Department of Electrical and Computer Engineering
North South University

Senior Design Project

Prototyping A Hybrid Car Using Commercially Available Off-The-Shelf (COTS) Low Cost Components

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Summer,2018

LETTER OF TRANSMITAL

September, 2018

To

Dr. Sazzad Hossain,

Chairman,

Department of Electrical and Computer Engineering North South University, Dhaka.

Subject: Submission of Capstone Project report on “Prototyping A Hybrid Car Using Commercially Available Off-The-Shelf (COTS) Low Cost Components.”

Dear Sir,

With due respect, we would like to submit our Capstone Project Report on “Prototyping A Hybrid Car Using Commercially Available Off-The-Shelf (COTS) Low Cost Components” as a part of our BSc program. The report deals with a prototype of a hybrid vehicle system. This project was very much valuable to us as it helped us gain experience from practical field and apply in real life. We tried to the maximum competence to meet all the dimensions required from this report.

We will be highly obliged if you kindly receive this report and provide your valuable judgment. It would be our immense pleasure if you find this report useful and informative to have an apparent perspective on the issue.

Sincerely Yours,

.....

Bristi Saha

ECE Department

North South University, Bangladesh.

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Showmik Sadnan

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Fatema Tuj Johora Kajol-

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DECLARATION

This is to declare that no part of this report or the project has been previously submitted elsewhere for the fulfillment of any other degree or program. Proper acknowledgement has been provided for any material that has been taken from previously published sources in the bibliography section of this report.

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APPROVAL

The capstone project entitled **"Prototyping A Hybrid Car Using Commercially Available Off-The-Shelf (COTS) Low Cost Components"** by **Bristi Saha** (ID#133 0800 043), **Showmik Sadnan** (ID#132 0159 045) and **Fatema Tuj Johora Kajol-(**ID #133 0691 043) is approved in partial fulfillment of the requirement of the Degree of Bachelor of Science in Computer Science and Engineering on September and has been accepted as satisfactory.

Supervisor's Signature

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ABSTRACT

In this report, we have represented a design of a Hybrid car which converts mechanical energy to electrical energy. The hybrid car converts the mechanical energy of the wheel rotations into electrical energy and stores it in a rechargeable battery. When the battery is fully charged, a controller switches from the combustion engine to the battery to power and drive the vehicle. The main objective of this project is to investigate the potential of replacing fossil fuel by renewable energy. Second objective is to develop a hybrid car design using domestically available components thus reducing the cost of manufacturing. A hybrid car presents a very efficient way to reduce the consumption of fuel and it is environmentally friendly. Hybrid vehicles can be categorized as series, parallel and combined architectures. Our system is designed as a series hybrid system. In the 21st century global warming, climate change, increasing price of oil and gas has reached an extreme level. Hybrid car is an innovative and sustainable concept which is very eco-friendly for our environment. It is possible these automobile designs will someday fully replace fossil fuel by renewable energy.

ACKNOWLEDGEMENT

By kindness of the Almighty we have successfully completed our senior design project entitled "**Prototyping A Hybrid Car Using Commercially Available Off-The-Shelf (COTS) Low Cost Components.**"

Our deep gratitude goes first to our faculty advisor Dr. Shahnewaz Siddique, who expertly guided us in our senior design project throughout the whole EEE499A and EEE499B. His guidance helped us in all type of research, writings and in completing the project.

Our sincere thanks also goes to North South University, Dhaka, Bangladesh for giving us such a platform where we can have an industrial level experience as a part of our academic knowledge.

We would also like to thank our friends Sudiptha Dey, Shohad Khan for helping us in this project.

Last but not the least, we would like to thank our family as their inspiration and guidance kept us focused and motivated.

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CHAPTER-1

OVERVIEW

1.1Introduction

A hybrid car is a car which generally uses multiple power sources. It actually uses an engine which is a combination of two or more sources of power. It means it is combining a petrol or diesel engine with a electric motor. It uses a rechargeable energy storage system to supplement fossil fuel energy for car propulsion.

Two decades ago, when hybrid car was first introduced, those were dismissed as a science project. But day by day these hybrid cars are becoming more popular. In recent years the pollution is increasing tremendously. Temperature is rising and green house effect has become a great issue. It has become a threat for our life. Also the price of fuel is increasing. Not only that it is decreasing in amount.

Hybrid car is a great establishment to cope up with this dilemma. The main advantage of a hybrid car are that it can lessen fuel use and emit less CO_2 compared to a conventional petrol or diesel engine car. This car is environment friendly as well as cost efficient. Day by day the popularity of this type of vehicle is increasing.

1.2 Basic of Hybrid Car

i. How Hybrid Car works

Nowadays there are many hybrid model in the market. Different automobile manufactures announce their own model. Most of the hybrid cars are the combination of an internal combustion engine and a battery. Both gasoline engine and electric motor works together to increase the power of wheels during heavy acceleration. Basically hybrid car converts the mechanical energy to electrical energy. By converting mechanical energy of wheel rotation into electrical energy, the vehicles store the electrical energy in a rechargeable battery. When battery is fully charged, a controller switches from combustion engine to the battery to power. This is the basic working principle of hybrid car.

ii. Types of Hybrid Car

a) Series Hybrid Car

In a series hybrid system, the wheels are not driven directly. In this case, an electric generator is driven by the combustion engine. The electric generator is usually a three-phase alternator plus rectifier. The electric motor provides power to the wheels. Battery charging and power supply in electric motor both are processed the generator. If the amount of power requirement is more large, the electricity is generated from both batteries and generators. A free wheel assists hybrid car. It minimizes the losses in the battery. So, efficiency is improved. it delivers peak energy during acceleration and generate energy during braking. At low speed flywheels are being charged. But at top speed flywheels are almost empty. When the driver starts the engine, power is received from the battery pack to the electric motor which turns the wheels.

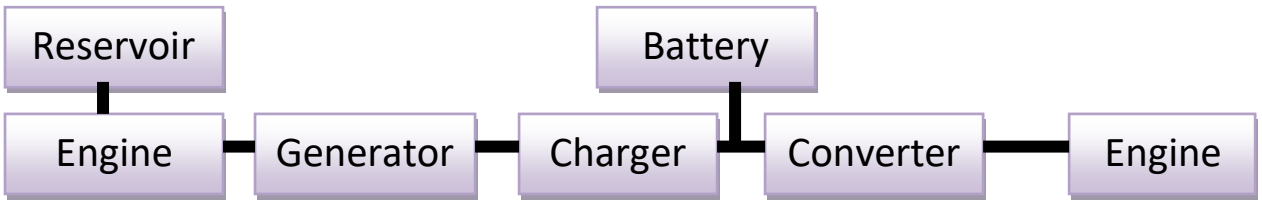


Fig.1.1.Block Diagram of Series Hybrid Car

b) Parallel Hybrid Car

In a parallel hybrid system, combustion engine and electric car both are used as series hybrid system. But there is only one transmission between them by which they can power the system at the same time. The batteries may be charged during braking. Without car movement the batteries cannot be charged because of fixed mechanical connection between electric motor and wheels.

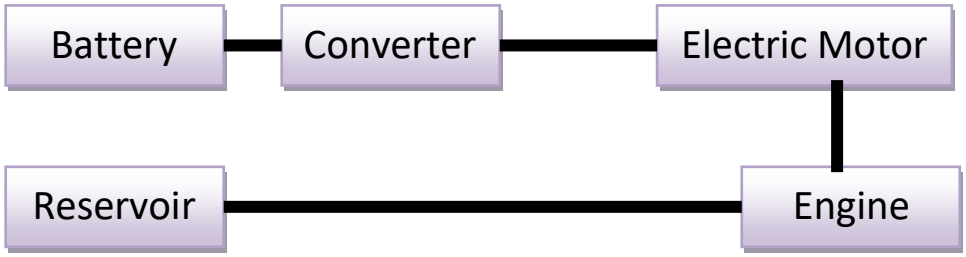
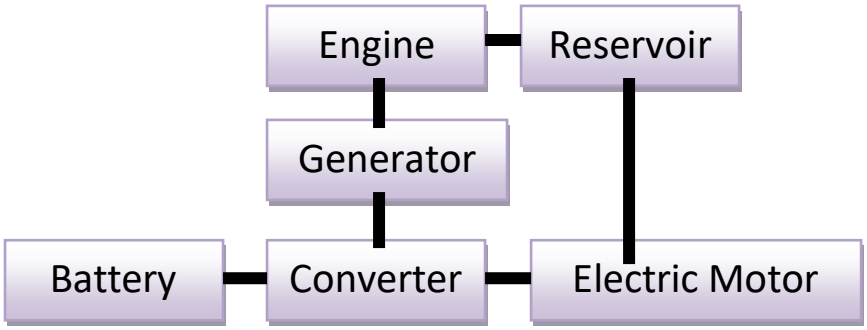


Fig.1.2.Block Diagram of Parallel Hybrid Car

c) Series-Parallel Hybrid Car

Basically in this category series and parallel both layout is merged to have the greater benefit or we can say both type of facility. In this type the engine is able to supply the motor or charge the battery tanks to generator.



d) Mild Hybrid Car

There is also a type named mild hybrid system. Mild hybrid car is different than the series and parallel hybrid car. The cost is also comparatively low. In mild hybrid system the electric motor helps the gasoline system, if more power is needed. But it is not only dependent on electric engine. When the car is stopped, the engine is also switched off by the control unit.

Hybrid car can be also categorized by full, micro, PHEV.

iii. Advantages and Disadvantages of Hybrid Car

a) Advantages:

Savings: Electric cars can be a great way to save money because the fuel cost is very cheap in this car.

No gas is Required: In hybrid cars the gas is not needed because the cars are charged by electricity.

No Emission: the electric cars are very eco-friendly to our environment. They doesn't harm the environment by toxic gas.

Cost Effective: Hybrid cars require less fuel or gasoline. So, it can reduce the cost.

Reduced Noise Pollution: Hybrid car reduce noise pollution.

Regenerative Breaking System: Brake while driving hybrid vehicles recharge battery.

Higher Resale Value: For increasing price of gasoline, hybrid vehicles command higher than average resale value.

Built from Light Materials: the engine of hybrid car is lighter and smaller which saves much energy.

b) Disadvantages:

Expensive : Hybrid cars can be comparatively expensive than regular cars.

Less Power: Since hybrid car is combined power, it is suited for city driving.

Comparatively Difficult to handle: In case of hybrid car there are some difficulties because of extra space and weight for gasoline powered engine, lighter electric and battery.

Difficult to Repair: Because of higher maintenance cost it's difficult to repair the car.

Presence of High Voltage in Batteries: High voltage of battery can increase the chance to get difficulties rescue the passengers in case of accidents.

iv. Performance

The gasoline engine of hybrid car is smaller than regular car. Regular cars need bigger engine to produce power to accelerate.

The small engine of hybrid car is more efficient.

Smaller engine is less heavier than bigger engine. So, hybrid car needs less energy to accelerate.

Bigger engine need less energy because of less heavy pistons and internal components.

In hybrid car smaller engine has less cylinders. So, fuel is saved.

1.3 Our Proposed Project

i. Description of the Project:

There are many automobile companies like Toyota, Tesla, Chevrolet Volt which has announced hybrid cars. But the price is not appropriate for all people. This should be more available for all.

The capability of our designed model is :

It is built with commercially available components.

The cost is lower.

This is eco-friendly.

This will decrease environmental pollution.

This will reduce the cost of gasoline and fossil fuels.

Middle class people will be able to afford this.

ii. Purpose of the Project:

The purpose of or project is mainly to reduce the cost of fossil fuels while maintaining amazing performances. Driving is one of the most regular activities of our daily life. Hybrid cars can be more suitable for our environment and to save money.

The main purpose of the car we have represented is to convert mechanical energy to electrical energy.

The concept of hybrid car is very innovative, sustainable and eco-friendly for our environment. By this concept the fossil fuel can be fully replaced by renewable energy. The problems which are increasing day by day as global warming, climate change increasing price of oil and gas can be decreased by using hybrid car.

iii. Difficulty:

The level of difficulty was not so high. The theory we have used is very clear and precious. We have used commercially available equipments. But we have to more concerned about the battery charging process. The battery we have used in project takes more times to charge. Another difficulty is there also. Since we used available and local components, the speed of car might be decreased if the road condition is bad. So, we have to work more to reduce this problem.

1.4 Motivation

Our dream is to design a hybrid car which can be more reliable, eco-friendly for our environment, sustainable for people. Nowadays most of the major automakers are more interested to build hybrid cars with new models. The invention of internal combustion engine can be one the most significant industry-wide challenges. If the technology of hybrid car can be spread worldwide, this will be very innovative. Our main goal is to fulfill all desired condition at very low cost with commercially available equipments.

1.5 Summary

In this chapter, we have briefly described the basics of hybrid car, types of hybrid car, how it works, the main idea of our project. We have discussed on our proposed project, purposes, difficulties what we have faced, what motivated us to design and build this system. The following chapters describe the theory and details of the components used, the mechanical description, designs, and the overall structure of the system.

CHAPTER-2

EXISTING SYSTEM

2.1 Introduction

In this chapter we will describe about some technology related to hybrid car. Different renowned vehicle companies have already developed hybrid cars which are so much eco friendly and energy saving. People are buying those to consume their fuel cost. Different hybrid cars use different mechanism but the main concept is same. Though there are so many hybrid cars already in market we have found out that those are quite expensive and not a thing for middle class people in a developing country like Bangladesh. so we tried to build a prototype first to lower the costing of making this luxurious car by using cheap and easily available components. applying this theory may be one can be able to build a car which will be less expensive and also local.

2.2 Existing Work

Actually there are verities type of hybrid cars that are already available in market now. Name of those are given below.

- Honda: Accord, Civic, Insight, CR-Z, Fit
- Toyota: Prius, Camry
- Nissan: Altima
- Lexus: LS 600h L, GS 450h, HS 250h, CT200h
- Mercedes: S400 Blue Hybrid
- Hyundai: Sonata
- Ford: Fusion
- Infiniti: M35h

- Lincoln: MKZ
- BMW: Active Hybrid 7
- Kia: Optima Hybrid
- Buick: Lacrosse eAssist
- Fisker: Karma
- Volkswagon: Jetta

lets describe some best work among these.

Honda: Accord 2018 a luxurious conventional HEV which uses 2.0 liter four cylinder engine attaching with a pair of electric motor which are fed by a lithium ion battery pack. The total system power is 212 horsepower. Transmission type is Continuously variable automatic mode select.

Fig.2.1.Honda Accord 2018

Toyota: Prius a front wheel drive and an automatic transmission system car which front wheel drive is 1.8L/110 MPG , uses four cylinder engine. Engine can be gas or electric. It is conventional hybrid car.

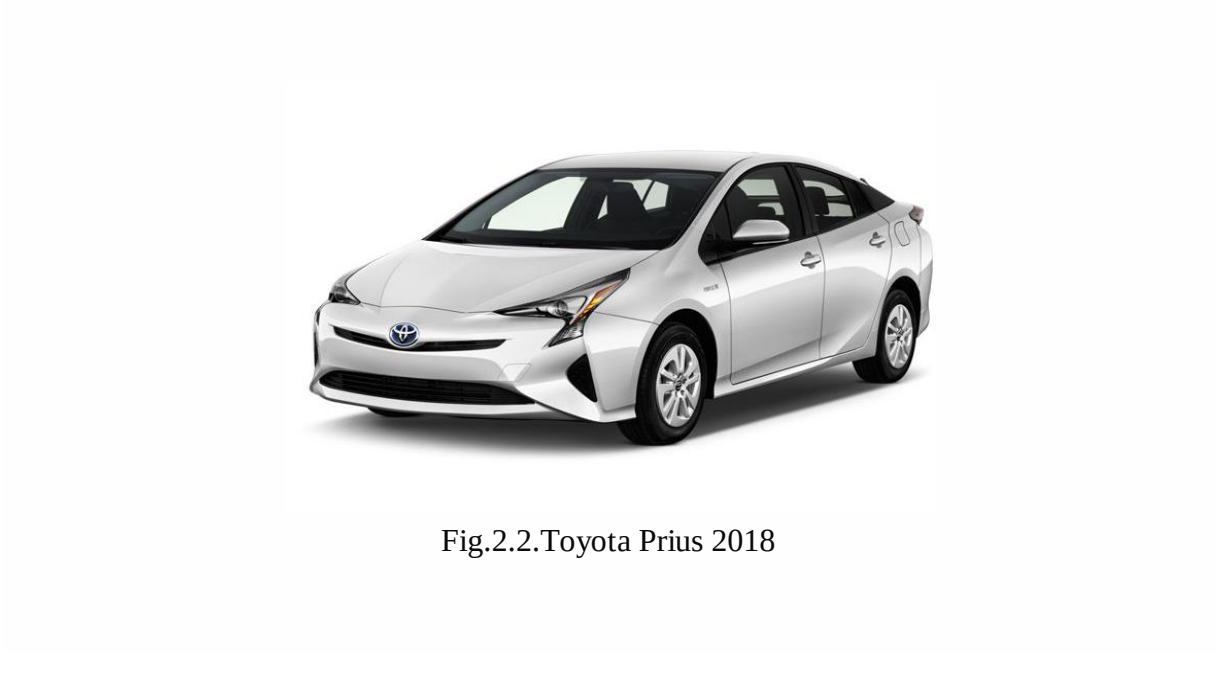


Fig.2.2.Toyota Prius 2018

BMW 7 series uses 8-speed shiftable automatic transmission. Its engine type is gas. The expensive one has the feature of all wheel drive train.

Fig.2.3. 2018 BMW 7

There are actually lots of hybrid cars which cannot be finished describing in few words. Every company has various type of model of hybrid car. But the interesting fact is that in Bangladesh hybrid car is not that much popular. If we can manufacture our own car it will be a great opportunity.

2.3 Summery

We have established a prototype which is cost efficient with locally available components. We studied different types of word related to hybrid car. Those are quite expensive and luxurious one. so we tried to build a system which would be more cheap and could be made with locally available equipments.

CHAPTER-3
SYSTEM DESIGN

3.1 Introduction

In this section we will describe about our system in detail.

3.2 System Description

There are two motor use one is the rear motor (Main Engine) and the another on the front motor (Generation motor). A 8V battery is connected with a rear motor which we named main engine. When the rear wheel rotate with the help of 8V battery the front wheels also rotates because the motors are connected in parallel. When the generation motor rotates, it provides 1A of current to the full wave rectifier which converts the AC current to DC current. There is a battery charger module TP4056 attached with the full wave rectifier for the protection of the rechargeable battery. And after that it goes through the rechargeable battery. And the rechargeable battery starts to charge itself. There is an Arduino UNO board connected with the rechargeable battery. When the rechargeable battery crossed the upper threshold which is V set in the Arduino, then the main power switches from main engine to rechargeable battery, And the rechargeable battery voltage goes under lower threshold which is 1V, then it again switches from rechargeable battery to main engine. The Arduino UNO board cannot provide enough amount of current to run a DC motor. So there is a motor driver used to get enough current to run the DC motor.

3.3 Block Diagram Of the System

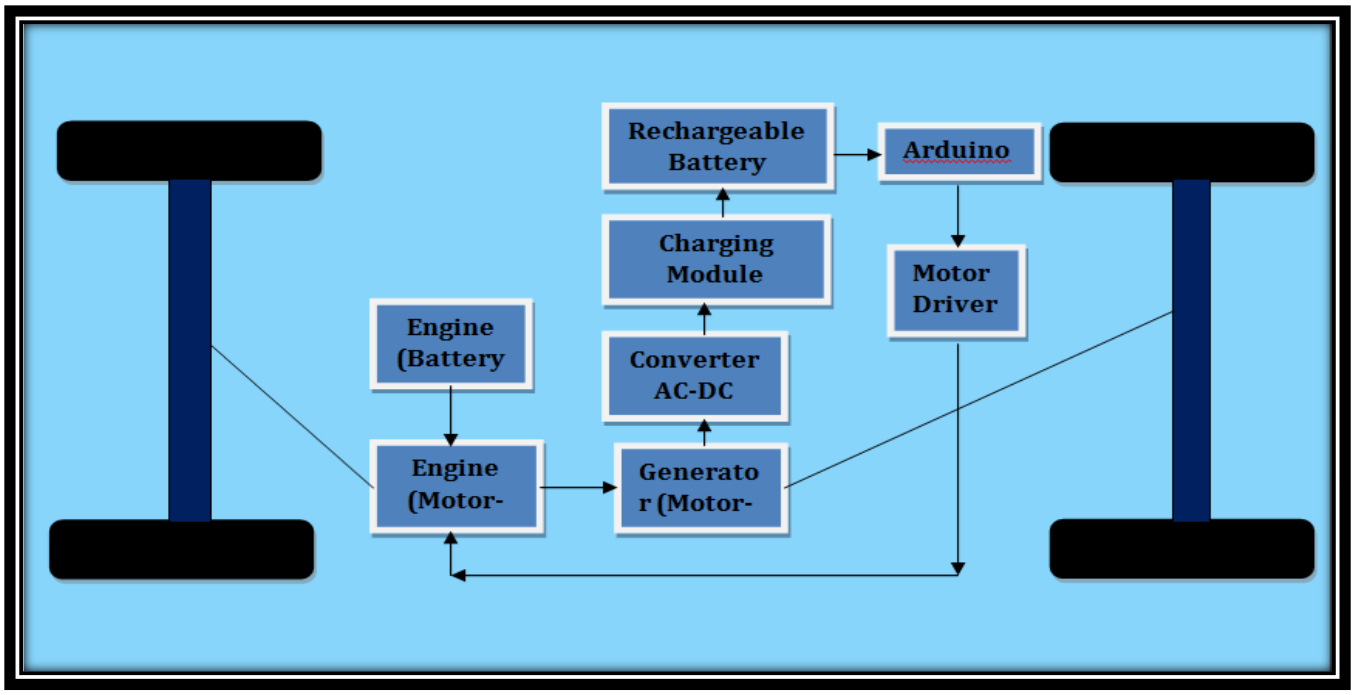


Fig.3.1.Block Diagram of the Prototype

3.4 Internal Part of the System

The internal parts circuits diagrams of the system are given below.

i. Full-Wave Rectifier:

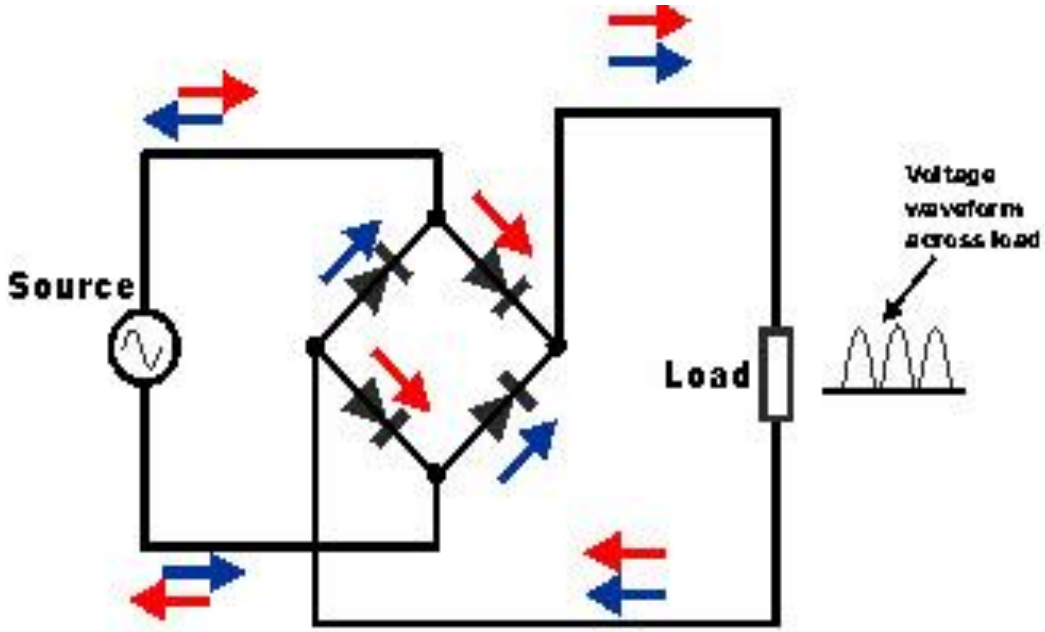


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Fig.3.2.Full Wave Rectifier Circuit

ii. TP 4056 Charging Module:

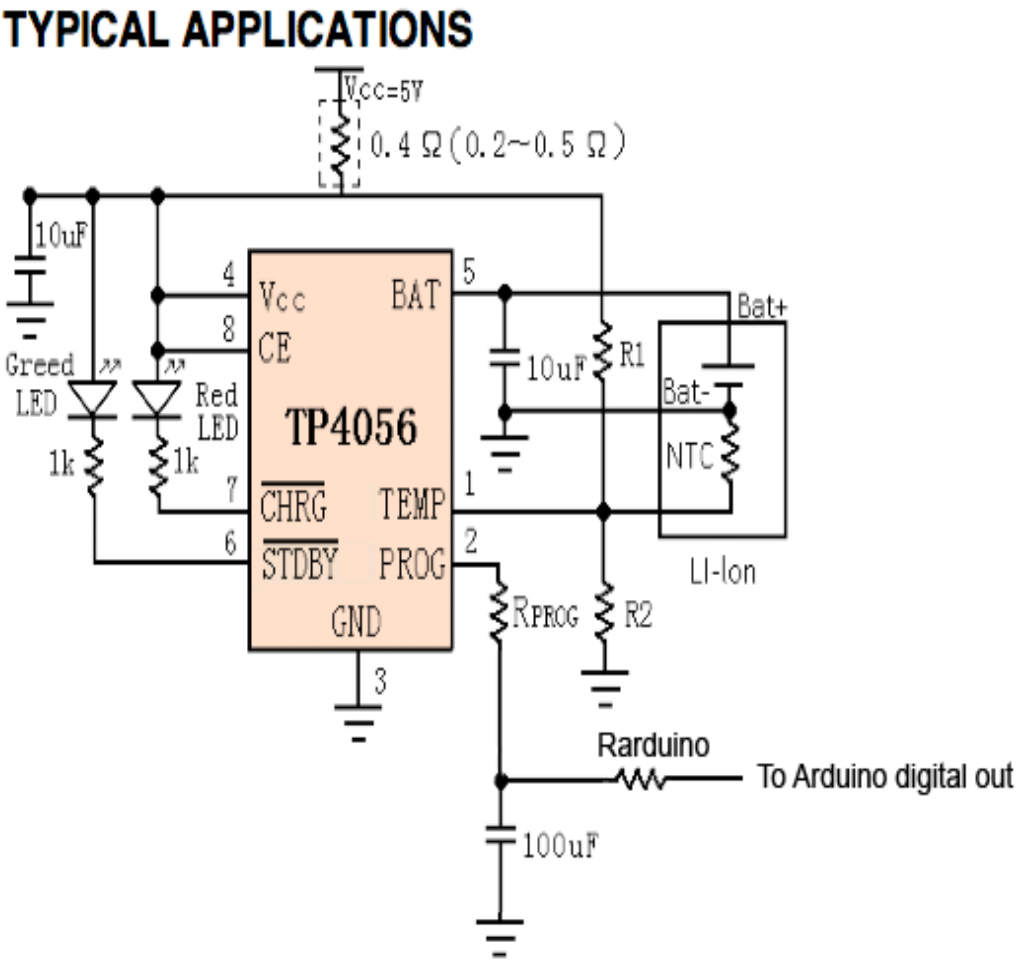

Fig.3..3.TP 4056 Charging Module

iii. Arduino UNO:

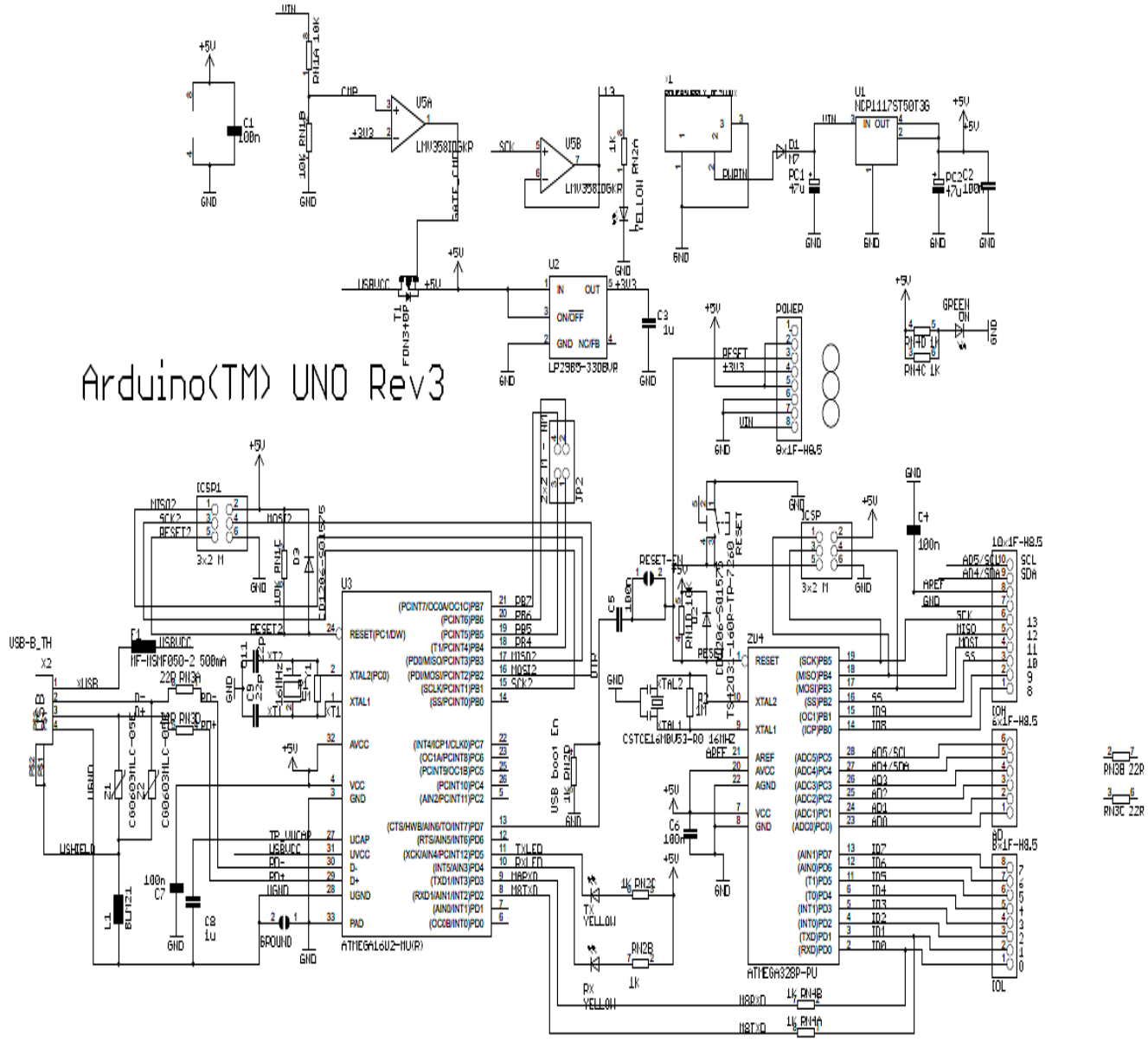

Fig.3.4.Arduino UNO

iv. Motor Driver (L298N)

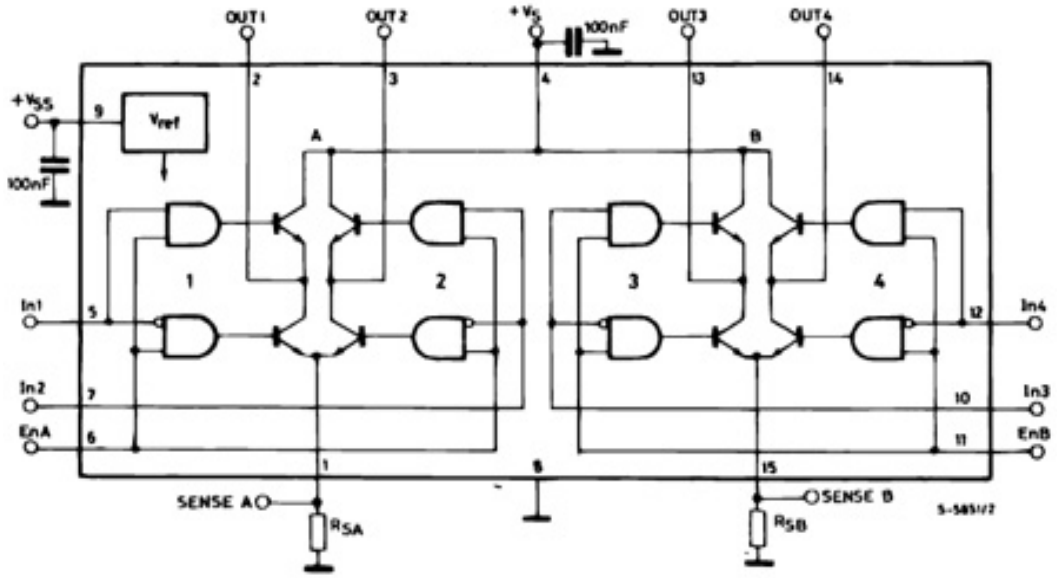

Fig.3.5.Motor Driver(L298N)

3.5 Step by Step Progress Of our System

i. 1st Stage

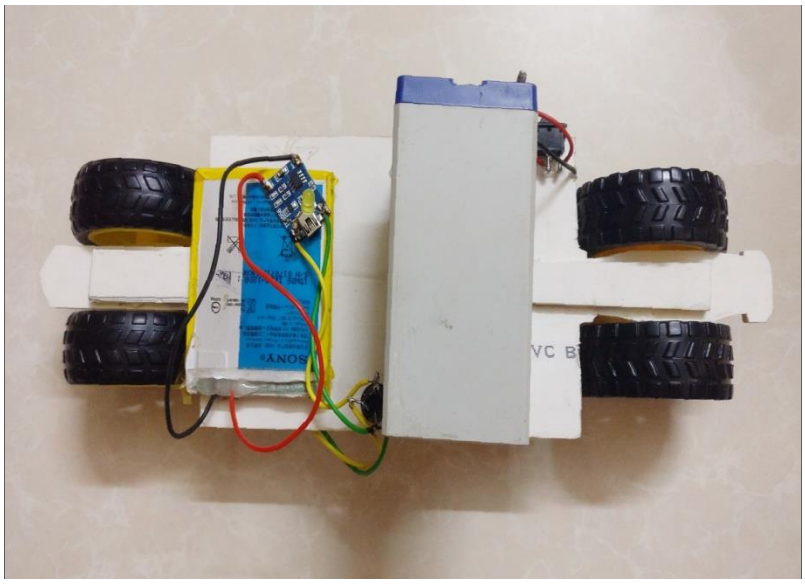

Fig.3.6.upper view of 1st Stage Model

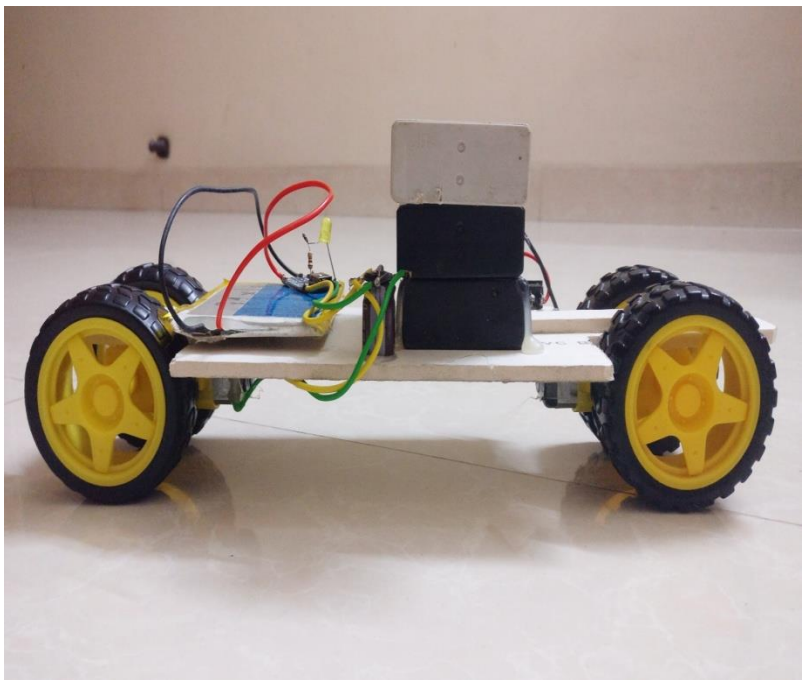

Fig.3.7.Side view of 1st Stage Model

ii. Second Stage

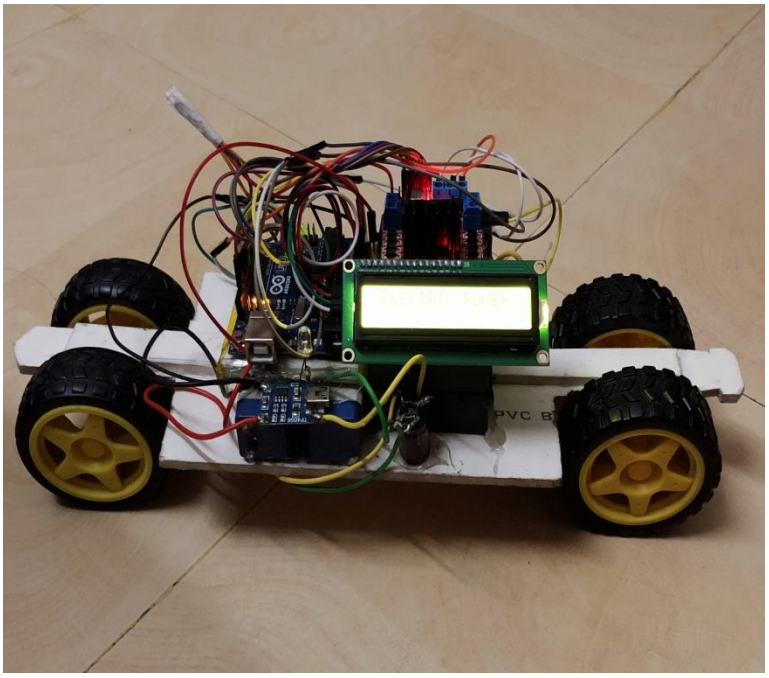

Fig.3.8.Open view of 2nd Stage Model

Fig.3.9. Final look of the System

CHAPTER-4

TECHNICAL DESCRIPTION

4.1 Introduction

This section is for the details information about the components. The basic information and the features are described in this section. The detailed picture of the component such as Arduino, Battery, Motor driver, Modules etc are given.

i. Arduino (UNO)

The Arduino UNO is a microcontroller board based on the ATmega328. It has 20 digital input/output pins (of which 6 can be used as PWM outputs and 6 can be used as analog inputs), a 16 MHz resonator, a USB connection, a power jack, an in-circuit system programming (ICSP) header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-DC adapter or battery to get started.

Fig.4.1.Arduino UNO

The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features an ATmega16U2 programmed as a USB-to-serial converter. This auxiliary microcontroller has its own USB boot loader, which allows advanced users to reprogram it. It communicates using the original STK500 protocol. The Uno also adds SDA and SCL pins next to the AREF. In addition, there are two new pins placed near the reset button. One is the IOREF that allow the shields to adapt to the voltage provided by the board. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. The Arduino UNO is generally considered the most user-friendly and popular board or the Arduino board series. The Arduino has an extensive support community, which makes it a very easy way to get started working with embedded electronics. The R3 is the third, and latest, revision of the Arduino UNO.

ii. Gear Motor

Gear motors are electric motors that utilize a type of gear system on the output of the motor. This gearing arrangement is called a gear reducer or gearbox. The combination of an electric motor and gearbox reduces design complexity and lowers cost, particularly for motors built for high torque and low speed applications. In addition, gearboxes can be used as a means to reorient the output shaft in a different direction.

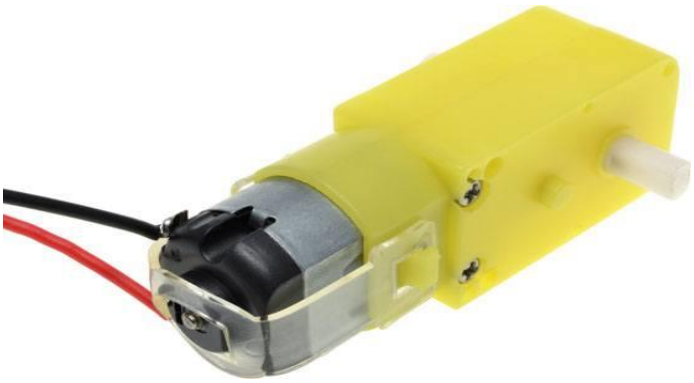

Fig.4.2.Gear Motor

A "gear motor" may be an AC or DC motor coupled with a gearbox or transmission. A gear motor adds mechanical gears to alter the speed/torque of the motor for an application. Usually such an addition is to reduce speed and increase torque. With plastic construction and colored in bright yellow, the DC gear motor measures approx. 2.5 inch long, 0.85 inch wide and 0.7 inch thick. The wheel can be mounted on either side or the gear motor works well between 4V to 12V .At a ratio of 1:48 you can get some really good torque at 5 Volts.

There are 4 types' gears in a gear motor.

a. Spur Gear:

Spur gears are the simplest type of gear, with straight teeth mounted on a parallel shaft. Spur gearboxes include one or more sets of pinion-gears, in which one pinion drives one gear. These sets can be stacked or cascaded to achieve higher reduction ratios. Spur gear systems are versatile, and can come in a range of sizes and gear ratios to meet specific torque and speed requirements. There are few advantages of spurs gear and those are: it has low cost, it is compact, it provides high gear ratio and torque output. There are also some disadvantages; it is quite noisy.

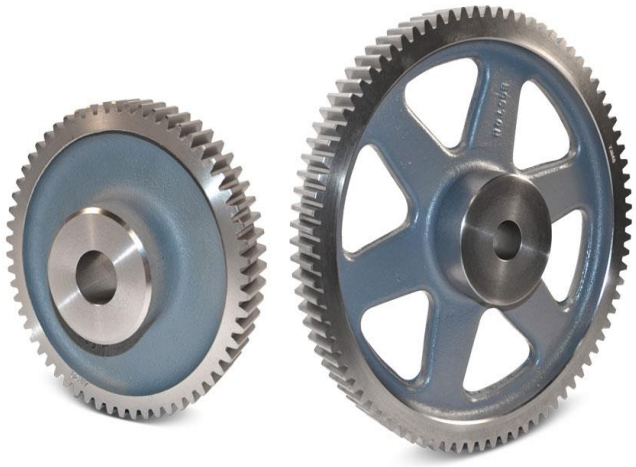

Fig.4.3.Spur Gear

b. Planetary Gear

Planetary gear heads involve several gears per stage rather than one pinion-gear set. A "sun gear" drives multiple planet or satellite gears, which then mesh on the inside of an internal gear to provide relatively high torque and power transmission ratings. Planetary gears also have some advantages and disadvantages. Advantages are: it has high power density, it has high stability, it has balanced gear load distribution. And disadvantages are it has a complex design, high bearing loads and maintenance difficulty.

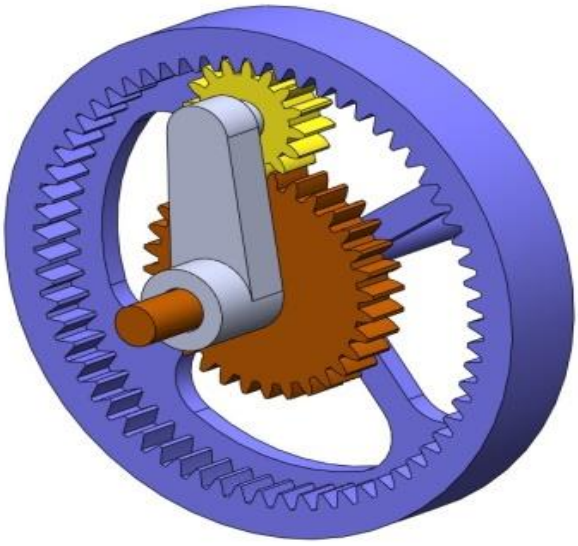

Fig.4.4.Planetery Gear

c. Worm Gears

Worm gearing uses right-angled drives in which a worm drives a wheel coupled to the output shaft or shafts. This arrangement is used for high reduction and compact right-angle power transmission. Because the wheel cannot turn the worm it can be used as a braking system for the gearbox. The gears are designed to handle high shock loads. The advantages of worm gears are: High precision, maintenance-free, low noise & right angle configuration. The disadvantages are: non reversible & low efficiency.

Fig.4.5.Worm Gear

d. Bevel Gears

Bevel gear sets have intersecting axes that are commonly, but not always, perpendicular. They mate via teeth on angled edges. The teeth can either be straight or spiral. Straight bevel gear teeth are used for slow speed applications, while spiral teeth are used for higher speed and performance requirements. The advantages of bevel gears are: Durable & right angle configuration and the disadvantages are: axes have to support forces & poorly cut teeth can cause excessive vibration and noise during operation.

Fig.4.6.Bevel Gear

iii. Battery

There are two 4v battery is needed for the prototype. These are rechargeable 4v battery, which are available on market. The model of the battery is Booster 4v 3ah, JST4-3A. Size of 47x47x101x106mm and weight of 0.37kg. The visual picture of the battery is given below:

Fig.4.7.Battery

iv. Rechargeable Battery

A rechargeable battery, storage battery, secondary cell, or accumulator is a type of electrical battery which can be charged, discharged into a load, and recharged many times, as opposed to a disposable or primary battery, which is supplied fully charged and discarded after use. It is composed of one or more electrochemical cells.

This is a Li-polymer rechargeable battery. It is a 3100 mAh battery with 11.8 wh, voltage of 3.7 volts. The specification of this battery is 1ICP/62/78 GB/T 18287-2013 AGPB013-A001. Which is made in china.

Fig.4.8. Li-Polymer Rechargeable Battery

v. Diode, Capacitors & Resistors

There are some diodes, capacitors and resistors are needed for the prototype.

A **diode** is a two-terminal electronic component that conducts current primarily in one direction it has low resistance in one direction, and high resistance in the other. A diode vacuum tube or thermionic diode is a vacuum tube with two electrodes, a heated cathode and a plate, in which electrons can flow in only one direction, from cathode to plate.

Fig.4.9.Diode

A **capacitor** is a passive two-terminal electrical component that stores potential energy in an electric field. The effect of a capacitor is known as capacitance. While some capacitance exists between any two electrical conductors in proximity in a circuit, a capacitor is a component designed to add capacitance to a circuit. The capacitor was originally known as a condenser.

Fig.4.10.Capacitor

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses.

Fig.4.11.Resistor

vi. LCD Display

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical. 16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots.

Features of 16×2 LCD module:

Operating Voltage is 4.7V to 5.3V

Current consumption is 1mA without backlight

Can display alphabets and numbers

Consists of two rows and each row can print 16 characters

Each character is build by a 5×8 pixel box

Can work on both 8-bit and 4-bit mode

It can also display any custom generated characters

Available in Green and Blue Backlight

Fig.4.12.LCD Display

vii. Li-Ion Battery Charger Module

This module is most commonly used with all projects involving a Lithium-ion battery. As we know a lithium battery should not be overcharged or over discharged, hence this module will monitor the voltage level of the battery during charging and discharging. If the values go beyond critical value the module will automatically disconnect the circuit and protect your battery.

It is always good to be careful while working with Lithium batteries. The module operates with 5V which can be provided by the USB mini cable that is commonly used for charging Smartphone. You can use any type of mobile charger and its cable to power this module. If you are planning to power it directly without the cable then the +5V should be connected to IN + and the IN – should be connected to ground.

Module Specifications:

This module can charge and discharge Lithium batteries safely

Suitable for 18650 cells and other 3.7V batteries

Charging current – 1A (adjustable)

Input Voltage: 4.5V to 5.5V

Full charge voltage 4.2V

Protects battery from over charging and over discharging

No verse polarity protection

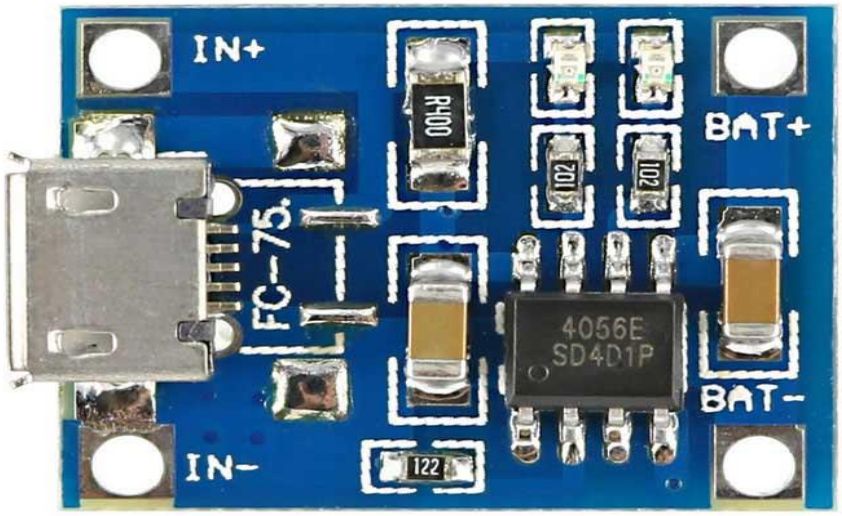

Fig.4.13. Li-Ion Battery Charger Module

viii. Motor Driver

The L298 is an integrated monolithic circuit in a 15- lead Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic levels and drive inductive loads such as relays, solenoids, DC and stepping motors.

Two enable inputs are provided to enable or disable the device independently of the input signals. The emitters of the lower transistors of each bridge are connected together and the corresponding external terminal can be used for the connection of an external sensing resistor. An additional supply input is provided so that the logic works at a lower voltage.

Features of Motor Drivers:

Operating supply voltage up to 46V

Low saturation voltage

Total DC current up to 2A

Over temperature protection

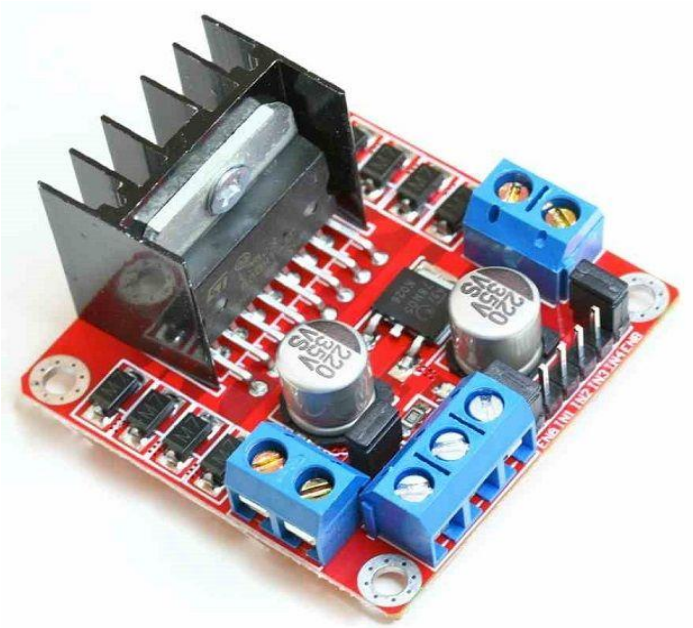

Fig.4.14.Motor Driver

ix. Wires

jump wires also known as jumper, jumper wire, jumper cable, DuPont wire, or DuPont cable – named for one manufacturer of them, is an electrical wire, or group of them in a cable, with a connector or pin at each end which is normally used to interconnect the components of a breadboard or other prototype or test circuit, internally or with other equipment or components, without soldering. Individual jump wires are fitted by inserting their "end connectors" into the slots provided in a breadboard, the header connector of a circuit board, or a piece of test equipment.

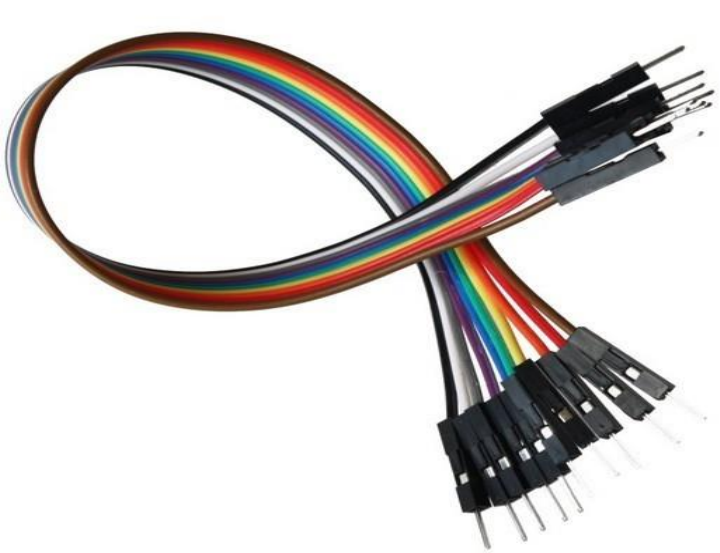

Fig.4.15.Wires

4.2 Summary

Here the details of the components has been described. Those describes the principle, features, advantages & disadvantages of the components, the usage of the components in this prototype, the images provides proper view of the components. By this section we can learn about the components we used for the prototype.

CHAPTER-5
DESIGN IMPLEMENTATION

5.1 Introduction

For our design implementation, we had to use some components to shape it as a project. These components were locally available and affordable. We need Arduino UNO, 8V Battery, motors, resistors, capacitors, Diode, LED, rechargeable battery, wheels, wires, Li-ion Battery charger unit. This

equipment's should be durable and should have good quality. Otherwise after designing, it might not work properly and this will increase the cost of manufacturing.

5.1 List of necessary Hardware Components

Serial Number	Equipment's	Quantity	Model
1	Arduino (UNO)	1	R3
2	Gear Motor	2	180±10rpm
3	Battery	2	4v+4v=8v
4	Li-ion rechargeable battery	1	3100 mAh, 3.7v
5	Diode	1	540
6	Capacitor	1	100uF
7	Resistor	5	100k Ohm
8	Wheel	4	Car wheel
9	Li-ion Battery charger module	1	TP4056
10	LED	1	Yellow
11	Wires	Approx. 40	Jump Wire
12	LCD Display	1	(16x2)
13	Motor driver	1	LN298N

Table.5.1: List of components

5.2 Principle of the Operation

This is a prototype of a hybrid car, so it has 4 wheels and a base to look it like a car. As this is a prototype of a hybrid car, two batteries of 4V is attached together as main power(Total 8V) , from where the prototype's rear motor, which is considered as a combustion engine is getting initial power. There is a switch which is used to determine the on and off state of the system. When the switch is on, the 8v(4V+4V) battery will provide power to the rear motor, and the rear motor will start to rotate. As the rear motor rotates, the front motor which is considered as induction motor of the system will rotate also. By the rotation of front motor, there will be an AC current produced by the front motor. There is a rechargeable battery which is considered as the secondary power. The rechargeable battery will charge by the current produced by the front motor. But the current provided by the front motor actually an AC current, whereas the rechargeable battery needs DC current to charge it-self. So there a full-wave rectifier is used. We know that, full-wave rectifier converts AC current to DC. So this is the main reason to use a full-wave rectifier in the system. The full wave rectifier consists of 4 diodes and a capacitor. The diodes are connected as bridge circuit and the capacitor is connected in the center of the bridge circuit. So when the full-wave rectifier provides dc current to charge the rechargeable battery, the battery starts to charge it-self. The rate of charge depends on the front motor used as induction motor. If the motor is more powerful, then it will provide more current then the motor is used in our system. So it will be needed less time to charge the rechargeable battery in that case. There is a battery charger circuit used right before the rechargeable battery in the system, which will provide safety to the rechargeable battery, if any unwanted occurrence happens during the operation. There is also a LED attached to the battery charger circuit to determine the charging state. When the rechargeable battery will charge, the LED will blink. There is a resistor attached with the LED for the safety of the LED. An Arduino UNO is

attached in the system for the switching purpose. Actually the Arduino UNO is a microcontroller which determines the battery charge level and provides action. When the battery is fully charged, it will switch the main power from combustion engine to rechargeable battery, whereas the combustion engine is the 8v battery in this prototype. That is how Arduino UNO is operating in this prototype. There a motor driver L298n is attached with the system. As Arduino UNO cannot provide enough current to run a DC motor the motor driver is used to get extra current for the motor in this prototype. There is a certain code needed for the Arduino UNO, which is given in the appendix section. There is a LCD display, which will provide the information of the rechargeable battery life and the charging and discharging state. This display is for the user, where the user will get information of the battery and its charging & discharging state. There are lots of wires needed for the connection purpose and other stuffs like glue gun, soldering equipments etc.

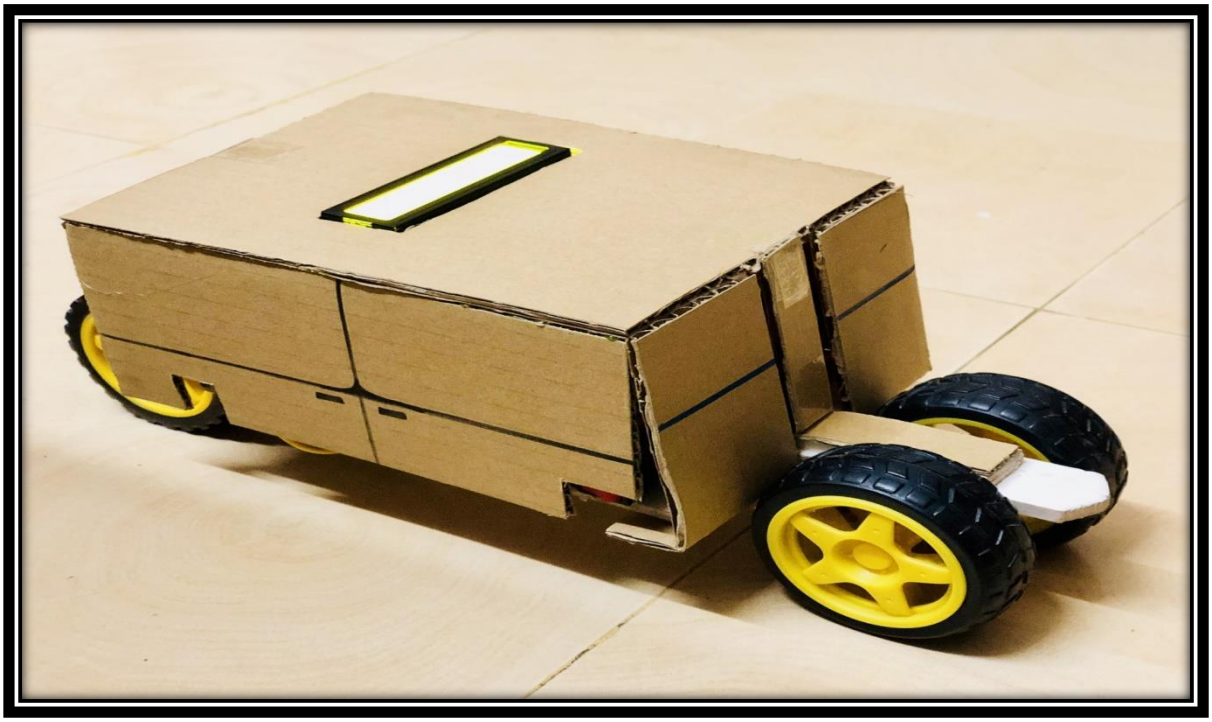

Fig.5.1.Final Model of Our Prototype

5.3 Summary

The components were well-set and full functional. The components we have used are affordable and easy to find. By using these components the project implementation was successful. By this section we have come to know about the working principle of the prototype. How it works? What are the problems? and what are the solutions?

CHAPTER-6

COST OF IMPLEMENTATION

6.1 Introduction

In this chapter we will discuss about the costing of our project. Initially when we were planning our design, we listed down the things we needed and as time passed we added more components to it. At first we bought some extra components but we didn't use those after researching more on our project and found some better and more cost efficient components.

6.2 Cost of Implementation

Total cost of the project is given in the next page. We tried our level best to reduce the cost as much as possible. Within a low cost we have designed our prototype and successfully made this project work.

Table 6.1 illustrates the name of the required product, specification, unit price, quantity, and the price.

PRODUCT	SPECIFICATION	UNIT PRICE	QUANTITY	TOTAL PRICE
Arduino(UNO)	R3	490TK	1	490TK
Gear Motor	180±10rpm	95TK	2	190TK
Battery	4V+4V=8V	320TK	2	640TK
Li-ion Rechargeable Battery	3100mAh,3.7V	1500TK	1	1500TK
Diode	540	1TK	4	4TK
Capacitor	100µF	2TK	1	2TK
Resistor	100KΩ	2TK	1	2TK
Wheel	Toy car wheel	70TK	4	280TK
Li-ion Battery Charger Module	TP4056	140TK	1	140TK
LED	White	5TK	1	5TK
Wires	Jumper wires	30TK	Approx.30	30TK
LCD Display	(16x2)	160TK	1	160TK
Dual Motor Driver	L298N	290	1	290
				Total Cost=3733

Table 6.1. Total Costing

6.3 Summary

In this chapter we have discussed about our costing regarding our design. We tried our best to reduce the budget by researching in the local markets to keep this prototype cost efficient.

CHAPTER-7

RESULT AND ANALYSIS

7.1 Introduction

The section result and Analysis contains the formulas and law of the needed to charge the battery, the output current of the generator motor and etc. By this section we can learn the output values of the components as well.

7.2 Result & Analysis

Results

The formula of calculating the current from the gear motors output-

Current, I= Px1000/ V.(cosΦ).n .....[2]

Where, P = Power

V = Voltage

cosΦ = Power factor

n = Efficiency

Current, I= $\frac{8\times1000}{8\times12.5\times80\%}$ =1A

The formula of calculating the time needed to charge the rechargeable battery is-

Time, t= $\frac{\text{Battery Capacity}}{\text{the rate of current provided by the front motor}}$ .....[1]

Time, t= $\frac{3700mAh}{1A}$= 3.72 hours

Analysis

The time needed to charge the rechargeable battery is 37.2 hours and the output current of the generator motor is a by the calculation. The Arduino Uno board provides maximum .80 mA current to the gear motor after switching, which is not sufficient for the gear motor. That's why a motor driver is used which is connected with the main supply of 8V. It increases the current form .80 mA to 2A[3]. There is also a full wave rectifier which converts AC current to DC current. Form the prototyping it is under stable that for higher purpose, the switching device should me more powerful, otherwise there will be output current problem further.

7.3 Summary

From this section, we have learned about the calculations like the time needed to charge the rechargeable battery, the output current of the single phase gear motor, the output current of Arduino Uno and the output current of the motor driver. These information will help for higher purpose implementation.

CHAPTER-8
DESIGN IMPACT

8.1 Introduction

In this chapter we will discuss about the various impacts of our project. There are different ways of impact about our project. We will also discuss about manufacturability and sustainability of our project in this chapter.

8.2 Impacts

i. Economic Impact

The economic impact of our project is very effective. Basically the system of hybrid car reduces the uses of fossil fuel and gasoline. The cost of fuel can be decreased by using hybrid car because the hybrid car is the combination of an internal combustion engine and battery.

ii. Social Impact

Hybrid car can become the most popular vehicles. People who uses hybrid car can feel special because they can enjoy the facilities of hybrid car. Obviously hybrid car is more premium. The social impact of our project is really important.

iii. Safety Impact

Since driving is a regular activity of our daily life, we have to ensure our safety first. It's true that a smaller vehicle with all safety features is not safe as a bigger vehicle. A hybrid car has comparatively smaller engine. For this reason, driving a hybrid car is perfectly safe in highway. But otherwise it's little risky. So, the safety impact of our project is very important. We are concerned to improve the safety issue of our project.

iv. Environmental Impact

Hybrid car has a big impact on environment. It's emission free. It can reduce air pollution, noise pollution, global warming. So, the environmental impact of our project is positive.

v. Impact in Real Life

Real life impact of our project is really worth saying. We have already discussed about the impact as economic, environmental, social, safety. Each of the impact is must plays an important role in our real life.

8.3 Manufacturability

We have tried to develop the manufacturability of our project. The performance of hybrid car is amazing as conventional car. Though hybrid car is more expensive, this has become more popular nowadays. Many automakers has announced various model of hybrid car. If we can implement this model in real life it will be a great value product.

8.4 Sustainability

The level of sustainability of our project is not so strong. We have made our project with low cost and commercially available components. Though it was our first attempt, we just made the model. In future, if we get proper investment we will add more features and will try to make it more sustainable.

8.5 Summary

We have discussed the different types of impacts of our project. We also have discussed about sustainability and manufacturability and how we can improve the impacts in our life.

CHAPTER-9

CONCLUSION

Conclusion

In conclusion we can say that the prototype we have designed works perfectly. But we have to work more to improve the project. Our hybrid car prototype converts mechanical energy of wheel rotation into electrical energy and stores it in a rechargeable battery. When the battery is fully charged, a controller switches from the combustion engine to the battery. Our main goal is to investigate the potential of replacing fossil fuel by renewable energy. The hybrid car prototype we have designed was built by domestically available components. The impacts of our project in real life like economical, social, environmental etc is really very effective. Hybrid cars are also eco-friendly. It plays an important role to maintain the balance of our environment. It reduces traffic noise pollution, global warming etc. it reduce the cost of fuel or gasoline. The project was completed successfully exceeding initial target. The cost of system has been reduced. Hybrid vehicles are more environmentally friendly than internal combustion vehicles. When the hybrid cars become more widespread, battery recycling will become economically possible. Research into other energy sources such as solar cells and renewable fuels make the future look brighter for hybrid cars. We have to plan to develop our system more. In future, we can add new features. We can use wind, solar to make the energy of engine more powerful. The popularity of hybrid car has spreading day by day.

CHAPTER-10

FUTURE WORK

10.1 Introduction

In this chapter, we will discuss about how we can add more features to our system to make it worth enough to reduce fuel cost and make it more eco friendly.

10.2 Future Planning

We have planned how we can successfully do the industrial marketing of our project. In order to make the idea result in big we have thought to do the industrial marketing if we get enough support from the government. We can ensure that our system will provide a great service for our customers. Middle class people will be able to afford a car which is saving fuel as well as eco friendly. The features we are planning to add in future is "Solar Panel".

10.3 Solar Cell

Solar cell is basically an electrical device that converts the energy from the light into electricity by photovoltaic effect. And solar panel is a package of solar cells. A calculator is a great example as we can see on some calculator we don't have any on-off button. As long as it got light it works.

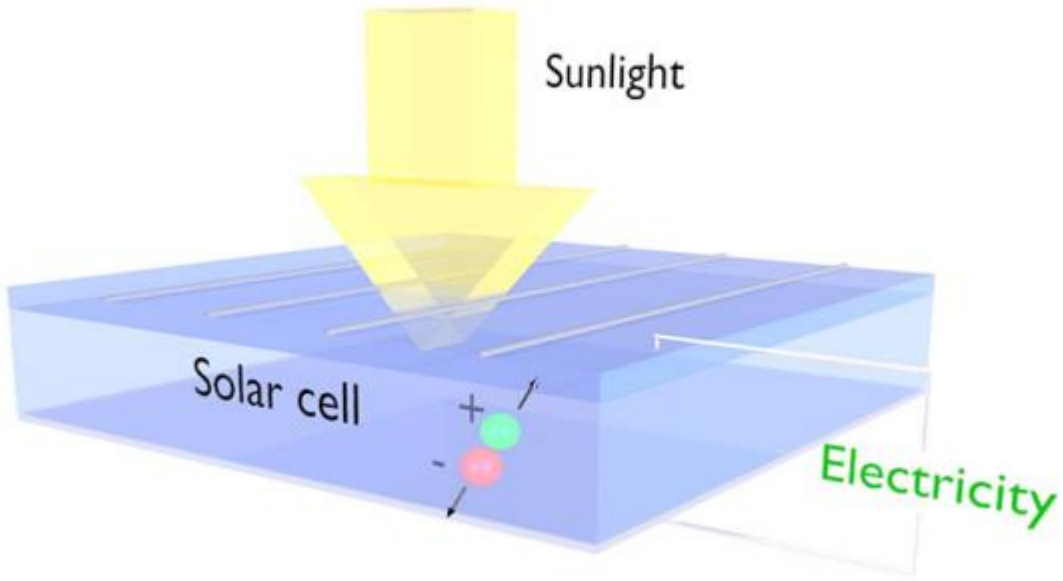

Fig.10.1. Anatomy of a Silicon Solar Cell

10.4 Idea of the Implementation

So how can we implement this cell or panel on our system. We have a plan to use solar panel on the roof of the car or our system. But using solar panel will make the car more expensive. So the solar panel will be available as an option on our system, so customers will have to pay extra for this feature. Driving a cars motor and consume fuel use is not possible with the energy that is coming from the solar panel. But the energy that will be got from the panel can be used to power cars air conditioning system or other internal system which doesn't need that much power.

10.5 Situation of Hybrid Car Around the World

Day by day sale of hybrid vehicles or plug in hybrid vehicles is increasing. People are now more concern about energy saving. Though initial cost of buying a hybrid card is high it eill lessen the cost later by consuming fuel cost. The bar charts below will show the current situation concerns around the world from a recent study.

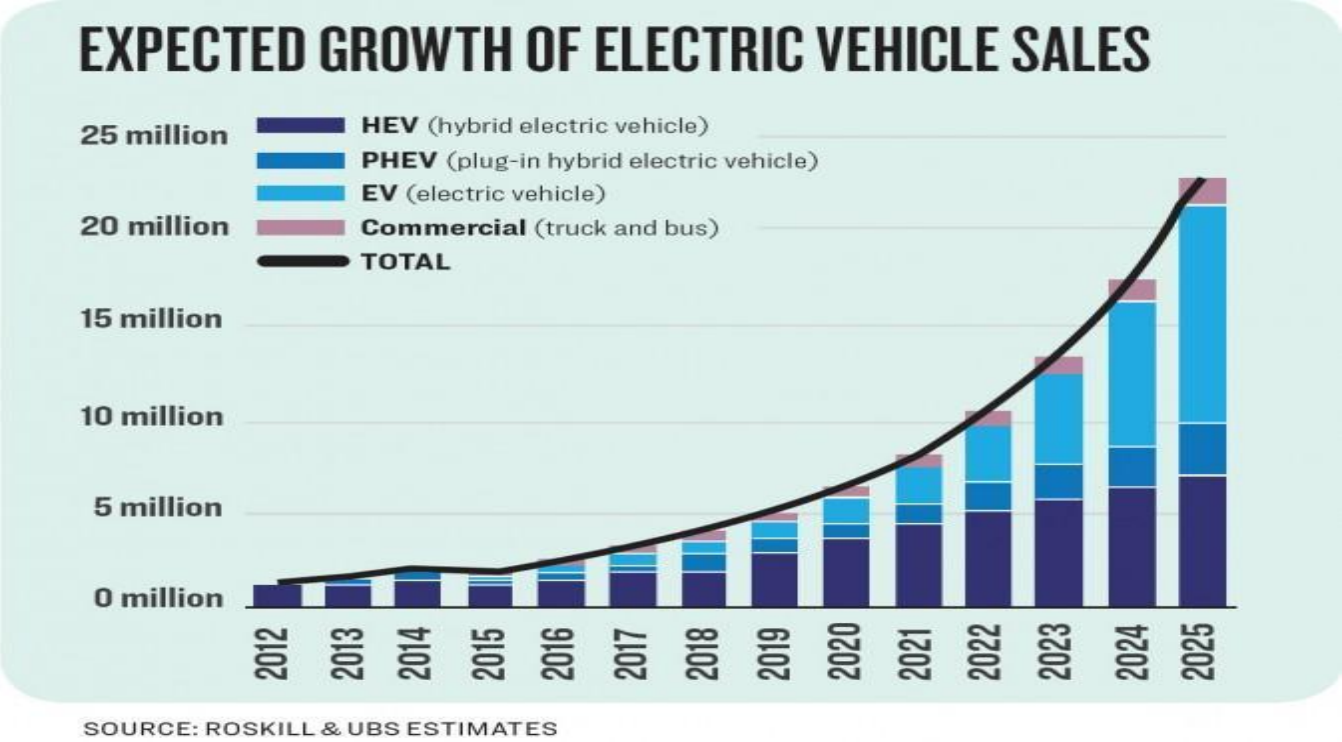

Fig.10.2 Expected Growth of Electric Vehicle Sales

We can see how rapidly the sale of hybrid car is increasing. If we get financial help and government support we will be able to build a hybrid car from our own country that will be cost efficient and also be eco friendly.

10.6 Summary

In this chapter, we have discussed how we can make our system more efficient by implementing more ideas in the future if we get proper support and investments. Our system can add a great value to the society if properly nourished and implemented. If we get proper support and investment we will be able to design an actual hybrid car with low budget which will lower fossil fuel consumption as well as lessen environment pollution.

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APPENDIX

Code For Switching Purpose

```
#include <LiquidCrystal_I2C.h>
LiquidCrystal_I2C lcd(0x27, 2, 1, 0, 4, 5, 6, 7, 3, POSITIVE);

int power=12;
int battery=13;
const float referenceVolts = 5.0;
const int batteryPin = 0;
const int ENA = 9;
const int IN1 = 7;
const int IN2 = 6;
const int IN3 = 5;
const int IN4 = 4;

void setup() {

    pinMode (power, OUTPUT                                    );
  pinMode (battery, OUTPUT);
  digitalWrite (power, HIGH);
  digitalWrite (battery, LOW);
  lcd.begin(16, 2);
  Serial.begin(9600);
  pinMode (IN1, OUTPUT);
  pinMode (IN2, OUTPUT);
  pinMode (IN3, OUTPUT);
  pinMode (IN4, OUTPUT);
  pinMode (ENA, OUTPUT);

}

void loop() {

 int val = analogRead(batteryPin);
  float voltage = (val / 1023.0) * referenceVolts;
 Serial.println(voltage);
 delay(500);
 analogWrite(ENA, 255);
 digitalWrite(IN1, HIGH);
```

```
 digitalWrite(IN2, LOW);
 digitalWrite(IN3, HIGH);
 digitalWrite(IN4, LOW);


if (voltage>3)
{
 digitalWrite (power, LOW);
 digitalWrite (battery, HIGH);
 lcd.print("    CHARGED");
 lcd.setCursor(0, 0);
 delay(1500);
 lcd.clear();
 lcd.print(" ELECTRIC POWER");
 lcd.setCursor(0, 1);
 delay(1500);
 lcd.clear();
}

 else if (voltage<1)
{
 digitalWrite (power, HIGH);
 digitalWrite (battery, LOW);
 lcd.print("   LOW BATTERY");
 lcd.setCursor(0, 0);
 delay(1500);
 lcd.clear();
 lcd.print("MECHANICAL POWER");
 lcd.setCursor(0, 1);
 delay(1500);
 lcd.clear();
}
}
```