot, which can be difficult to manage.Potential power sources could be:

- pneumatic (compressed gases)

- Solar power (using the sun's energy and converting it into electrical power)
- hydraulics (liquids)
- flywheel energy storage
- organic garbage (through anaerobic digestion)
- nuclear

- **Actuation**

Actuators are the "muscles" of a robot, the parts which convert stored energy into movement. By far the most popular actuators are electric motors that rotate a wheel or gear, and linear actuators that control industrial robots in factories. There are some recent advances in alternative types of actuators, powered by electricity, chemicals, or compressed air.

- **Electric motors**

The vast majority of robots use electric motors, often brushed and brushless DC motors in portable robots or AC motors in industrial robots and CNC machines. These motors are often preferred in systems with lighter loads, and where the predominant form of motion is rotational.

- **Sensing**

Sensors allow robots to receive information about a certain measurement of the environment, or internal components. This is essential for robots to perform their tasks, and act upon any changes in the environment to calculate the appropriate response. They are used for various forms of measurements, to give the robots warnings about safety or malfunctions, and to provide real time information of the task it is performing.**Manipulation**Robots need to manipulate objects; pick up, modify, destroy, or otherwise have an effect. Thus the "hands" of a robot are often referred to as end effectors, while the "arm" is referred to as a manipulator. Most robot arms have replaceable effectors, each allowing them to perform some small range of tasks. Some have a fixed manipulator which cannot be replaced, while a few have one very general purpose manipulator, for example a humanoid hand. Learning how to manipulate a robot often requires a close feedback between human to the robot, although there are several methods for remote manipulation of robots.

Locomotion

For simplicity most mobile robots have four wheels or a number of continuous tracks. Some researchers have tried to create more complex wheeled robots with only one or two wheels. These can have certain advantages such as greater efficiency and reduced parts, as well asallowing a robot to navigate in confined places that a four-wheeled robot would not be able to.

2.3 Robotic Types

Two-wheeled balancing robots Balancing robots generally use a gyroscope to detect how much a robot is falling and then drive the wheels proportionally in the same direction, to counterbalance the fall at hundreds of times per second, based on the dynamics of an inverted pendulum.Many different balancing robots have been designed.While the Segway is not commonly thought of as a robot, it can be thought of as a component of a robot, when used as such Segway refer to them as RMP (Robotic Mobility Platform). An example of this use has been as NASA's Robonaut that has been mounted on a Segway.

- **One-wheeled balancing robots**

A one-wheeled balancing robot is an extension of a two-wheeled balancing robot so that it can move in any 2D direction using a round ball as its only wheel. Several one-wheeled balancing robots have been designed recently, such as Carnegie Mellon University's "Ballbot" that is the approximate height and width of a person, and Tohoku Gakuin University's "BallIP".Because of the long, thin shape and ability to maneuver in tight spaces, they have the potential to function better than other robots in environments with people.

- **Spherical orb robots**

Several attempts have been made in robots that are completely inside a spherical ball, either by spinning a weight inside the ball,or by rotating the outer shells of the sphere. These have also been referred to as an orb bot[59] or a ball bot.

- **Six-wheeled**

robotsUsing six wheels instead of four wheels can give better traction or grip in outdoor terrain such as on rocky dirt or grass.

- **Climbing**

Several different approaches have been used to develop robots that have the ability to climb vertical surfaces. One approach mimics the movements of a human climber on a wall with protrusions; adjusting the center of mass and moving each limb in turn to gain leverage. An example of this is Capuchin,built by Dr. Ruixiang Zhang at Stanford University, California. Another approach uses the specialized toe pad method of wall-climbing geckoes, which can run on smooth surfaces such as vertical glass. Examples of this approach include Wallbot and Stickybot. China's Technology Daily reported on November 15, 2008 that Dr. Li HiuYeung and his research group of New Concept Aircraft (Zhuhai) Co., Ltd. had successfully developed a bionic gecko robot named "Speedy Freelander". According to Dr. Li, the gecko robot could rapidly climb up and down a variety of building walls, navigate through ground and wall fissures, and walk upside-down on the ceiling. It was also able to adapt to the surfaces of smooth glass, rough, sticky or dusty walls as well as various types of metallic materials. It could also identify and circumvent obstacles automatically. Its flexibility and speed were comparable to a natural gecko. A third approach is to mimic the motion of a snake climbing a pole.[citation needed]. Lastely one may mimic the movements of a human climber on a wall with protrusions; adjusting thecenter of mass and moving each limb in turn to gain leverage.

- **Flying**

A modern passenger airliner is essentially a flying robot, with two humans to manage it. The autopilot can control the plane for each stage of the journey, including takeoff, normal flight, and even landing.Other flying robots are uninhabited, and are known as unmanned aerial vehicles (UAVs). They can be smaller and lighter without a human pilot on board, and fly into dangerous territory for military surveillance missions. Some can even fire on targets under command. UAVs are also being developed which can fire on targets automatically, without the need for a command from a human. Other flying robots include cruise missiles, the Entomopter, and the Epson micro helicopter robot. Robots such as the Air Penguin, Air Ray, and Air Jelly have lighter-than-air bodies, propelled by paddles, and guided by sonar.

- **Swimming (Piscine)**

It is calculated that when swimming some fish can achieve a propulsive efficiency greater than 90%.Furthermore, they can accelerate and maneuver far better than any man-made boat or submarine, and produce less noise and water disturbance. Therefore, many researchers studying underwater robots would like to copy this type of locomotion. Notable examples are the Essex University Computer Science Robotic Fish G9, and the Robot Tuna built by the Institute of Field Robotics, to analyze and mathematically model thunniform motion. The Aqua Penguin,designed and built by Festo of Germany, copies the streamlined shape and propulsion by front "flippers" of penguins. Festo have also built the Aqua Ray and Aqua Jelly, which emulate the locomotion of manta ray, and jellyfish, respectively

- **Dynamics and kinematics**

The study of motion can be divided into kinematics and dynamics.Direct kinematics refers to the calculation of end effector position, orientation, velocity, and acceleration when the corresponding joint values are known. Inverse kinematics refers to the opposite case in which required joint values are calculated for given end effector values, as done in path planning.

Some special aspects of kinematics include handling of redundancy (different possibilities of performing the same movement), collision avoidance, and singularity avoidance. Once all relevant positions, velocities, and accelerations have been calculated using kinematics, methods from the field of dynamics are used to study the effect of forces upon these movements. Direct dynamics refers to the calculation of accelerations in the robot once the applied forces are known. Direct dynamics is used in computer simulations of the robot. Inverse dynamics refers to the calculation of the actuator forces necessary to create a prescribed end effector acceleration. This information can be used to improve the control algorithms of a robot.

- **Educational robotics**

In each area mentioned above, researchers strive to develop new concepts and strategies, improve existing ones, and improve the interaction between these areas. To do this, criteria for "optimal" performance and ways to optimize design, structure, and control of robots must be developed and implemented.

Robotics engineers design robots, maintain them, develop new applications for them, and conduct research to expand the potential of robotics. Robots have become a popular educational tool in some middle and high schools, particularly in parts of the USA, as well as in numerous youth summer camps, raising interest in programming, artificial intelligence and robotics among students. First-year computer science courses at some universities now include programming of a robot in addition to traditional software engineering-based coursework

- **Career training**

Universities offer bachelors, masters, and doctoral degrees in the field of robotics. Vocational schools offer robotics training aimed at careers in robotics.

Certification

The Robotics Certification Standards Alliance (RCSA) is an international robotics certification authority that confers various industry- and educational-related robotics certifications.

Robotics afterschool programs

Many schools across the country are beginning to add robotics programs to their after school curriculum. Some major programs for afterschool robotics include FIRST Robotics Competition, Botball and B.E.S.T. Robotics.Robotics competitions often include aspects of business and marketing as well as engineering and design. The Lego company began a program for children to learn and get excited about robotics at a young age.

2.4 Robotic Applications :

As more and more robots are designed for specific tasks this method of classification becomes more relevant. For example, many robots are designed for assembly work, which may not be readily adaptable for other applications. They are termed as "assembly robots". For seam welding, some suppliers provide complete welding systems with the robot i.e. the welding equipment along with other material handling facilities like turntables etc. as an integrated unit. Such an integrated robotic system is called a "welding robot" even though its discrete manipulator unit could be adapted to a variety of tasks. Some robots are specifically designed for heavy load manipulation, and are labelled as "heavy duty robots."

Current and potential applications include:

Military robotsCaterpillar plans to develop remote controlled machines and expects to develop fully autonomous heavy robots by 2021.[1]Somecranes

- already are remote controlled.
- It was demonstrated that a robot can perform a herding task.

- Robots are increasingly used in manufacturing (since the 1960s). In the auto industry they can amount for more than half of the "labor". There are even "lights off" factories such as an IBM keyboard manufacturing factory in Texas that is 100% automated.
- Robots such as HOSPI are used as couriers in hospitals (hospital robot). Other hospital tasks performed by robots are receptionists, guides and porters helpers,
- Robots can serve as waiters and cooks. also at home. Boris is a robot that can load a dishwasher.
- Robot combat for sport – hobby or sport event where two or more robots fight in an arena to disable each other. This has developed from a hobby in the 1990s to several TV series worldwide.
- Cleanup of contaminated areas, such as toxic waste or nuclear facilities.-Agricultural robots (AgRobots,).
- Domestic robots, cleaning and caring for the elderly
- Medical robots performing low-invasive surgery
- Household robots with full use.
- Nano robots

2.5 Importance of line following robot

- There as several factors to consider to using agv in control system:-
- **Mobility:**

Mobility in general is the ability to move freely in working environment. Mobile robots have ability to do their tasks in various places in working environment unlike fixed robots or manipulators, which are widely used in car industries. Manipulators are programmed in such a way that they can repeat the same sequence of actions over and over again, faster, cheaper, and more accurate than humans. Typically, manipulators consist of a movable arm fixed to a point on the round, which can assemble or manufacture different parts. Besides moving around this fixed point, the robots are not able of moving freely and therefore they are not fully mobile. Robot can be categorized as fully mobile if it does not have limited range in movement. Therefore, if the robot has degree of mobility, it is called mobile robots, then mobile robot must have some kind of a control system or algorithm to determine and guide it during its movement. The type of that control system or algorithm of the mobile robot determines its autonomy

- **Autonomy**

General definition of autonomy is “self directing freedom”; for a mobile robot, it specifies to what extent a robot relies on prior information from the environment to achieve its tasks. Information from the environment can be a feedback from sensors to sense the floor of the workspace or detecting obstacles in the way of the robot. Degree of importance of this information on control algorithm of the robot movement determines its degree of autonomy as well. Based on degree of autonomy mobile robots can be divided into non-autonomous, semi- autonomous and fully autonomous robots.

Non-autonomous mobile robots controlled manually by humans therefore, actions it manipulates is based on navigation commands received .In case of semi-autonomous robots, it either can be navigated by themselves or can be steered by humans.In contrast, fully autonomous robots are steered solely by the robots themselves, which means the robots do not require human interaction to fulfill their tasks. Semi or fully autonomous robots suitable to perform tasks in which each action to be taken is unknown. The robot has to determine by itself how to get to the goals to be achieved by it .

2.6 Functions of line following robotic vehicle :

- **Guidance** :The vehicles follow a predetermined path route, which is optimized for the material flow pattern of the given application.
- **Routing**:Routing is the vehicles ability to make decisions along the guided path in order to select optimum routes to specific destinati
- **Load Transfer** :Load transfer is the pick up and delivery method for an line following robotic system, which may be simple or integrated with other sub systems.
- **System Management**:System management is the method of system control used to order system operation.

2.7 Navigation of robot

Navigation is to important for all apps of robot.

Robot navigation means the robot's ability to determine its own position in its frame of reference and then to plan a path towards some goal location

- **The path**

The definition of pathways is generally accomplished using wires embedded in the floor or by reflective paint on the floor surface. Sensors on the vehicle that can follow the guide wires or paints achieve guidance.

The term guidance refers to the ways by which the LFRV pathways are defined and the vehicle control system that follows the pathways.

When paint strips are used to define the vehicle pathways, the vehicle possesses an optical sensor system that is capable of scanning the paint.

The strips can be taped, sprayed or painted on the floor. The paint guidance system is useful in an environment where electrical noises would render the guidance wire system unreliable or when the installation of the guide wire system in the floor surface would not be appropriate. One problem with the paint strip guidance is that the paint strip must be maintained and kept clean and unscratched. In the case of wire guidance systems, wires are embedded in a small channel cut into the surface of the floor. The channel should be thick enough . A frequency generator is then used to provide the guidance signal carried. The signal is of relatively low voltage, low current

- **Shape of The Path**

Track component by way of black width larger than the width robot used, aspects track white, choose black and white, because of black can absorb light significantly reverse color white, which reflects light in large quantities, track shape depends on the use of robot or depends on who uses it .

CHAPTER THREE

ROBOTIC CONTROL

3.1 Introduction

A control system is a device, or set of devices, that manages, commands, directs or regulates the behaviour of other devices or systems.

Control system theory evolved as an engineering discipline and due to universality of the principles involved ,it is extended to various fields like economy,sociology,biology,medicine etc.Control theory has played a vital role in the advance of engineering and science.The automatic control has become an integral part of modern manufacturing and industrial processes.For example ,numerical control of machine tools in manufacturing industries,controlling pressure,temperature,humidity,viscosity and flow in process industry.

When a number of elements or components are connected in sequence to perform a specific function,the group thus formed is called a system.In a system when the output quantity is controlled by varying the input quantity,the system is called **control system**.The output quantity is called controlled variable or response and input quantity is called command signal or excitation.

3.2 Types of Control systems:

Control systems is of two types.They are :

- **Open loop control system:**

Any physical system which does not automatically correct the variation in its output,is called an open loop system or controlsystem in which the output quantity has no effect upon the input quantity are called **open-loop control system**.

This means that the output is not feedback to the input for correction as shown in figure(3.2)

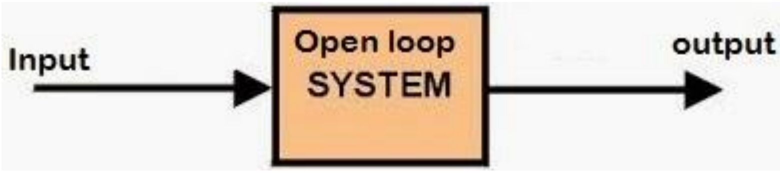

Figure3.1:open loop system

- **Closed loop control system:**

Control systems in which the output has an effect upon the input quantity in order to maintain the desired output value are called **closed loop systems**. The **open loop system** can be modified as closed loop system by

providing a feedback .The provision of feedback automatically corrects the changes in output due to disturbances .Hence the closed loop system is also called automatic control system. The general block diagram of an automatic **control system** is shown in figure below. It consists of an error detector ,a controller ,plant (open loop system) and feedback path elements

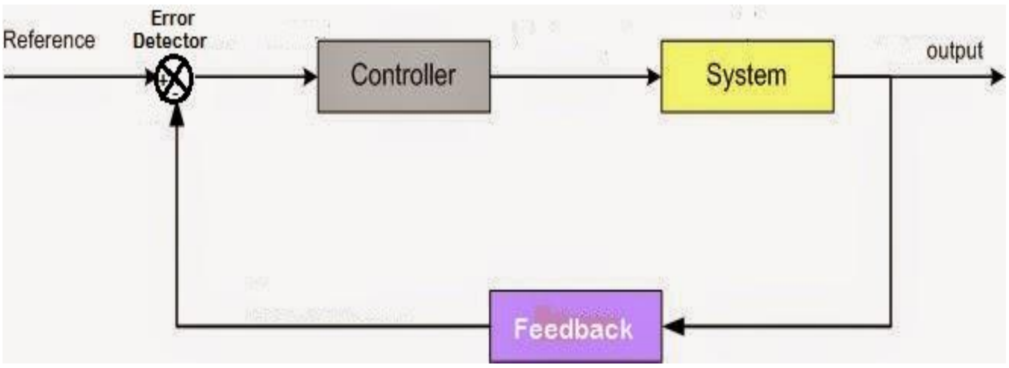

Figure3.2:Feed back control system

- **Logic control**

systems for industrial and commercial machinery were historically implemented at main voltage using interconnected relays, designed using ladder logic. Today, most such systems are constructed with programmable logic controllers (PLCs) or microcontrollers. The notation of ladder logic is still in use as a programming idiom for PLCs. Logic controllers may respond to switches, light sensors, pressure switches, etc., and can cause the machinery to start and stop various operations. Logic systems are used to sequence mechanical operations in many applications. PLC software can be written in many different ways – ladder diagrams, SFC – sequential function charts or in language terms known as statement lists.

Examples include elevators, washing machines and other systems with interrelated stop-go operations.

Logic systems are quite easy to design, and can handle very complex operations. Some aspects of logic system design make use of Boolean logic.[2]

- Microcontrollers

A microcontroller (or MCU, short for microcontroller unit) is a small computer on a single integrated circuit containing a processor core, memory, and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a typically small amount of RAM. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes. Mixed signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems .

- Arduino As a Type of Microcontrollers

Arduino is an open-source project that created microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.

The project is based on microcontroller board designs, produced by several vendors, using various microcontrollers. These systems provide sets of digital and analog input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits. The boards feature serial communication interfaces, including Universal Serial Bus (USB) on some models, for loading programs from personal computers. For programming the microcontrollers, The arduino project provides an integrated development environment (IDE) based on a programming language named Processing, which also supports the languages C and C++.The first arduino was introduced in 2005, aiming to provide a low cost, easy way for novices and professionals to create devices that interact with their environment using sensors and actuators. Common examples of such devices intended for beginner hobbyists include simple robots, thermostats, and motion detectors.

Arduino boards are available commercially in preassembled form, or as do-it-yourself kits. The hardware design specifications are openly available, allowing the arduino boards to be produced by anyone. Adafruit Industries estimated in mid-2011 that over 300,000 official Arduinos had been commercially produced, and in 2013 that 700,000 official boards were in users' hansa.

- Development

Arduino is open-source hardware. The hardware reference designs are distributed under a Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduino website. Layout and production files for some versions of the hardware are also available. The source code for the IDE is released under the GNU General Public License, version

Nevertheless an official Bill of Materials of Arduino boards has never been released by the staff of Arduino.

Although the hardware and software designs are freely available under copyleft licenses, the developers have requested that the name "Arduino" be exclusive to the official product and not be used for derived works without permission. The official policy document on use of the Arduino name emphasizes that the project is open to incorporating work by others into the official product.Several Arduino-compatible products commercially released have avoided the Arduino name by using -duino name variants. The Arduino project provides the Arduinointegrated development environment (IDE), which is a cross-platform application written in the programming language Java. It originated from the IDE for the languages Processing and Wiring. It is designed to introduce programming to artists and other newcomers unfamiliar with software development. It includes a code editor with features such as syntax highlighting, brace matching, and automatic indentation, and provides simple one-click mechanism to compile and load programs to an Arduino board. A program written with the IDE for Arduino is called a "sketch".

A typical Arduino C/C++ sketch consist of two functions that are compiled and linked with a program stub main() into an executable cyclic executive program:

- setup(): a function that runs once at the start of a program and that can initialize settings.
- loop(): a function called repeatedly until the board powers off.

After compiling and linking with the GNU toolchain, also included with the IDE distribution, the Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal coding that is loaded into the Arduino board by a loader program in the board's firmware.

- **Other IDE**

Arduino programs may be written in any programming language with a compiler that produces binary machine code. Atmel provides a development environment for their microcontrollers, AVR Studio and the newer Atmel Studio, which can be used for programming Arduino.

Arduino can be controlled using C/C++ interpreter Ch without the binary code. Two textbooks "Learning Arduino with Ch Programming for the Absolute Beginner" and "Learning Arduino with C Programming" are freely available.

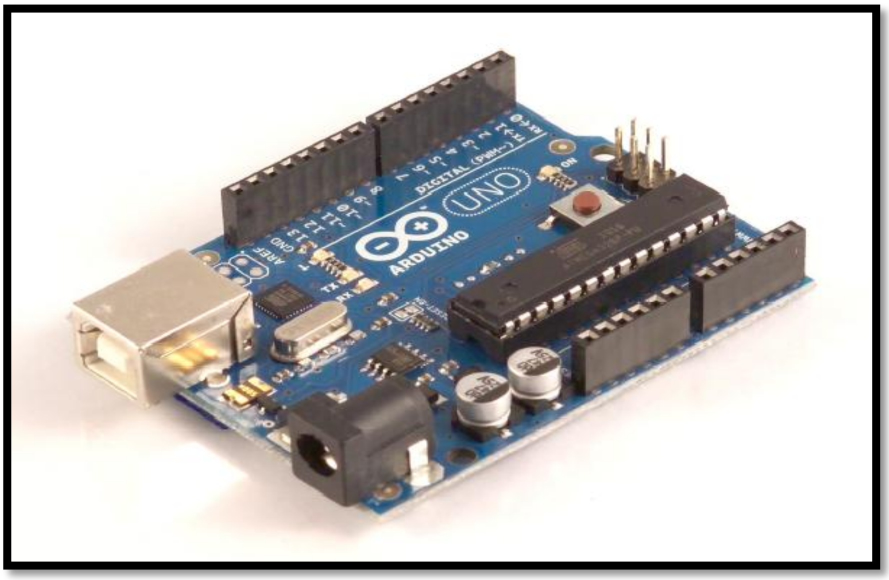

Figure3.3 : Arduino-UNO

- **Sample program**

The bare minimum code to start a sketch program consists of two functions setup()and loop().

```
void setup() {
  // put your setup code here, to run once at startup
}
void loop() {
  // put your main code here, to run repeatedly
}
```

Arduino boards contain an LED and a load resistor connected between pin 13 and ground which is a convenient feature for many tests.

A typical program for a beginning Arduino programmer blinks a light-emitting diode (LED) on and off. This program is usually loaded in the Arduino board by the manufacturer. In the Arduino environment, a user might write such a program as shown:

Power LED (red) and integrated LED on Line 13 (green) on Arduino compatible board, made in China

```
#define LED_PIN 13                // Pin number attached to LED
void setup() {
pinMode(LED_PIN, OUTPUT);
  }
    // Enable pin 13 for digital output.
void loop() {
digitalWrite(LED_PIN, HIGH);    // Turn on the LED.
   delay(1000);                 // Wait one second. (1000 milliseconds)
digitalWrite(LED_PIN, LOW);     // Turn off the LED.
   delay(1000);                 // Wait one second.
}
```

-Applicationsof arduino

- Xoscillo, an open-source oscilloscope
- Scientific equipmentsuch as the Chemduino.
- Arduinome, a MIDI controller device that mimics the Monome.
- OBDuino, a trip computer that uses the on-board diagnostics interface found in most modern cars.
- Ardupilot, drone software and hardware.
- ArduinoPhone, a do-it-yourself cell phone.
- GertDuino, an Arduino mate for the Raspberry Pi.
- Water quality testing platform.
- Homemade CNC using Arduino and DC motors with close loop control by Homofaciens .
- DC motor control using Arduino and H-Bridge .

3.3 Sensor

sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps which dim or brighten by touching the base, besides innumerable applications of which most people are never aware. With advances in micro machinery and easy-to-use micro controller platforms, the uses of sensors have expanded beyond the most traditional fields of temperature, pressure or flow measurement .

Types of sensors

A photo-resistor (or light-dependent resistor, LDR, or photocell) is a light-controlled variable resistor. The resistance of a photo-resistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photo-resistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits.

A photo-resistor is made of a high resistance semiconductor. In the dark, a photo-resistor can have a resistance as high as several mega-ohms (MΩ), while in the light, a photo-resistor can have a resistance as low as a few hundred ohms. If incident light on a photo-resistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photo-resistor can substantially differ among dissimilar devices. Moreover, unique photo-resistors may react substantially differently to photons within certain wavelength bands.

A photoelectric device can be either intrinsic or extrinsic. An intrinsic semiconductor has its own charge carriers and is not an efficient semiconductor, for example, silicon. In intrinsic devices the only available electrons are in the valence band, and hence the photon must have enough energy to excite the electron across the entire band gap. Extrinsic devices have impurities, also called do pants, added whose ground state energy is closer to the conduction band; since the electrons do not have as far to jump, lower energy photons (that is, longer wavelengths and lower frequencies) are sufficient to trigger the device. If a sample of silicon has some of its atoms replaced by phosphorus atoms (impurities), there will be extra electrons available for conduction. This is an example of an extrinsic semiconductor .[5]

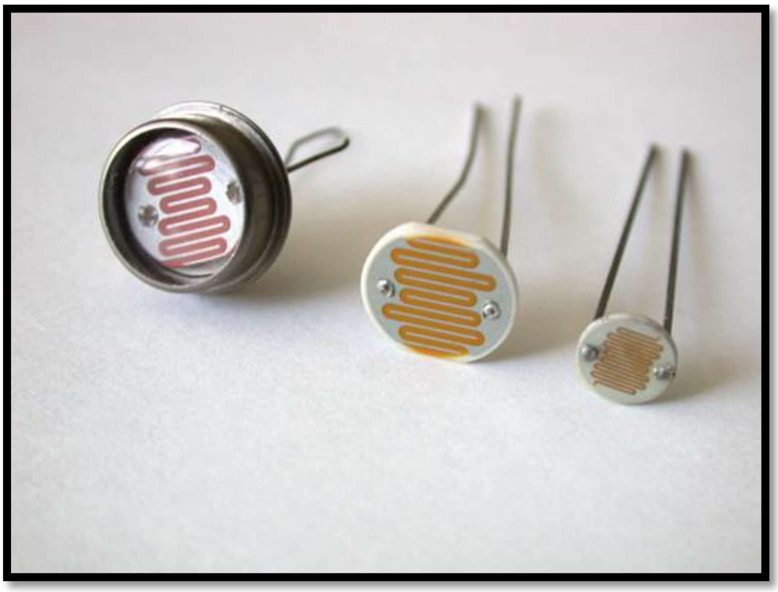

Figure 3.4 : Photo-resistor Sensor

A light-emitting diode (LED) is a two-leadsemiconductorlight source. It is a p–n junctiondiode, which emits light when activated When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. [4]

An LED is often small in area (less than 1 mm2) and integrated optical components may be used to shape its radiation pattern.

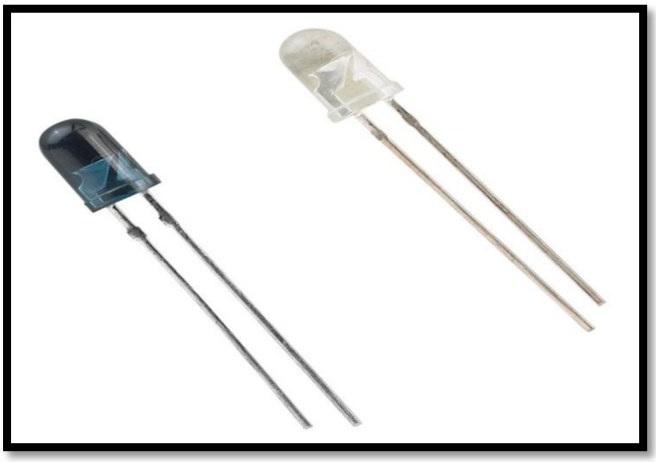

Figure 3.5 : Light-emitting diode Sensor

In this chapter we talk about the components we used in LFRV, the definition of each component and its role in the project, with adding a block describe how all components work together in one unit .

3.4 Brushed DC motor

All self-commutated DC motors are by definition run on DC electric power. Most DC motors are small PM types. They contain a brushed internal mechanical commutation to reverse motor windings' current in synchronism with rotation DC machines are defined as follows : Armature circuit - A winding where the load current is carried, such that can be either stationary or rotating part of motor or generator.

Field circuit - A set of windings that produces a magnetic field so that the electromagnetic induction can take place in electric machines.

- **Commutation**

A mechanical technique in which rectification can be achieved, or from which DC can be derived, in DC machines.

Motion is one of the primary differentiators between a robot and a computer. More robots get their motion from DC (Direct Current) motors than from any other mechanism as shown Figure 3.6.

Figure 3.6 : Dc Motor

This chapter details the different varieties of DC motors and their characteristics. If you don’t find this subject interesting, you can skim this chapter and move on to the next. Motors won’t be selected and attached to the line-following robot circuit until the next chapter.

- **DC Motors Work**

In an electric motor, electricity is converted to motion by magnetism. Most people have played with a pair of magnets. Placing the magnets facing each other causes the magnets to attract and pull together. Turning one of the magnets around causes the pair to repel each other and push apart.

One magnet can attract with enough strength to drag the other magnet across a surface. This technique can be improved by adding a third magnet. The first magnet attracts the second magnet, while the third magnet repels from the rear.

When magnets are mounted around a pole, the combination of pulling and pushing can result in a rotating motion. A magnet on the shaft or pole is attracted to a magnet mounted nearby, while simultaneously being repelled by another magnet mounted on the opposite side. As soon as the shaft rotates to the magnet pulling it, the shaft magnet flips polarity and starts pushing away.

The key to making this mechanism operate is that flowing electricity can create a magneticfield. Instead of physically flipping over a magnet to change from attract to repel, the flow of electricity can be flipped forwards and backwards.

- **Looking Inside an Iron -Core Permanent-Magnet DC Brush Motor**

An iron-core permanent-magnet DC brush motor (see Figure 3.7) consists of two major sections: the stationary parts (stator) and the rotating parts (rotor). The cap, also called the endcap or assembly, at the end of the motor is connected to the stator and doesn't move.

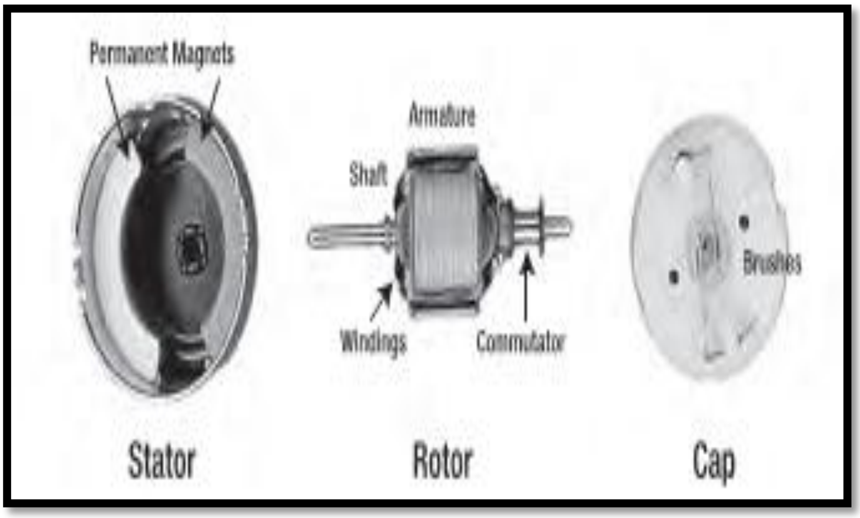

Figure 3.7 : Stator – Rotor – Cap of Motor

- **Stator**

The classic stator (the stationary part) includes two permanent magnets mounted opposite each other in a metal can (see Figure 3.8). The term "permanent magnets" indicates that the magnets remain magnetized even when the electricity is turned off. The magnetic field created by the electricity is going to push and pull against these two permanent magnets.

A pair of permanent magnets removed from the metal can. The clip in the foreground keeps the magnets from sliding together. At high enough temperatures (Curie temperature), permanent magnets lose their magnetic field, resulting in reduced performance or even complete failure. Therefore , it's important not to abuse a motor by allowing it to overheat during use. Provide for adequate ventilation and, if possible, mount the motor body against other metal object s to provide a large thermal path to wick away the heat.

Interestingly, the metal container that makes up the body of the motor acts as a return path for the magnetic field. As such, less of the magnetic field is "leaked" into nearby components.

- **Rotor**

The rotor (the rotating part) is built around a shaft. The shaft sticks out the end of the motor body so that wheels, belts, fan blades, or gears can be connected to it.

To limit friction, only a small portion of the rotor touches the motor body. High-quality motors and large motors often include ball bearings at those locations to improve carrying strength and decrease friction.

- **Rotor Windings**

In the middle of the shaft is an armature containing many windings of wire (see Figure 3.9). The wire carries the electricity around and around an iron core in an oval loop. This increases the magnetic field that pushes and pulls against the permanent magnets on the stator.

Figure 3.9 : Rotor Windings

Motor shaft and armature with wire windings and an iron-based core Besides generating and transmitting the magnetic field, the iron core also dissipates and evenly distributes heat, allowing for hard running. However, the relatively heavy iron core makes it more difficult to start or stop the shaft because of inertia.

Note: Almost all motors have three or more windings. Motors with only two windings wouldn't necessarily rotate in the same direction at power up, nor would they necessarily rotate all the way around. For example: Initially the shaft would rotate toward the first magnet, but then the windings reverse, so it might rotate back the way it came.

Hopefully, inertia would carry the rotor around in the direction it was already going.

- **Rotor Brushes**

The "brush" term in "DC brush motor" indicates that the motor has brushes. The brushes connect directly to the battery or other power source. As stated earlier, the brushes press against the commutator to make the connection between the battery and the armature windings. The brushes must press firmly (see Figure 3.10) or else the electrical connection breaks and the electrical flow ceases.

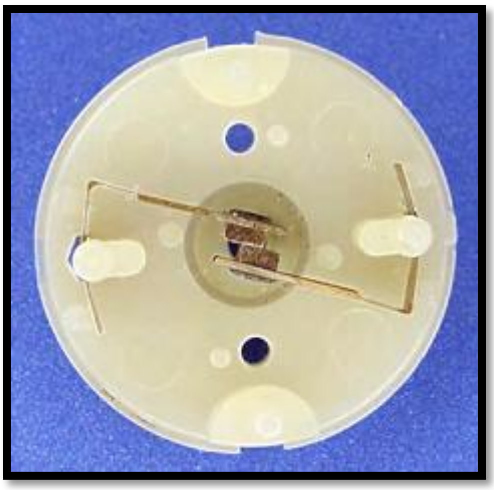

Figure 3.9 : Rotor Brushes

Brushes with pads pressed against each other because the motor shaft has been removed

There are a couple of downsides to brushes. First, the pressing of the brushes against the rotor adds friction, thus slowing down the motor and increasing heat. Second, the constant making and breaking of contacts generates electrical noise (like television static when a vacuum cleaner is run) and causes sparking. Last, but most important, the brushes wear out. Even the most well-made, well-maintained brush motor is eventually going to encounter brush failure. Brush degeneration is caused more by sparking than by friction. High-end brush motors have capacitors to absorb sparks and the motors are designed to be serviceable to replace the brushes.

CHAPTER FOUR

Robotic Implementation

4.1Introduction

The line follower is a self-operating car that detects and follows a line that is drawn on the floor. The path consists of a black line on a white surface (or it may be reverse of that .

The control system used must sense a line and maneuver the robot to stay on course, while constantly correcting the wrong moves using feedback mechanism, thus forming a simple yet effective closed loop System. The robot is designed to follow very tight curves.

Basic Design And Requirements

- A sensor to detect the line on the surface . we used LDR module sensor, it is cheap and easy to build and use.
- A microprocessor to run the code that takes inputs from the sensor and control the motion of robot. we used a cheap single chip computer called an Arduino-uno.
- The Arduino cannot drive the motors (used to actually make the car run) directly, so a motor driver is used. A motor driver in our case is 16pin chip called L293D. It can drive 2 DC motors.
- Battery to power the whole thing .
- A chassis to hold everything .

4.2 System Description

The system is compromised from a 4 wheels car with 2 DC motors and gears used as the main body of LFRV ,2 LDR sensors connected under the front side of the car, the distance between two sensors is enough to put the linr between them, and the distance between sensors and the line is about 2 cm and this is the best range for sensor sensitivity .all component connected as shown in figure 4.1 and figure 4.2 .

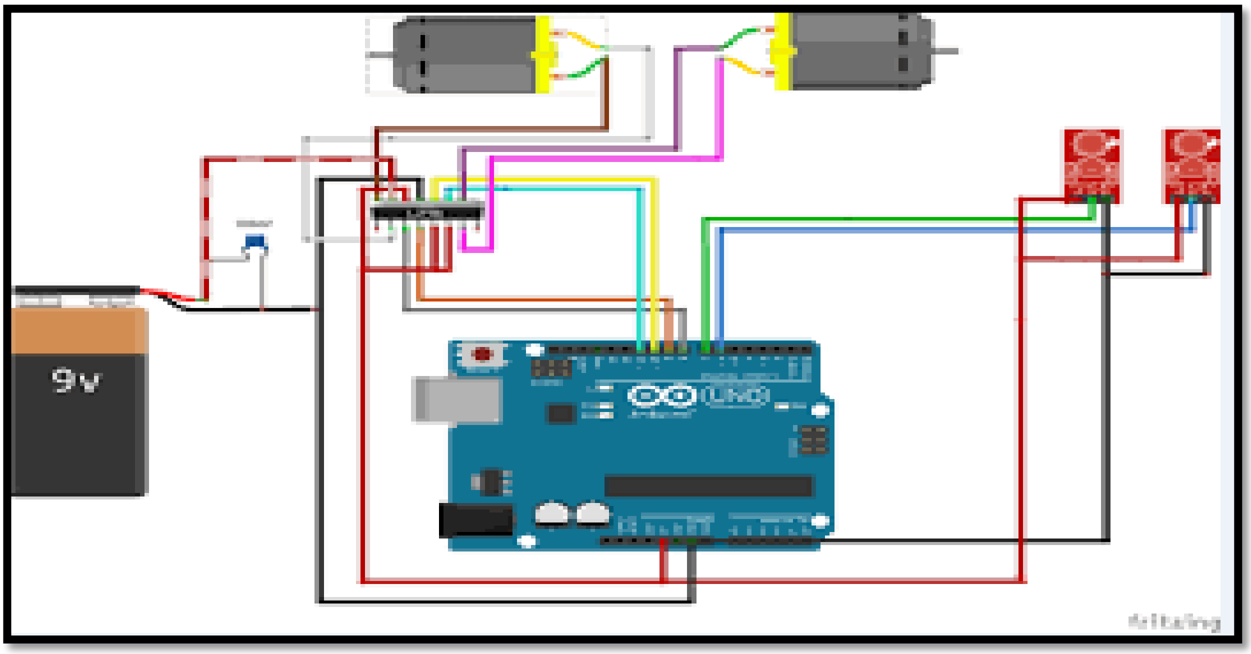

Figure 4.1 : Vehicle with designed circuit

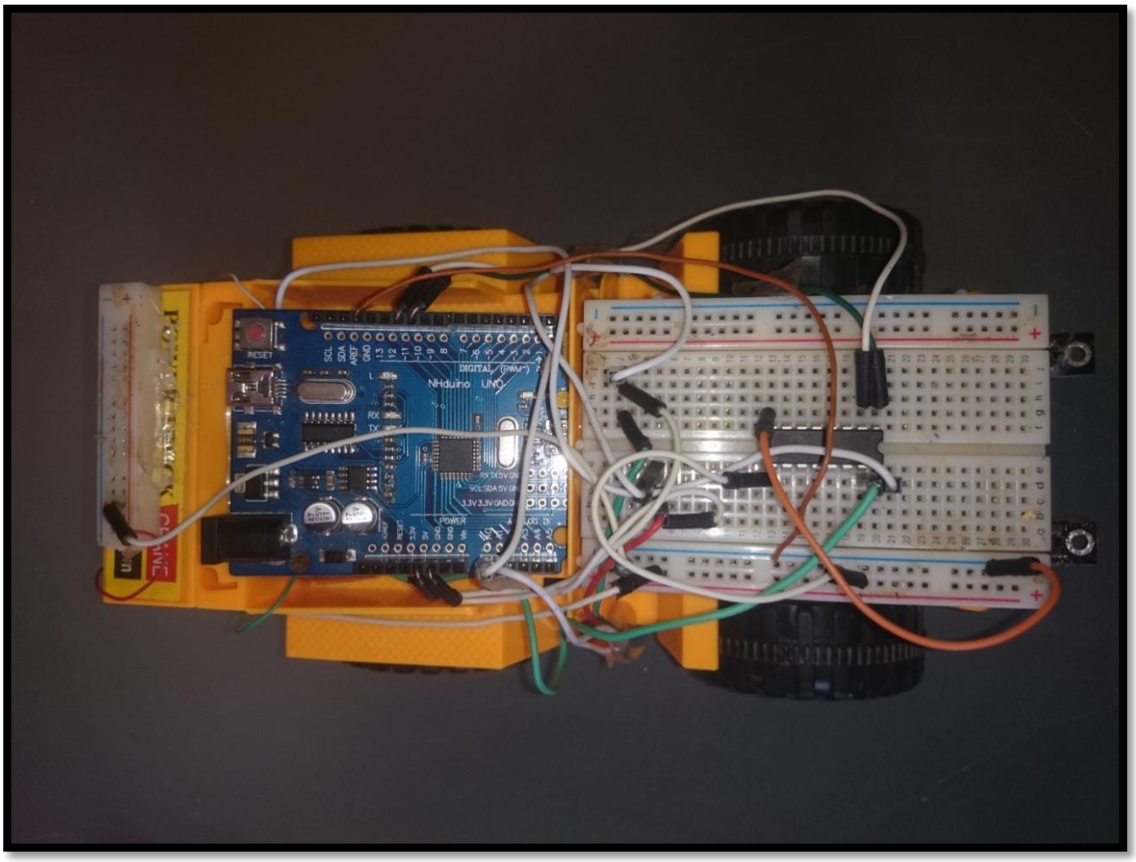

Figure 4.2 : Bread Board and Arduino-UNO

Operationoperation of system has been divided to three sections shown belowin the block diagram below :

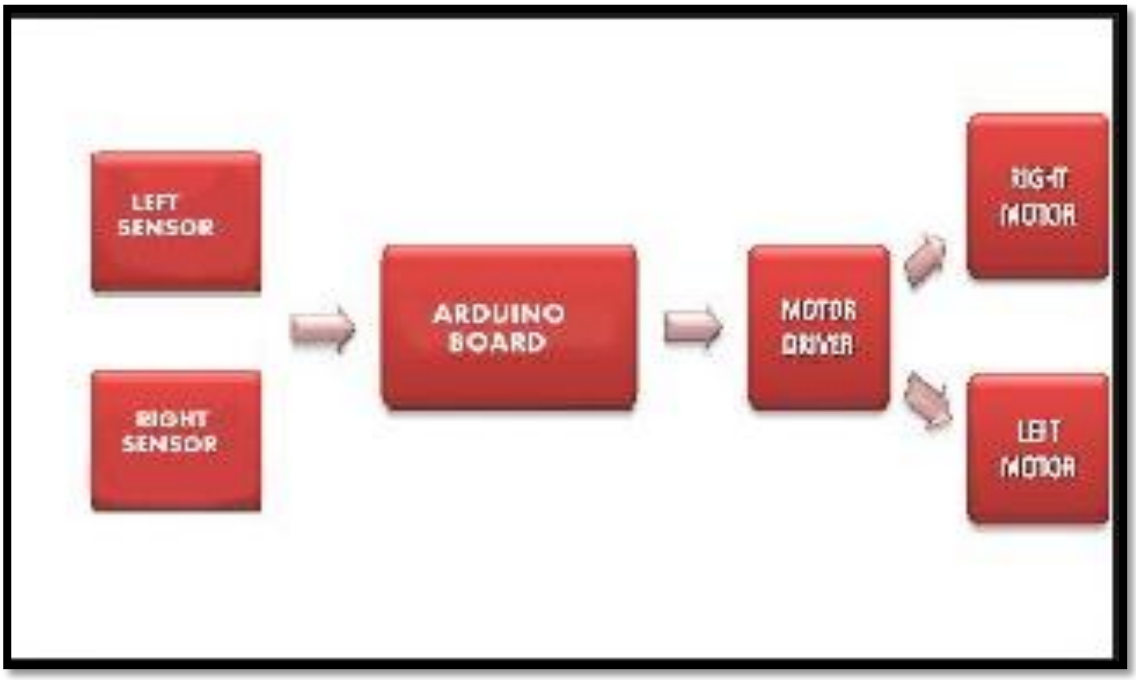

Figure 4.3 : block diagram

- **Input section**

LDR sensor module is used to detect the intensity of light. It is associated with both analog output pin and digital output pin labeled as AO and DO respectively on the board. When there is light, the resistance of LDR will become low according to the intensity of light. The greater the intensity of light, the lower the resistance of LDR. The sensor has a potentiometer knob that can b e adjusted to change the sensitivity of LDR towards light.

Figure 4.4 : LDR Sensor Module

- Uses high quality light dependent resistor.
- Potentiometer to adjust light brightness threshold.
- Digital Output

- Fixed bolt hole for convenient installation
- Uses LM393 wide voltage comparator
- LED indicator – ON when ambient light is more than threshold
- Operating Voltage is 3.3-5 V
- Dimensions: 3.2cm x 1.4cm

Description The module has 3 pins- Vcc, GND, DO(digital output). This module is used to detect ambient light. If the ambient light intensity is less than the threshold value set using the potentiometer, DO outputs HIGH(1) value and when the ambient light intensity

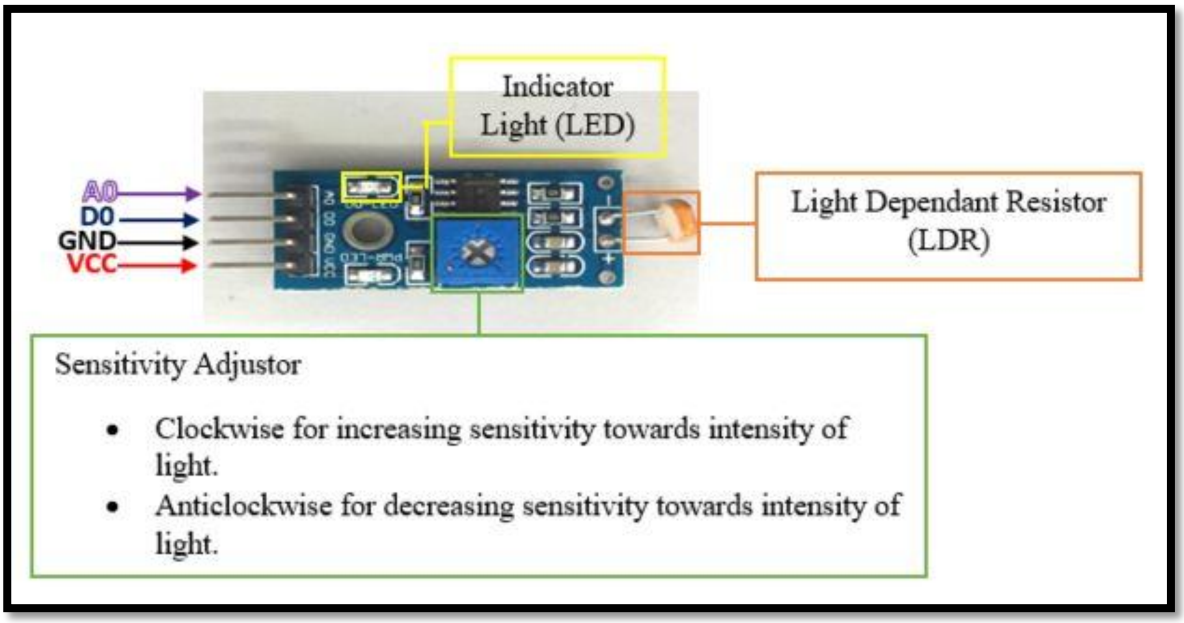

Figure 4.5 : LDR Sensor Module

is more than the set threshold, DO outputs a LOW(0) value

operationPhotosensitive resistor module most sensitive to environmental light intensity is generally used to detect the ambient brightness and light intensity.

Module light conditions or light intensity reach the set threshold, DO port output high, when the external ambient light intensity exceeds a set threshold, the module D0 output low;

Digital output D0 directly connected to the MCU, and detect high or low TTL, thereby detecting ambient light intensity changes;

Digital output module DO can directly drive the relay module, which can be composed of a photoelectric switch;

Analog output module AO and AD modules can be connected through the AD converter, you can get a more accurate light intensity value .

Pin details

- VCC = 3.3V to 5V DC
- GND = Ground
- DO = Digital Output
- AO = Analog Output

Sample Hardware InstallationLDR sensor

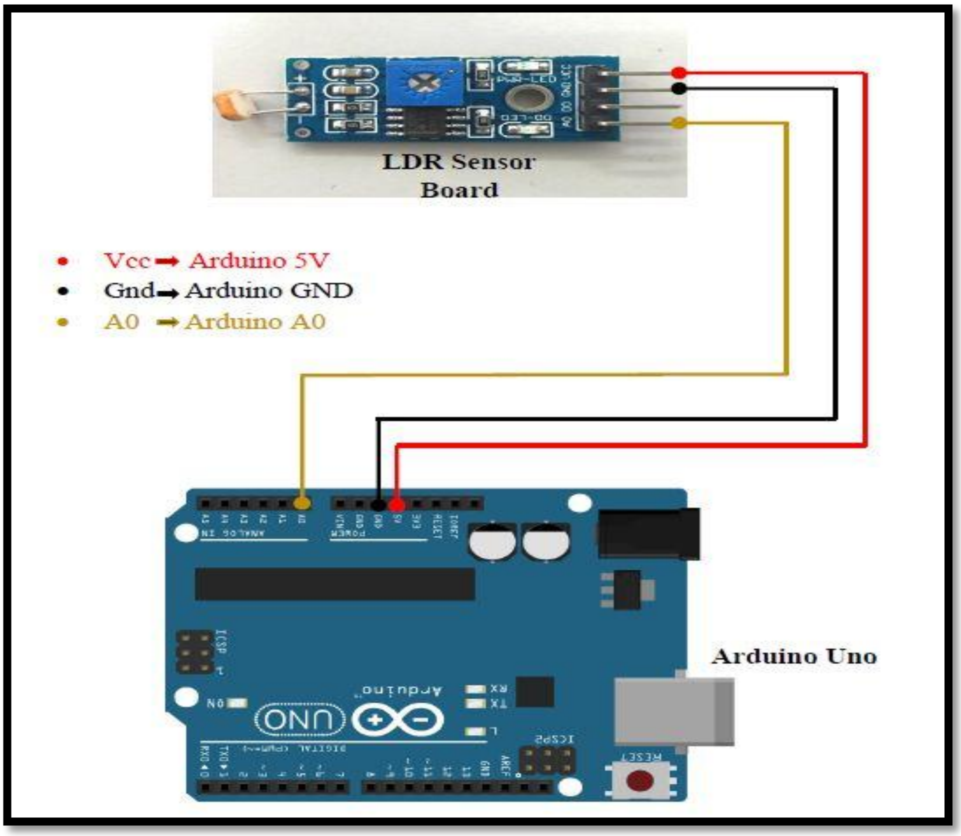

Figure 4.6 : Instruction of Arduino-UNO

4.3 Control section

Arduino UNOEAGLE files: arduino-duemilanove-uno-design.zip

Schematic: arduino-uno-schematic.pdf

Microcontroller ATmega328

Operating Voltage5V

Input Volta (recommended) 7-12V

Input Voltage (limits) 6-20V

Digital I/O Pins 14 (of which 6 provide PWM output)

Analog Input Pins 6

DC Current per I/O Pin40 mA

DC Current for 3.3V Pin 50 mA

Flash Memory 32 KB of which 0.5 KB used by bootloader

SRAM 2 KB

EEPROM 1 KB

Clock Speed 16 MHz

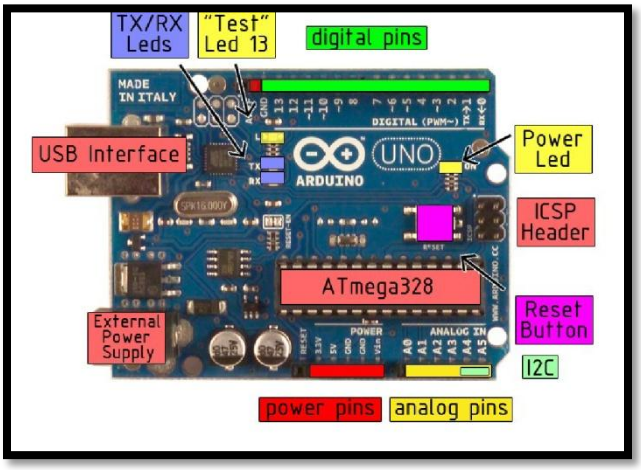

Figure 4.7: Instruction of Arduino-UNo

Pin 11 = output   motor 1

Pin 10 = output motor 2

A0 = input (sense 1)

A 1 = input (sense 2)

Software

constintphotocellPin = A0;

constint photocellPin1 = A1;

intphotocellReading;

int photocellReading1;

int m1 = 11;

```
int m2 = 10;
void setup(void)
{
Serial.begin(9600);
//pinMode(photocellPin, INPUT);
pinMode(m1, OUTPUT);
pinMode(m2, OUTPUT);
}
void loop(void)
 {
if (photocellReading> 500)
analogWrite(m1, 160);
else
analogWrite(m1, 0);
if (photocellReading1 > 500)
analogWrite(m2, 160);
else
analogWrite(m2, 0);
delay(0);
}
```

- **Out put section**

For moving a robot we have two dc motors attached to wheels gears. DC motors are most easy to control. One dc motor requires only two signals for its operation If we want to change its direction just reverse the polarity of power supply a cross it. we vary speed by varying the voltage across motor.

- **Use of gears**

The DC motors don't have enough torque to drive a robot directly by connecting wheels in it. Gears used to increase the torque of dc motor on the expense of its speed .

- **Reason of using Two Motors**

By using two motors we can move our robot in any direction. This steering Mechanism of robot is called as differential drive.

Let's check how it works :

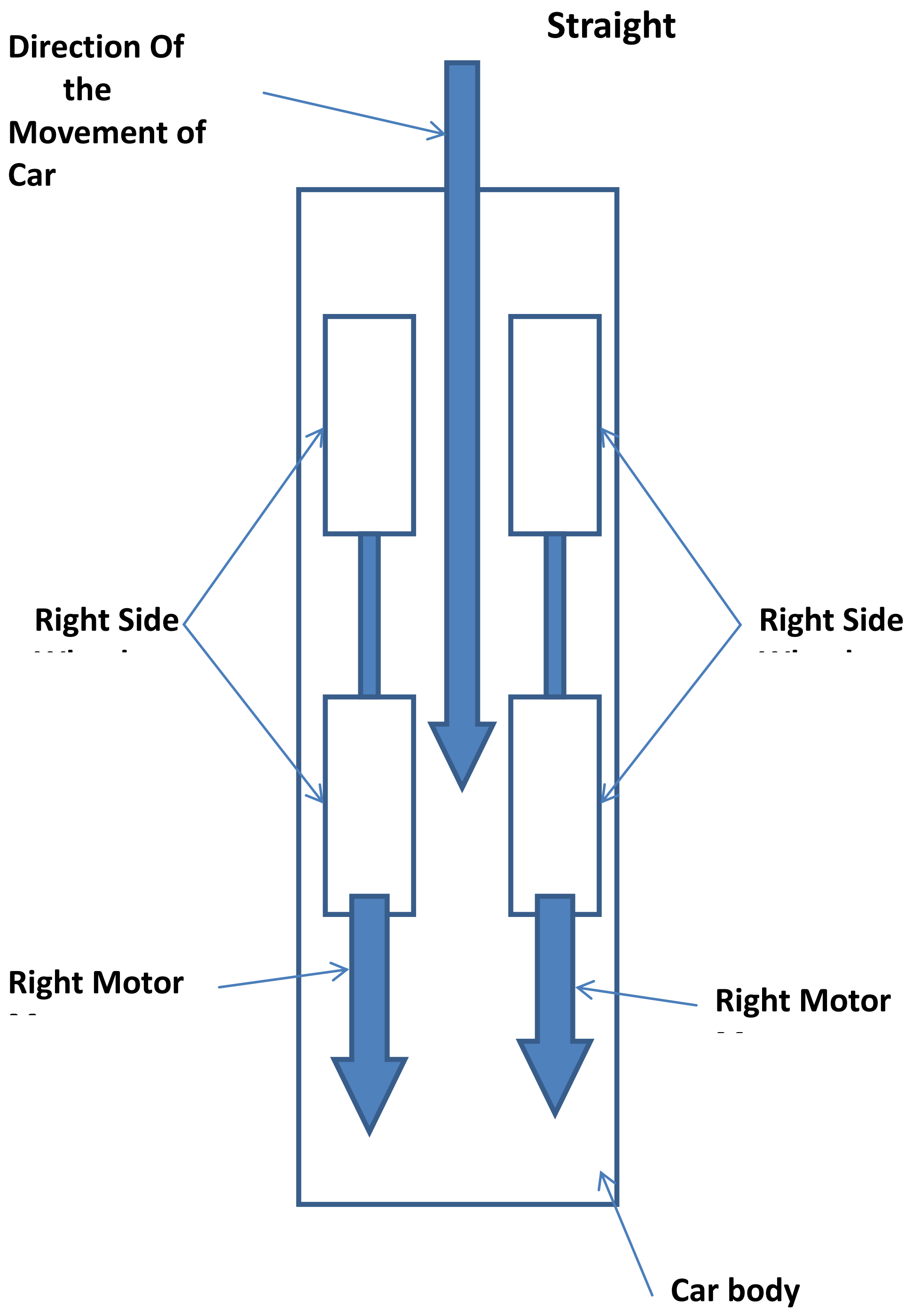

Figure 4.8 : Direction of Movement.

Movement Description

Left Motor	Right Motor	Car Movement
Straight	Straight	Straight
Stop	Straight	Left
Straight	Stop	Right

Table 4.1: Movement Description

- **IC L293D**

This is a motor driver IC that can drive two motor simultaneously. Let' see how we use this IC.

From microcontroller we cannot connect a motor directly because microcontroller ca not give sufficient current to drive the DC motors. Motor driver is a current enhancing device, it can also be act as Switching Device. Thus we insert motor driver in between motor and microcontroller. Motor driver take the input signals from microcontroller and generate corresponding output for motor.

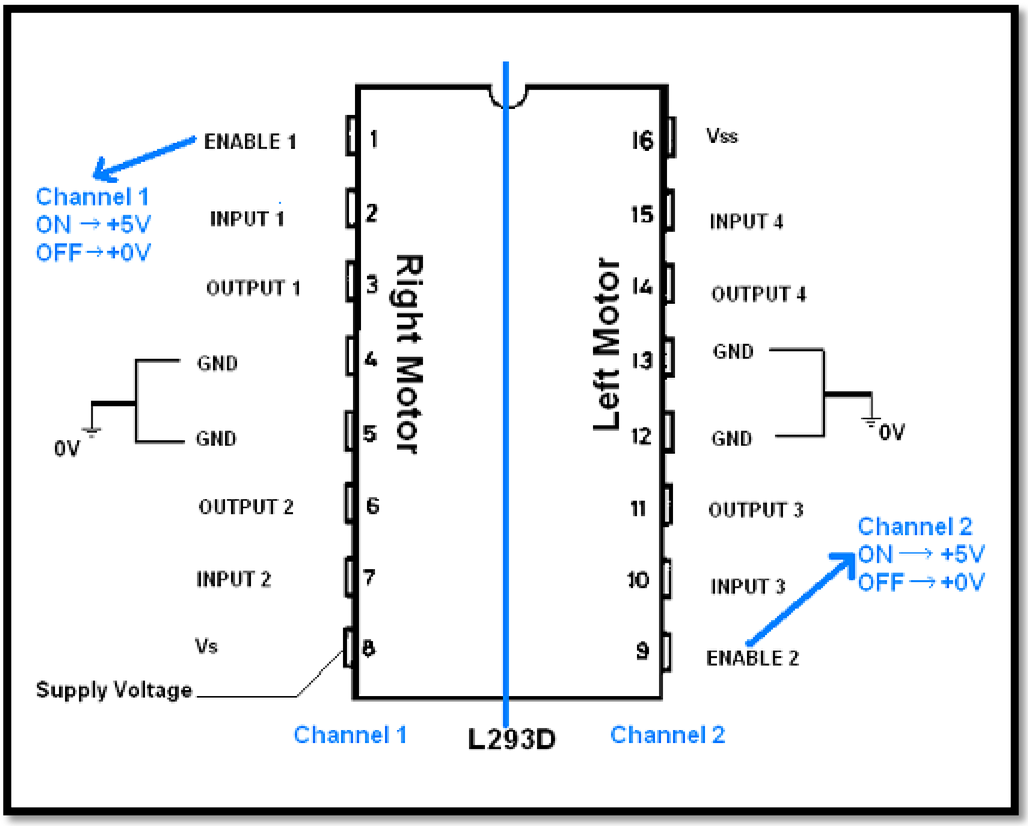

Figure4.9: Pin Details of L293D

- **Points regarding L293D**
- Supply voltage (Vss) is the Voltage at which we wish to drive the motor.
- Logical Supply Voltage will decide what value of input voltage should be considered as high or low .So if we set Logical Supply Voltage equals to +5V, then -0.3V to 1.5V will be considered as Input Low Voltage and 2.3 V to 5V will be considered as Input High Voltage.
- L293D has 2 Channels .One channel is used for one motor.
  - Channel 1 - Pin 1 to 8
  - Channel 2 - Pin 9 to 16
- Enable Pin is use to enable or to make a channel active. Enable pin is also

called as Chip Inhibit Pin.

- All Input (Pin No. 2, 7,10and15) of L293D IC is the output from microcontroller (ATmega16A).
- All Output (Pin No. 3, 6,11and 14) of L293D IC goes to the input of Right and Left motor.
- **Output Connection**

OUTPUT 1 (Pin No 3) --- Negative Terminal of Right Motor

OUTPUT 2 (Pin No 6) --- Positive Terminal of Right Motor

OUTPUT 3 (Pin No 10) --- Positive Terminal of Left Motor

OUTPUT 4 (Pin No 14) --- Negative Terminal of Left Motor

- **Line Tracking**

We put the car up the black line to be between the 2 sensors, so the sensors sense both white sides of the line ,while the sensor read white color ,the DC motor which connected with it keep running, and when there a turn in the line ,one sensor read black color and stop the motor connected with ,while the other sensor still sensing white color and keep the other motor running caused in turning of the car until the other sensor sense a white color by the end of the turn, and car move straight again.

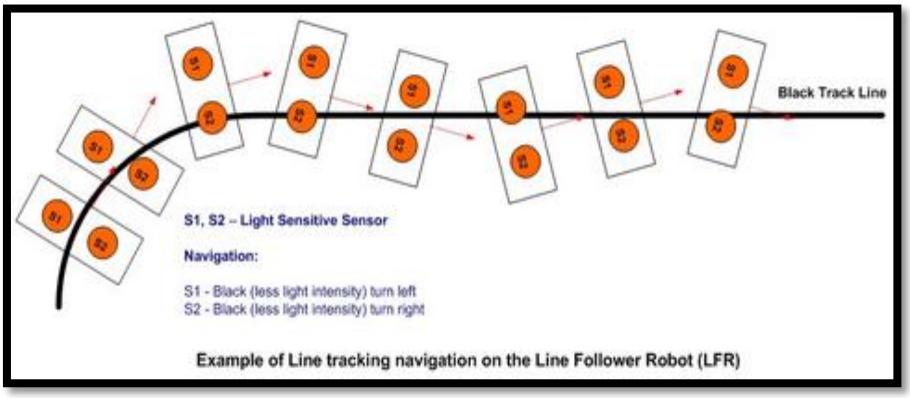

Figure 4.10 : Line Tracking.

- **Line end**

When both LDR sensors sense black color, both DC motor stop and the car stop according to that ,this state represent the end of the line

.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

The line following robot successfully tracked the black line this will confirm the output production line control of the industrial applications can be increased without any losses of delay time .The speed of the line follower robot can be modified according to the carve path . In case of the straight path the robot speed will increase while in case of the carve path the robot speed will decrease.

5.2 Recommendations

- More sensors will be added to increase accuracy in the specified path.
- Using Altrasonic sensor to make the robot able to avoid any obstacle shown in front of it.
- Using PID controller to improve response of the system.

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