SOLAR AND WIND POWERED HYBRID ENERGY VEHICLE

A Project Report

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BONAFIDE CERTIFICATE

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ABSTRACT

Energy crisis and pollution caused by vehicle emissions are one of the most important issues in the present society. Electric vehicles (EVs) are becoming more prevalent in modern society. Using an electric vehicle can minimize the damages that the transportation sectionhas on the environment. Due to the charging time of battery of electric vehicle, requirementof charging on board is explored as option. This paper deals with the design of a hybrid model of a solar and wind, which uses the battery as its storage system. Renewable energysources like solar PV systems and wind turbines are strongly advised for use in EV applications. The utilization of ecologically friendly energy sources like solar and wind energy is inevitable in light of global warming and the potential for fossil fuel shortages. This system allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources. The power generated from the wind and solar is fluctuating in nature. The system obtains maximum solar energy during day time and maximum wind energy during the night because the wind blows more at night compared to day time. The main contribution of this paper is to charge EVs with renewableenergies both in the daytime and nighttime. Utilizing solar and wind energy has the benefitof being cheap, plentiful, pollution-free, and available everywhere. Therefore battery of thevehicle can be charged by using hybrid energy system.

Keywords:

Renewable Energy, Solar Power, Solar PV systems, Wind turbines, ecologically friendly energy.

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List of Acronyms

IoT	-	Internet of Things
RE	-	Renewable Energy
LCD	-	Liquid Crystal Display
PV	-	Photovoltaic
WT	-	Wind Turbine
BMS	-	Battery Management System
A.I	-	Analog Input
D.I	-	Digital Input
GND	-	Ground
TX	-	Transmitting Pin
RX	-	Receiving Pin
VCC	-	Common Collector Voltage

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CHAPTER-1

INTRODUCTION

1.1 OVERVIEW

Due to depleting fossil fuel and imts detrimental effect on the environment alternative energy source is a mandate. The wind and solar energy resources are prospective options. As conventional sources are insufficient in meeting the load demands, the other forms of energy sources can compensate for the difference. The air quality of cities is mainly affected by vehicle emissions. Among the renewable energy sources harnessing wind energy with wind turbines appears to be the most promising source of renewable energy. Wind energy conversion systems are used to capture the energy available in the wind toconvert into electrical energy. The solar photovoltaic system and wind systems have been promoted around the world on a comparatively larger scale. These independent systems cannot provide a continuous source of energy, as they are seasonal. For example, a solar photovoltaic energy system cannot provide reliable power during non-sunny days. The wind system cannot satisfy constant load demands due to significant fluctuations in the magnitude of wind speeds from hour to hour throughout the year. Therefore, energy storage systems will be required for each of these systems in order tosatisfy the power demands. Usually, the storage system is expensive and the size has to be reduced to a minimum possible for the renewable energy system to be cost effective.The power generated from both wind and solar components is stored in a battery bank. A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power. The other advantage of solar/wind hybrid system is that when solar and wind power production is used together, the reliability of the system is enhanced. Additionally, the size of battery storage can be reduced slightly as there is less reliance on one method of power production. Often, when there is no sun, there is plenty of wind. The conventional electric car finds the difficulty of charging it after few kilometers but the wind and solar powered car help to eliminate this drawback as this car has the facility to be charged on board due to the wind and solar energy. Here power is generated from wind turbines and the solar panels and is directed to the battery for the charging. The battery is recharged on board and the vehicle doesn't need to be standby for charging.

1.2. BLUETOOTH

Bluetooth is a ubiquitous wireless technology standard designed for short-range communication between electronic devices. Developed by Ericsson in the 1990s, it has since become an integral part of modern technology ecosystems. Operating on the 2.4 GHz frequency band, Bluetooth facilitates data exchange over distances of up to approximately 10 meters, though newer versions have extended this range. The technology uses low-power radio waves for connectivity, making it energy-efficient and suitable for various applications, from connecting peripherals like keyboards, mice, and headphones to enabling data transfer between smartphones, tablets, and computers. Bluetooth is renowned for its versatility and ease of use, offering seamless pairing and connection processes across compatible devices.

Over the years, Bluetooth has evolved through multiple iterations, each bringing improvements in speed, range, and functionality. Version 5.0, for instance, introduced features like increased data transfer rates, longer range, and enhanced connectivity stability. These advancements have broadened the scope of Bluetooth applications, from smart home devices and wearable technology to automotive systems and industrial automation. Bluetooth's widespread adoption has made it a cornerstone of the Internet of Things (IoT) ecosystem, enabling seamless communication between a myriad of interconnected devices. Its standardized protocols ensure interoperability and compatibility across a diverse range of products from various manufacturers.

1.3 EMBEDDED SYSTEMS

As its name suggests, Embedded means something that is attached to another thing. An embedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system or it can be a part of alarge system. An embedded system is a microcontroller or microprocessor based system which is designed to perform a specific task.

1.4 ARDUINO UNO

Arduino Uno is a popular microcontroller board that serves as the foundation for countless electronics projects and prototypes. It's part of the Arduino platform, which includes hardware, software, and a supportive community, making it accessible to beginners and advanced users alike.

It's based on the ATmega328P microcontroller and features 14 digital input/outputpins, 6 analog input pins, USB connectivity, and a reset button. Arduino Uno can be powered via USB, external DC power, or battery. It's compatible with a wide range of sensors, shields, and accessories and can be programmed using the Arduino IDE. Arduino Unois used for prototyping, education, home automation, IoT projects, and robotics due toits ease of use and versatility.

1.5 SOLAR PANEL

A solar panel, also known as a photovoltaic (PV) panel, is a device that converts sunlight into electricity. It is made up of solar cells, typically composed of semiconductor materials like silicon, which absorb photons from sunlight and generate an electric current as a result of the photovoltaic effect. Solar panels are widely used to harness solar energy for various applications, including residential and commercial electricity generation, as well as powering remote equipment and vehicles.

1.6 WIND TURBINE

A wind turbine is a device that converts the kinetic energy of wind into mechanicalenergy, which is then typically converted into electricity. It consists of blades mounted on a rotor, which spins when the wind blows. The rotation of the rotor drives a generator, producing electrical power. Wind turbines are typically installed in locations with consistent wind patterns, such as open plains or offshore locations,and are used to generate renewable electricity on a large scale. They are a key component of wind energy systems, which provide a sustainable and environmentally friendly alternative to fossil fuel-based electricity generation.

CHAPTER 2

LITERATURE SURVEY

TITLE: "Design and Analysis of a Solar-Wind Hybrid Energy System for Vehicle Power Generation"

AUTHOR: F. Yildiz, M. Korkmaz

ABSTRACT: This paper presents the design and analysis of a solar-wind hybrid energy system for vehicle power generation. The hybrid system consists of a wind turbine, a solar panel, a battery bank, and a power conditioning unit. The system is designed to provide continuous power to an electric vehicle charging station. The wind turbine and solar panel are integrated to take advantage of the complementary nature of the two energy sources. A simulation model of the hybrid system is developed using MATLAB/Simulink software to evaluate the performance of the system under different operating conditions. The simulation results show that the hybrid system can provide a reliable and cost-effective solution for electric vehicle charging.

Drawback:

Space Requirements: Wind turbines and solar panels require significant space for installation, especially if the hybrid system is intended to provide power for a charging station with high demand. Finding suitable locations with ample wind and sunlight, as well as acquiring sufficient land or rooftop space, could be challenging.

Initial Cost: The initial cost of installing a solar-wind hybrid energy system, including the wind turbine, solar panels, battery bank, and power conditioning unit, can be substantial. While there may be long-term cost savings from reduced reliance on grid electricity, the upfront investment may be a barrier for some users or organizations.

TITLE: "A Review of Solar and Wind Powered Electric Vehicle Charging Systems"

AUTHOR: S. S. Pathak, S. S. Singh, and B. Singh

ABSTRACT: Electric vehicles (EVs) are gaining popularity worldwide due to their potential to reduce greenhouse gas emissions and dependence on fossil fuels. However, the limited range of EVs and the lack of charging infrastructure remain significant barriers to their widespread adoption. Solar and wind powered electric vehicle charging systems can provide a sustainable and cost-effective solution to these challenges. This paper provides a comprehensive review of the existing literature on solar and wind powered EV charging systems. The review covers various aspects of these systems, including design and implementation, performance evaluation, and economic analysis. The paper also identifies key research gaps and provides recommendations for future research.

Drawback:

Energy Storage Challenges: Storing excess energy generated from solar and wind sources for use during periods of low generation or high demand requires efficient and cost-effective energy storage solutions. Current battery technologies may not be able to adequately store the amount of energy needed for reliable EV charging.

Environmental Impact: While solar and wind energy are renewable and have lower environmental impact compared to fossil fuels, the manufacturing, installation, and disposal of solar panels, wind turbines, and associated components still have environmental consequences. It's important to consider the overall lifecycle environmental footprint of these systems.

TITLE: "Design and Analysis of a Solar-Wind Powered Electric Vehicle Charging Station"

AUTHOR: S. H. Lee and S. S. Kim

ABSTRACT: This paper presents the design and analysis of a solar-wind powered electric vehicle charging station. The charging station is designed to provide a reliable and sustainable source of power for electric vehicles. The system consists of a wind turbine, a solar panel, a battery bank, and a power conditioning unit. The system is designed to operate in standalone mode, meaning that it is not connected to the grid. The performance of the system is evaluated using a simulation model developed in MATLAB/Simulink software. The simulation results show that the hybrid charging station can provide a reliable and cost-effective solution for electric vehicle charging.

Drawback:

Complexity of Maintenance: Maintaining the reliability and efficiency of the charging station over time will require regular maintenance of components such as the wind turbine, solar panels, batteries, and power conditioning unit. Ensuring that all components are functioning optimally and addressing any issues that arise may require specialized knowledge and expertise.

Scalability: The scalability of standalone solar-wind charging stations may be limited by factors such as space constraints, energy storage capacity, and the availability of suitable wind and solar resources. Expanding the charging station to accommodate a larger number of vehicles or higher energy demand may require significant additional investment and infrastructure.

TITLE: "Performance Analysis of a Wind-Solar Hybrid Energy System for Electric Vehicle Charging Station"

AUTHOR: T. H. Lee, J. W. Kim, and D. H. Lee

ABSTRACT: This paper presents a performance analysis of a wind-solar hybrid energy system for an electric vehicle charging station. The hybrid system consists of a wind turbine, a solar panel, a battery bank, and a power conditioning unit. The system is designed to provide a sustainable and cost-effective source of power for electric vehicles. A simulation model of the hybrid system is developed using MATLAB/Simulink software to evaluate the performance of the system under different operating conditions. The simulation results show that the hybrid system can provide a reliable and sustainable source of power for electric vehicle charging.

Drawback:

Dependence on Simulation Models: While simulation models can provide valuable insights into the performance of the hybrid energy system under different operating conditions, they may not always accurately reflect real-world conditions. Variability in weather patterns, equipment degradation over time, and other factors may affect the actual performance of the system in practice.

High Initial Cost: The initial cost of installing a wind-solar hybrid charging station, including the wind turbine, solar panels, battery bank, and power conditioning unit, can be substantial. While there may be long-term cost savings from reduced reliance on grid electricity, the upfront investment may be a barrier for some users or organizations.

CHAPTER-3

PROPOSED SYSTEM

3.1. SOLAR AND WIND POWERED HYBRID ENERGY VEHICLE

As the demand for sustainable transportation continues to grow, there are many proposed systems for solar and wind powered hybrid energy vehicles. Here are a few examples:

1. Solar and Wind-Powered Electric Buses: In this proposed system, electric buses would be equipped with solar panels on their roofs and wind turbines mounted on top. The solar panels and wind turbines would generate electricity that could be stored in batteries on the bus, allowing it to travel long distances without the need for recharging.

2. Solar and Wind-Powered Hybrid Trucks: This proposed system involves equipping diesel-powered trucks with solar panels and wind turbines. The solar panels and wind turbines would provide electricity to supplement the truck's diesel engine, reducing its fuel consumption and emissions.

3. Solar and Wind-Powered Electric Boats: In this proposed system, electric boats would be equipped with solar panels on their decks and wind turbines mounted on their masts. The solar panels and wind turbines would generate electricity to power the boat's electric motor and other onboard systems.

4. Solar and Wind-Powered Electric Aircraft: This proposed system involves developing electric aircraft that are powered by solar panels and wind turbines. The solar panels and wind turbines would provide electricity to power the aircraft's electric motor and onboard systems, allowing it to fly long distances without the need for refueling.

5. Solar and Wind-Powered Personal Vehicles: In this proposed system, personal vehicles such as cars, motorcycles, and bicycles would be equipped with solar panels and wind turbines. The solar panels and wind turbines would provide electricity to supplement the vehicle's battery or power the electric motor directly.

These proposed systems demonstrate the potential for solar and wind powered hybrid energy vehicles to revolutionize the transportation industry and provide sustainable alternatives to fossil fuel-powered vehicles. However, further research and development are needed to make these systems more efficient and cost-effective.

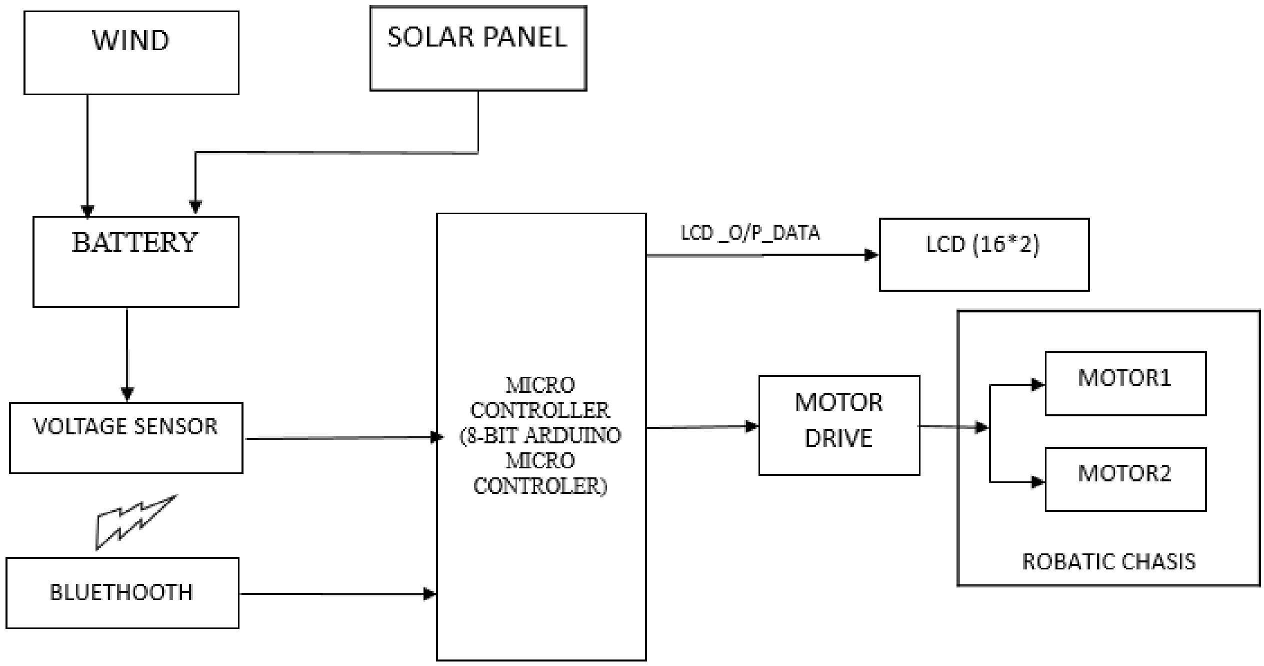

Fig 3.1: SOLAR AND WIND POWERED HYBRID ENERGY VEHICLE

3.2. EMBEDDED SYSTEM

As its name suggests, Embedded means something that is attached to another thing. Anembedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system or it can be a part of a large system. An embedded system is a microcontroller or microprocessor based system which is designed to perform a specific task. For example, a fire alarm is an embedded smoke.

An embedded system has three components:

- It has hardware.
- It has application software.
- It has Real Time Operating system (RTOS) that supervises the application software and provide mechanism to let the processor run a process as per scheduling by following a plan to control the latencies. RTOS defines the way the system works. It sets the rules during the execution of application program. A small scale embedded system may not have RTOS.

So we can define an embedded system as a Microcontroller based, software driven and reliable, real-time control system.

3.3. CHARACTERISTICS OF AN EMBEDDED SYSTEM

Single-functioned – An embedded system usually performs a specialized operation and does the same repeatedly. For example: A pager always functions as a pager.

Tightly constrained – All computing systems have constraints on design metrics, but those on an embedded system can be especially tight. Design metrics is a measure of an implementation's features such as its cost, size, power, and performance. It must be of a size to fit on a single chip, must perform fast enough to process data in real time and consume minimum power to extend battery life. typically refers to a situation or condition where there are very strict limitations, restrictions, or boundaries placed on something. It implies that there is little room for flexibility or deviation from these constraints. This term is often used in various contexts, such as in engineering, finance, project management, or problem-solving scenarios, to indicate the narrow margins.

Reactive and Real time – Many embedded systems must continually react to changes in the system's environment and must compute certain results in real time without any delay. Consider an example of a car cruise controller; it continually monitors and reacts to speed and brake sensors. It must compute acceleration or de-accelerations repeatedly within a limited time; a delayed computation can result in failure to control of the car.

Microprocessors based – It must be microprocessor or microcontroller based.

Memory – It must have a memory, as its software usually embeds in ROM. It does not need any secondary memories in the computer.

Connected – It must have connected peripherals to connect input and output devices.

HW-SW systems – Software is used for more features and flexibility. Hardware is used for performance and security.

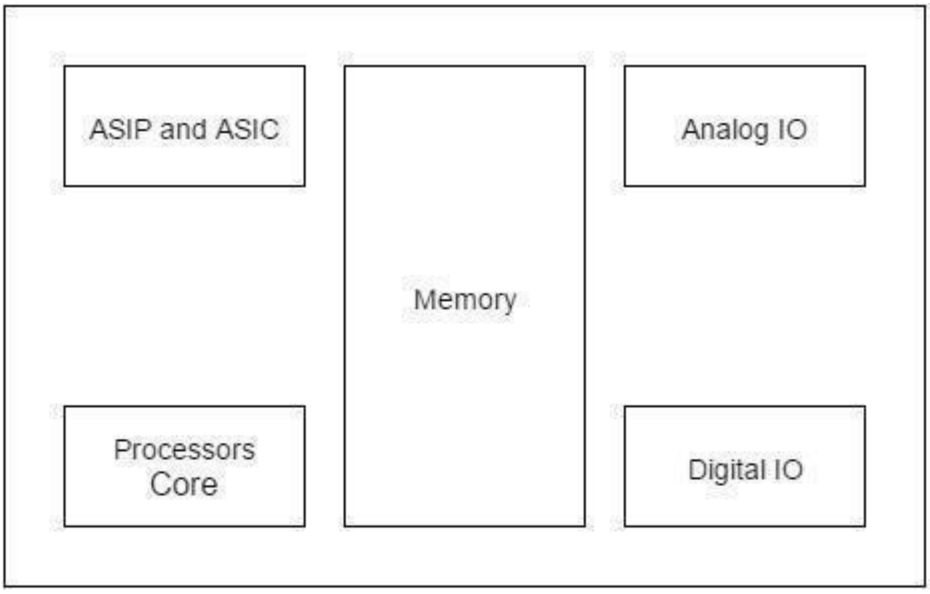

Fig 3.2: CHARACTERISTICS OF AN EMBEDDED SYSTEM

3.4. BASIC STRUCTURE OF AN EMBEDDED SYSTEM

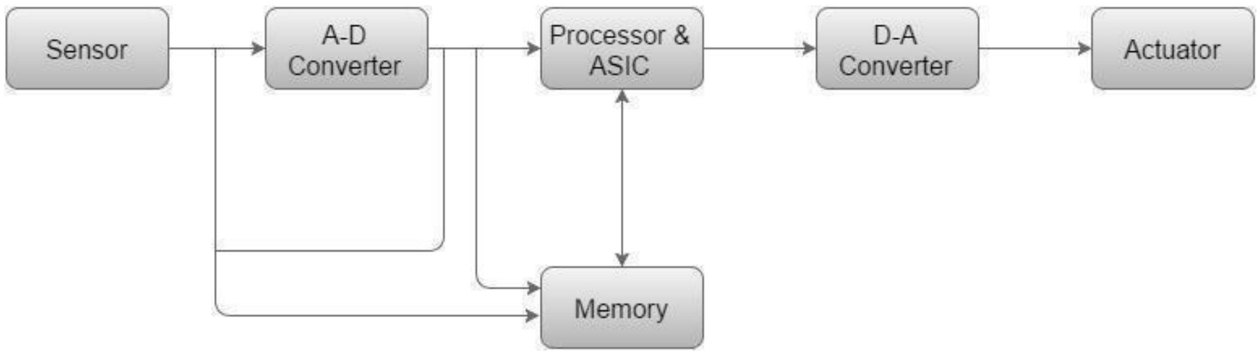

Fig 3.3: BASIC STRUCTURE OF AN EMBEDDED SYSTEM

- **Sensor** − It measures the physical quantity and converts it to an electrical signal which can be read by an observer or by any electronic instrument like an A2D converter. A sensor stores the measured quantity to the memory.
- **A-D Converter** − An analog-to-digital converter converts the analog signal sent by the sensor into a digital signal.
- **Processor & ASICs** − Processors process the data to measure the output and store it to the memory.
- **D-A Converter** − A digital-to-analog converter converts the digital data fed by the processor to analog data
- **Actuator** − An actuator compares the output given by the D-A Converter to the actual (expected) output stored in it and stores the approved output.

3.5. EMBEDDED SYSTEM SOFTWARE

A typical industrial microcontroller is quite unsophisticated compared to a typical enterprise desktop computer and generally depends on a simpler, less-memory-intensive program environment. The simplest devices run on bare metal and are programmed directly using the chip CPU's machine code language.

Often, however, embedded systems use operating systems or language platforms tailoredto embedded use, particularly where real-time operating environments must be served. Athigher levels of chip capability, such as those found in SoCs, designers have increasinglydecided that the systems are generally fast enough and tasks tolerant of slight variations in reaction time that "near-real-time" approaches are suitable. In these instances, stripped-down versions of the Linux operating system are commonly deployed, though there are also other operating systems that have been pared down to run on embedded systems, including Embedded Java and Windows IoT (formerly Windows Embedded). Generally,storage of programs and operating systems on embedded devices make use either of flashor rewritable flash memory.

CHAPTER-4

HARDWARE DESRIPTION

4.1. ARDUINO

Arduino is open-source hardware. The hardware reference designs are distributed undera Creative Commons Attribution Share-Alike 2.5 license and are available on the Arduinowebsite. 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 Arduino staff.

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 project name by using various names ending in arduino.

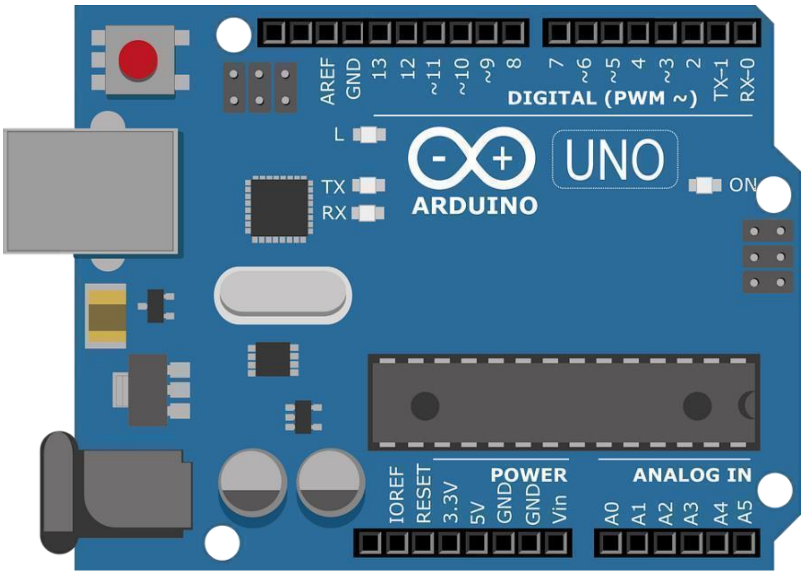

Fig 4.1.1: ARDUINO BOARD

An Arduino board consists of an Atmel 8-,16-or32-bit AVR microcontroller (ATmega8, ATmega168, ATmega328, ATmega1280, ATmega2560), but other makers' microcontrollers have been used since 2015. The boards use single-row pins or female headers that facilitate connections for programming and incorporation into other circuits. These may connect with add-on modules termed shields. Multiple, and possibly stacked shields may be individually addressable via an I²C serial bus. Most boards include a 5 V linear regulator and a 16 MHz crystal oscillatoror ceramic resonator. Some designs, such as the LilyPad, run at 8 MHz and dispense withthe onboard voltage regulator due to specific form-factor restrictions.

Arduino microcontrollers are pre-programmed with a boot loader that simplifies uploading of programs to the on-chip flash memory. The default bootloader of the Aduino UNO is the optiboot bootloader. Boards are loaded with program code via a serial connection to another computer. Some serial Arduino boards contain a level shifter circuit to convert between RS-232 logic levels and transistor–transistor logic (TTL) level signals. Current Arduino boards are programmed via Universal Serial Bus (USB), implemented using USB-to-serial adapter chips such as the FTDI FT232. Some boards, such as later-model Uno boards, substitute the FTDI chip with a separate AVR chip containing USB-to-serial firmware, which is reprogrammable via its own ICSP header. Other variants, such as the Arduino Mini and the unofficial Boarduino, use a detachable USB-to-serial adapter board or cable, Bluetooth or other methods, when used with traditional microcontroller tools instead of the Arduino IDE, standard AVR in-system programming (ISP) programming is used.

The Arduino board exposes most of the microcontroller's I/O pins for use by other circuits. The *Diecimila*, *Duemilanove*, and current *Uno* provide 14 digital I/O pins, six of which can produce pulse-width modulated signals, and six analog inputs, which can also be used as six digital I/O pins. These pins are on the top of the board, via female 0.1 -inch (2.54 mm) headers. Several plug-in application shields are also commercially available. The Arduino Nano, and Arduino-compatible Bare Bones Board and arduino boards may provide male header pins on the underside of the board that can plug into solderless breadboards

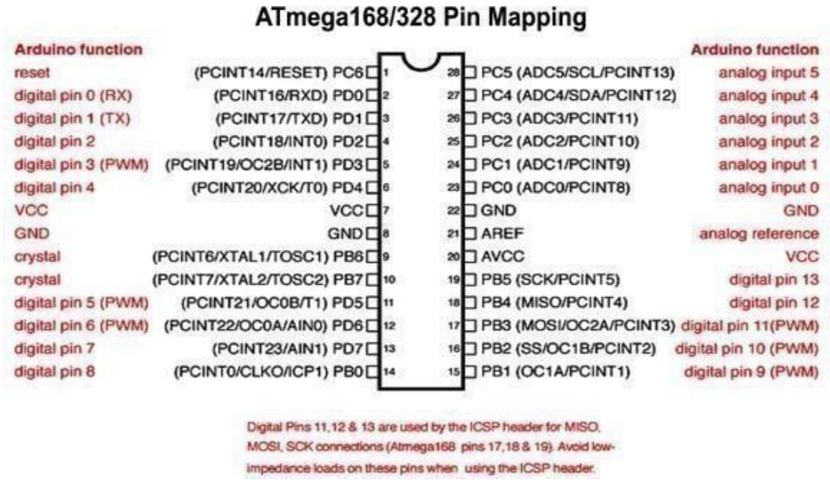

Fig 4.1.2: ARDUINO PIN DIAGRAM

4.1.1 Technical specs

Microcontroller	-	ATmega328P
Operating Voltage	-	5V
Input Voltage (recommended)	-	7-12V
Input Voltage (limit)	-	6-20V
Digital I/O Pins	-	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	-	6
Analog Input Pins	-	6
DC Current per I/O Pin	-	20 mA
DC Current for 3.3V Pin	-	50 mA
Flash Memory	-	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	-	2 KB (ATmega328P)
EEPROM	-	1 KB (ATmega328P)
Clock Speed	-	16 MHz
Length	-	68.6 mm
Width	-	53.4 mm
Weight	-	25 g

4.2. LIQUID CRYSTAL DISPLAY (LCD): -

LCD is a type of display used in digital watches and many portable computers. LCD displays utilize to sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through them. LCD technology has advanced very rapidly since its initial inception over a decade ago for use in lap top computers. Technical achievements has resulted in brighter displace, higher resolutions, reduce response times and cheaper manufacturing process.

The liquid crystals can be manipulated through an applied electric voltage so that light is allowed to pass or is blocked. By carefully controlling where and what wavelength (color) of light is allowed to pass, the LCD monitor is able to display images. A backlight provides LCD monitor’s brightness.

Fig 4.2.1: LIQUID CRYSTAL DISPLAY (LCD)

Over the years many improvements have been made to LCD to help enhance resolution,image, sharpness and response times.

One of the latest such advancement is applied to glass during acts as switch allowing control of light at the pixel level, greatly improving LCD’s ability to display small-sized fonts and image clearly.

Other advances have allowed LCD’s to greatly reduce liquid crystal cell response times.Response time is basically the amount of time it takes for a pixel to “change colors”, in reality response time is the amount of time it takes a liquid crystal cell to go from being active to inactive.

The declining prices of LCDs.

The ability to display numbers, characters and graphics. This is in contrast to LEDs, whichare limited to numbers and a few characters.

An intelligent LCD display of two lines, 20 characters per line that is interfaced to the pic16f72 microcontroller.

Incorporation of a refreshing controller into the LCD, thereby relieving the CPU to keep displaying the data. Ease of programming for characters and graphics.

Most of the LCD modules conform to a standard interface specification. A 14-pin accessis provided having eight data lines, three control lines and three power lines. The connections are laid out in one of the two common configurations, either two rows of seven pins, or a single row of 14 pins.

One of these pins is numbered on the LCD’s printed circuit board (PCB), but if not, it is quite easy to locate pin1. Since this pin is connected to ground, it often has a thicker PCBtrack, connected to it, and it is generally connected to metal work at same point.

4.2.1. PIN DIAGRAM OF LCD: -

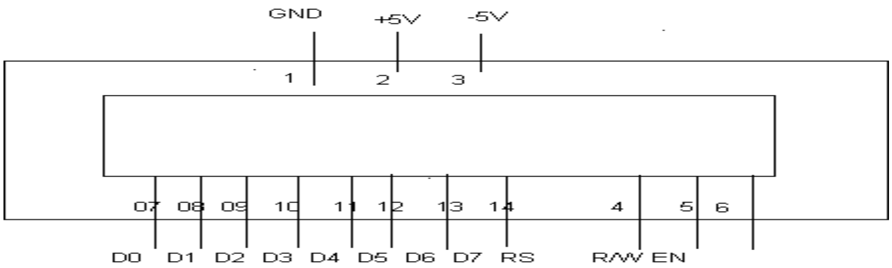

Fig 4.2.2: PIN DIAGRAM OF LCD

4.2.2. PIN DESCRIPTIONS: -

4.2.2.1 : Vcc, Vss and Vee: -

While Vcc and Vss provide +5V and ground respectively, Vee is used for controlling LCD contrast.

4.2.2.2 : RS Register Select: -

There are two very important registers inside the LCD. The RS pin is used for their selection as follows.

If RS=0, the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home, etc.

If RS=1, the data register is selected, allowing the user to send data to be displayed on the LCD.

4.2.2.3 :R/W, read/write: -

R/W input allows the user to write information to the LCD or read information from it.

R/W = 1 for reading.

R/W= 0 for writing.

4.2.2.4 : EN, enable: -

The LCD to latch information presented to its data pins uses the enable pin. When data is supplied to data pins, a high–to-low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450 ns wide.

4.2.2.5 :D0 – D7: -

The 8–bit data pins, DO – D7, are used to send information to the LCD or read the contents of the LCD's internal registers.

To display letters and numbers, we send ASCII codes for the letters A–Z, a-z numbers 0-9 to these pins while making RS=1.

There are also instruction command codes that can be sent to the LCD to clear the display or force the cursor to home position or blink the instruction command codes.

We also use RS = 0 to check the busy flag bit to see if the LCD is ready to receive information. The busy flag is D7 and can be read when R/W=1 and RS=0, as follows: if R/W = 1, RS = 0. When D7= 1 (busy flag = 1), the LCD is busy taking care of internal operations and will not accept any information.

4.3. VOLTAGE SENSOR:

Fig 4.3: VOLTAGE SENSOR

4.3.1. Description:-

Voltage Sensor is a precise low cost sensor for measuring voltage. It is based on principle of resistive voltage divider design. It can make the red terminal connector input voltageto 5 times smaller. Arduino analog input voltages up to 5V, the voltage detection moduleinput voltage not greater than 5Vx5=25V (if using 3.3V systems, input voltage not greater than 3.3Vx5=16.5V).

Arduino AVR chips have 10-bit AD, so this module simulates a resolution of 0.00489V(5V/1023), so the minimum voltage of input voltage detection module is 0.00489Vx5=0.02445V.

4.3.2. Features:-

- Voltage input range: DC 0-25V
- Voltage detection range: DC 0.02445V-25V
- Voltage Analog Resolution: 0.00489V
- DC input connector: Terminal cathode connected to VCC, GND negative pole
- Output interface: "+" connect 5/3.3V, "-" connect GND, "s" connect the Arduino AD pins

4.4. SOLAR PANEL:-

A solar panel, or photo-voltaic (PV) module, is an assembly of photo-voltaic cells. Solar panels use sunlight as a source of energy and generate direct current electricity A collection of PV modules is called a PV panel, and a system of panels is an array. Arrays of a photovoltaic system supply solar electricity to electrical equipment.

This 12V 10Watt Solar Panel is Engineered with high-efficiency polycrystalline silicon solar cells.

This is the best quality solar panel we found in a comparative market with excellent performance even weak sunlight. It is Durable anti-eye enough to make a unique processing panel, Perfect for making solar robots and for use as a general purpose solar panel.

Fig 4.1: SOLAR PANEL

4.4.1. Features:

- Type of Product : Solar Panel & Module
- Material : Steel
- Panel Wattage: 10Watt
- Voltage: 12V
- Dimensions: 34x28.5x2mm
- Weight: 1.125gm.

4.5. BLUETOOTH:-

4.5.1. Introduction To Bluetooth:

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard, and many more consumer applications.
- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

4.5.2. HC-05 Bluetooth Module:

- HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.

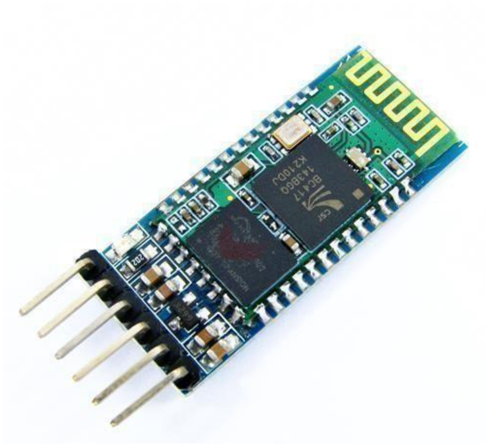

Fig 4.5.1.HC-05 BLUETOOTH MODULE

4.5.3. HC-05 Bluetooth Module Pin Diagram

Fig 4.5.2.HC-05 BLUETOOTH MODULE PIN DIAGRAM

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

1. **Data mode:** Exchange of data between devices.
2. **Command mode:** It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.

2. **VCC:** Connect 5 V or 3.3 V to this Pin.
3. **GND:** Ground Pin of module.
4. **TXD:** Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
5. **RXD:** Receive data serially (received data will be transmitted wirelessly by Bluetooth module).
6. **State:** It tells whether module is connected or not.

4.5.4. HC-05 module Information

- HC-05 has **red LED** which indicates **connection status**, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.
- This module **works on 3.3V**. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.
- As HC-05 Bluetooth module has **3.3V level for RX/TX** and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.
- The data transfer rate of HC-05 module can vary up to **1Mbps** is in the **range of 10 meters**.

4.5.5. Specification of HC-05 Bluetooth Module

- Bluetooth version: 2.0 + EDR (Enhanced Data Rate)
- Frequency: 2.4 GHz ISM band
- Modulation: GFSK (Gaussian Frequency Shift Keying)
- Transmit power: Class 2 (up to 4 dBm)
- Sensitivity: -80 dBm typical
- Range: approximately 10 meters (or 33 feet) in open air

- Profiles supported: SPP (Serial Port Profile), HID (Human Interface Device) and others
- Operating voltage: 3.3V to 5V DC
- Operating current: less than 50mA
- Standby current: less than 2.5mA
- Sleep current: less than 1mA
- Interface: UART (Universal Asynchronous Receiver/Transmitter)
- Baud rates: 1200, 2400, 4800, 9600, 19200, 38400, 57600, 115200, 230400, and 460800
- Operating temperature: -20°C to 75°C (-4°F to 167°F)

4.5.6. Bluetooth communication between Devices

E.g. Send data from Smartphone terminal to HC-05 Bluetooth module and see this data on PC serial terminal and vice versa.

To communicate smartphone with HC-05 Bluetooth module, smartphone requires Bluetooth terminal application for transmitting and receiving data. You can find Bluetooth terminal applications for android and windows in respective app. store.

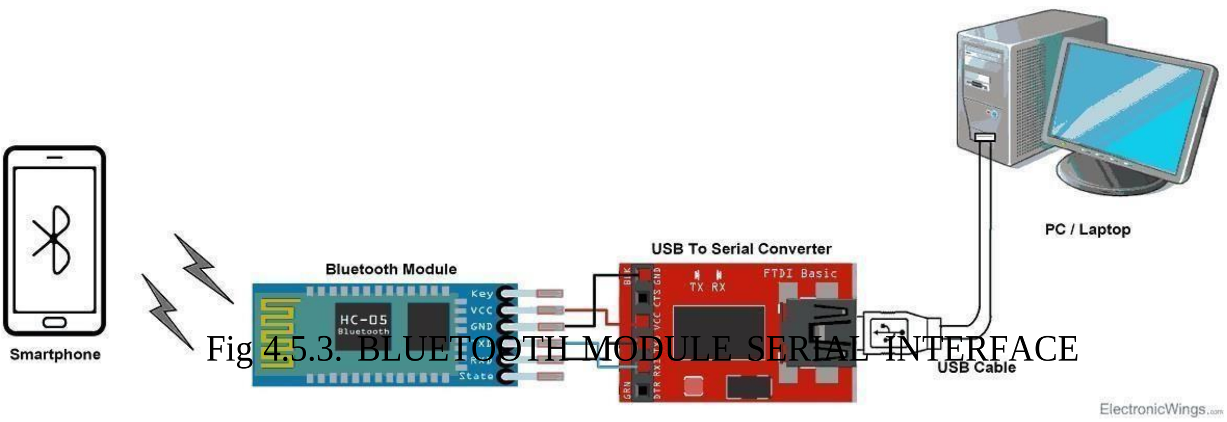

Fig 4.5.3. BLUETOOTH MODULE SERIAL INTERFACE

Fig 4.5.3. Bluetooth communication between Devices

So, when we want to communicate through smartphone with HC-05 Bluetooth module,connect this HC-05 module to the PC via serial to USB converter.

Before establishing communication between two Bluetooth devices, 1st we need to pairHC-05 module to smartphone for communication.

4.5.7. **Pair HC-05 and smartphone**:

1. Search for new Bluetooth device from your phone. You will find Bluetooth device with “HC-05” name.
2. Click on connect/pair device option; default pin for HC-05 is 1234 or 0000.

After pairing two Bluetooth devices, open terminal software (e.g. Teraterm, Realterm etc.) in PC, and select the port where we have connected USB to serial module. Also select default baud rate of 9600 bps.

In smart phone, open Bluetooth terminal application and connect to paired device HC-05.
It is simple to communicate, we just have to type in the Bluetooth terminal application of smartphone. Characters will get sent wirelessly to Bluetooth module HC-05. HC-05 will automatically transmit it serially to the PC, which will appear on terminal. Same way we can send data from PC to smartphone.

4.5.8. **Command Mode:**

- When we want to change settings of HC-05 Bluetooth module like change password for connection, baud rate, Bluetooth device’s name etc.
- To do this, HC-05 has AT commands.
- To use HC-05 Bluetooth module in AT command mode, connect “Key” pin to High (VCC).
- Default Baud rate of HC-05 in command mode is 38400bps.
- Following are some AT command generally used to change setting of Bluetooth module.

- To send these commands, we have to connect HC-05 Bluetooth module to the PC via serial to USB converter and transmit these command through serial terminal of PC.

Command	**Description**	**Response**
AT	Checking communication	OK
AT+PSWD=XXXX	Set Password e.g. AT+PSWD=4567	OK
AT+NAME=XXXX	Set Bluetooth Device Name e.g. AT+NAME=MyHC-05	OK
AT+UART=Baud rate, stop bit, parity bit	Change Baud rate e.g. AT+UART=9600,1,0	OK
AT+VERSION?	Respond version no. of Bluetooth module	+Version: XX OK e.g. +Version: 2.0 20130107 OK
AT+ORGL	Send detail of setting done by manufacturer	Parameters: device type, module mode, serial parameter, passkey, etc.

Fig 4.5.4. Command Mode Tabalution

4.5.9. Alternate options for HC-05 Bluetooth Module:

1. **HC-06 Bluetooth module**: This is a similar module to the HC-05, but it is limited to a slave role only. It has a smaller form factor and is generally cheaper than the HC-05. However, it does not support some of the advanced features of the HC-05, such as the ability to enter AT mode to configure the module.

2. **HM-10 Bluetooth module**: This is a more advanced Bluetooth module that supports Bluetooth 4.0 (BLE) and can act as both a master and slave device. It also supports a wider range of AT commands for configuring the module, and has a longer range than the HC-05. However, it is generally more expensive than the HC-05.

3. **RN-42 Bluetooth module**: This is another Bluetooth module that supports both the SPP and HID profiles, similar to the HC-05. It has a longer range than the HC-05 and supports faster data rates. However, it is also more expensive and may require additional configuration to work properly.

4. **ESP32 Bluetooth module**: This is a powerful Wi-Fi and Bluetooth module that includes a dual-core processor and support for both Bluetooth Classic and BLE. It is more expensive than the HC-05, but offers more advanced features and capabilities.

5. **nRF24L01+ Wireless module**: This is a wireless module that operates at 2.4GHz and uses a different protocol than Bluetooth. It is generally cheaper than Bluetooth modules and can be used for applications where a shorter range and lower data rate are acceptable.

4.6. ROBOTIC VEHICLE:-

The field of robotics encompasses a broad spectrum of technologies in which computational intelligence is embedded in physical machines, creating systems with capabilities far exceeding the core components alone.

Such vehicles are "unmanned," in the sense that no humans are on board. These vehicles move by themselves, under their own power, with sensors and computational resources onboard to guide their motion. Robotic vehicles are capable of traveling where people cannot go, or wherethe hazards of human presence are great.

4.6.1. PRODUCT DESCRIPTION:

A Vehicle full set robot contains two DC gear motors. The machine consists of minimum mechanical tools resulting in a high quality robot. These motors are directly controlled by two modes. Pulses from micro controller and it can be controlled by means of Motor drive. It can be moved to forward direction and reverse direction for detection of the object.

Robotic vehicles are capable of traveling where people cannot go, or where the hazards of human presence are great. To reach the surface of Mars, a spacecraft must travel more than one year, and on arrival the surface has no air, water, or resources to support human life.

Fig 4.6. ROBOTIC VECHICLE FULL SET

4.6.2. FEATURES:

- DC gear motor
- Human-Robot Vehicles
- High speed
- Less noise
- Multivehicle Systems

4.6.3. APPLICATIONS:

- Industrial products.
- Lab automation.
- Military and law enforcement.
- Recreation and hobby

4.7. BATTERY:

12V 1.3Ah Rechargeable Lead Acid Battery is normally use for robots in competition. Wired or Wireless Robots runs for a long time with high speed with this type of battery. Seal Lead Acid (SLA) Rechargeable battery is the most common general purpose battery.

Low cost, robust and less maintenance required are the advantages of SLA. But it is considered heavy weight for certain robotic application. To charge SLA batteries, you can use any general DC power supply as long as it provides the correct voltage to your battery.

Fig 4.7. BATTERY

4.7.1. Features:

- Rechargeable
- Recyclable
- No Memory Effect
- Able to use for most of the 12V controllers, motors or any other appliances

4.7.2. Specification:

- Voltage: 12V
- Capacity: 1.3Ah
- Size: 98mm x 43mm x 52 mm
- Weight: 0.450kg

4.8. DC GEAR MOTOR GENERAL DESCRIPTION:-

The relationship between torque vs speed and current is linear as shown left; as the load on a motor increases, Speed will decrease. The graph pictured here represents the characteristics of a typical motor. As long as the motor is used in the area of high efficiency (as represented by the shaded area) long life and good performance can be expected.

However, using the motor outside this range will result in high temperature rises and deterioration of motor parts. A motor's basic rating point is slightly lower than its maximum efficiency point. Load torque can be determined by measuring the current drawn when the motor is attached to a machine whose actual load value is known.

4.8.1. PRODUCT DESCRIPTION:

Geared dc motors can be defined as a n extension of dc motors A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaftper minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed.

Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. A DC motor can be used at a voltage lower than the rated voltage. But, below 1000 rpm, the speed becomes unstable, and the motor will not run smoothly.

Fig 4.8. DC GEAR MOTOR

4.8.2. FEATURES:

- Supply voltage: 12VDC
- Speed: 100rpm
- Long Lifetime, Low Noise, Smooth Motion

4.8.3. APPLICATIONS:

- Coin Changing equipment
- Peristaltic Pumps
- Damper Actuators
- Fan Oscillators
- Photo copier

4.9. MOTOR DRIVE:-

Motor controllers, also known as motor drivers or motor drives, regulate the speed, torque, and direction of the motors based on input commands. These controllers receive signals fromthe vehicle's control system, usually a microcontroller or a microprocessor, and convert theminto appropriate electrical signals to drive the motors.

The motor drive system consists of motors, motor controllers, and associated electronics responsible for controlling the movement of the robot. These components remain unchanged, but their control interface is modified to accept commands received wirelessly via Bluetooth.

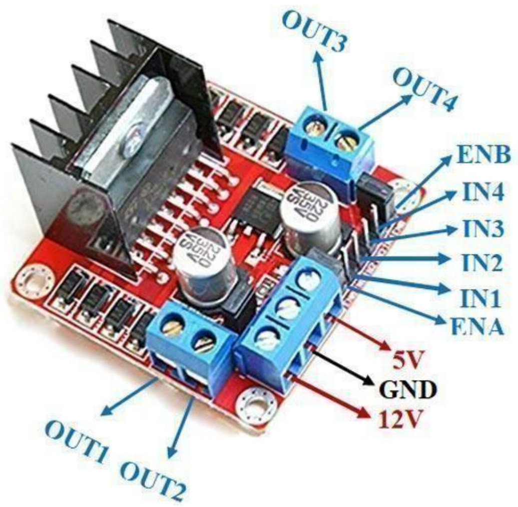

Fig 4.9. MOTOR DRIVE

The digital signal determines the direction of rotation of the motor. By configuring the input control pins (IN1, IN2, IN3, IN4) appropriately, the switches in the H-bridges are set to control the direction of current flow through the motor. For example, setting IN1 and IN2 HIGH and IN3 and IN4 LOW would cause the motor to rotate in one direction, while reversing the input signals would cause the motor to rotate in the opposite direction.

The PWM signal is applied to the enable pins (EN) of the H-bridges. By varying the duty cycle of the PWM signal, the effective voltage applied to the motor terminals is modulated,controlling the motor speed. A higher duty cycle results in a higher average voltage and thus higher motor speed.

CHAPTER-5

SOFTWARE IMPLEMENTATION

5.1 SOFTWARE REQUIREMENTS

- ARDUINO IDE
- EMBEDDED C

5.2 EMBEDDED SYSTEM SOFTWARE

A typical industrial microcontroller is quite unsophisticated compared to a typical enterprise desktop computer and generally depends on a simpler, less-memory-intensive program environment. The simplest devices run on bare metal and are programmed directly using the chip CPU's machine code language. Often, however, embedded systems use operating systems or language platforms tailored to embedded use, particularly where real-time operating environments must be served. At higher levels of chip capability, such as those found in SoCs, designers have increasingly decided that the systems are generally fast enough and tasks tolerant of slight variations in reaction time that "near-real-time" approaches are suitable. In these instances, stripped-down versions of the Linux operating system are commonly deployed, though there are also other operating systems that have been pared down to run on embedded systems, including Embedded Java and Windows IoT (formerly Windows Embedded). Generally, storage of programs and operating systems on embedded devices make use either of flash or rewritable flash memory.

5.2.1 Arduino – Program Structure:

```
Void setup ( )
{
}
```

PURPOSE: The **setup()** function is called when a sketch starts. Use it to initialize the variables, pin modes, start using libraries, etc. The setup function will only runonce, after each power up or reset of the Arduino board.

- **INPUT**: -
- **OUTPUT**: -
- **RETURN**: -

Void Loop ( )

{

}

PURPOSE: After creating a **setup()** function, which initializes and sets the initialvalues, the **loop()** function does precisely what its name suggests, and loopsconsecutively, allowing your program to change and respond. Use it to activelycontrol the Arduino board.

- **INPUT**: -
- **OUTPUT**: -
- **RETURN**: -

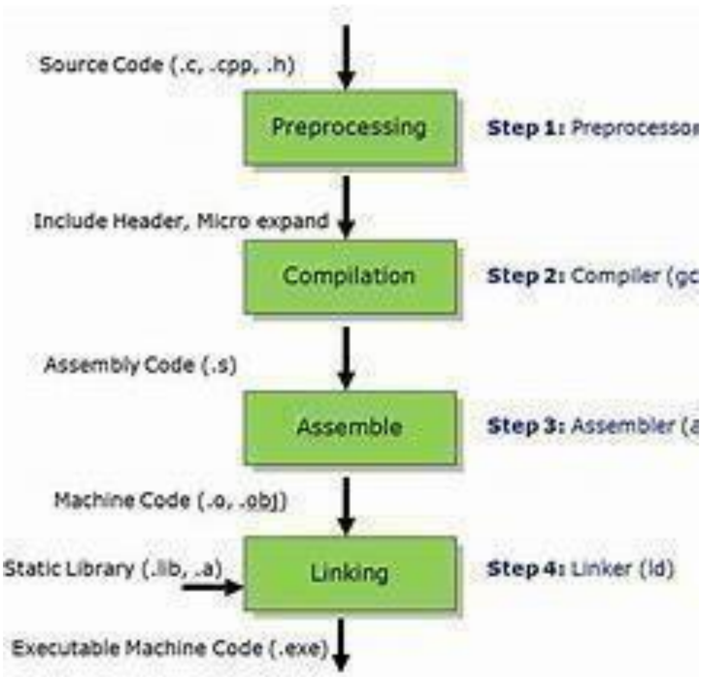

Fig 5.2.1 Flow of Code in Embedded C

5.3 ARDUINO IDE

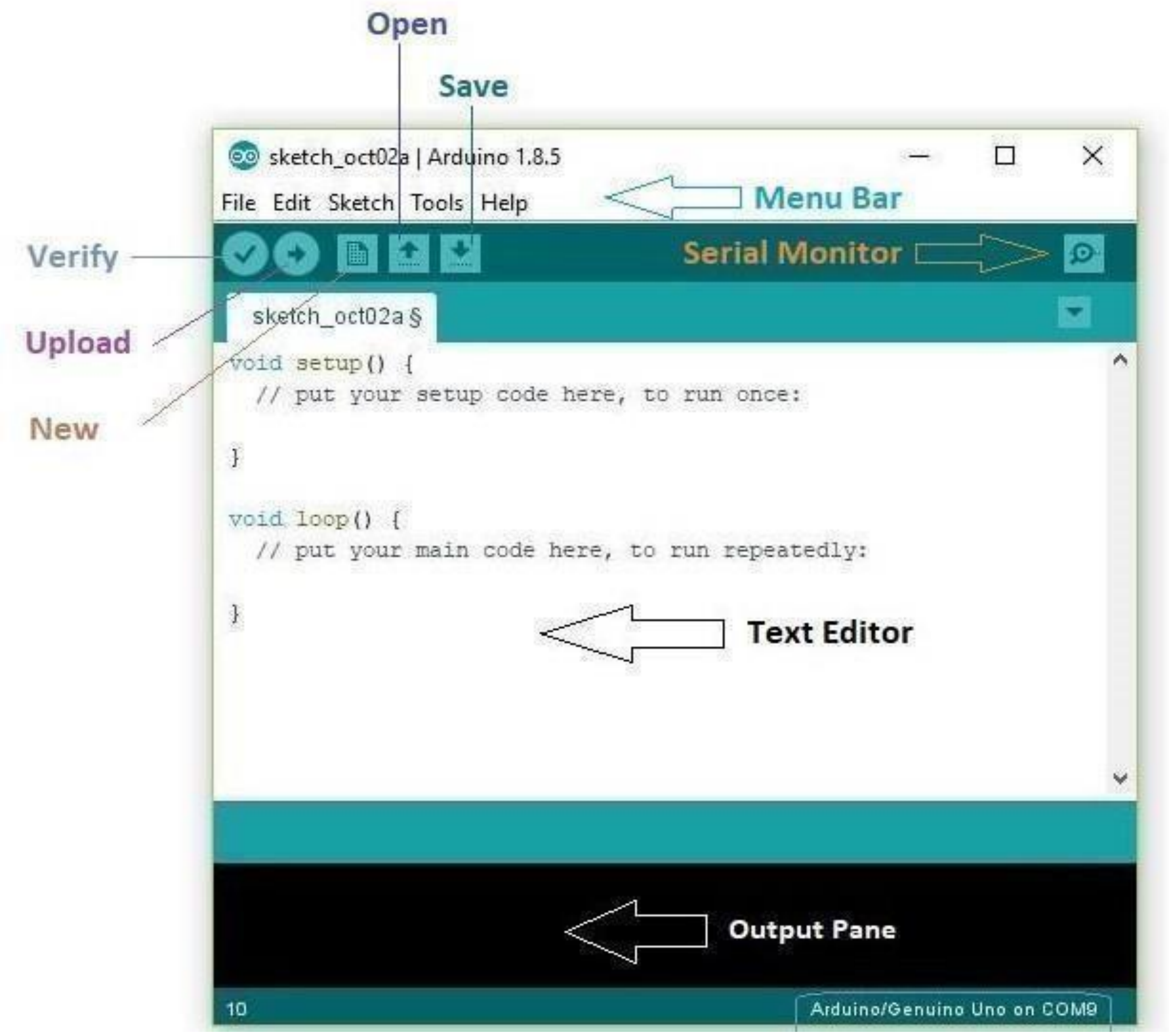

Fig 5.3 Arduino IDE

IDE – Integrated Development Environment

The **Arduino Integrated Development Environment (IDE)**, also known as **Arduino Software (IDE)**, is an open-source tool used for programming and interacting with **Arduino boards**. It provides a text editor where you write your code (referred to as "sketches"), which are saved with the .ino extension. The IDE handles code compilation, uploading, and debugging, making it easier to create digital and interactive devices by combining Arduino boards with other components. In essence, it's a crucial software for anyone working with Arduino.

1. **Cross-Platform Compatibility**: The Arduino IDE is available for **Windows, macOS, and Linux**, making it accessible to a wide range of users regardless of their operating system.
2. **Library Management**: The IDE allows you to easily manage **libraries** (pre-written code modules) that extend the functionality of your Arduino projects. You can install, update, and include libraries directly from the IDE.
3. **Serial Monitor**: When working with Arduino boards, communication often happens through the **serial port**. The IDE provides a **Serial Monitor** tool that allows you to send and receive data between your computer and the Arduino board. It's useful for debugging and monitoring sensor readings.
4. **Board Manager**: You can select the specific **Arduino board model** you're using from the **Board Manager** within the IDE. This ensures that the compiler generates code compatible with your chosen board.
5. **Syntax Highlighting and Autocompletion**: The IDE offers **syntax highlighting** to make your code more readable. It also provides **autocompletion** suggestions as you type, which speeds up development.
6. **Compile and Upload**: With a single click, you can **compile** your code and upload it to the connected Arduino board. The IDE handles the compilation process, converting your human-readable code into machine-executable instructions.
7. **Community Support**: The Arduino community is vast, and the IDE benefits from this collective knowledge. You'll find plenty of **tutorials, forums, and examples** online to help you learn and troubleshoot.

CHAPTER-6

RESULT AND DISCUSSION

6.1. Arduino Bluetooth Contoller Application

An Arduino Bluetooth controller app is a mobile application designed to interact with an Arduino microcontroller board via Bluetooth communication. Typically, the app allows users to send commands, data, or instructions from their mobile device to the Arduino board wirelessly using Bluetooth technology. These commands can be used to control various electronic devices or systems connected to the Arduino, such as motors, lights, sensors, or actuators.

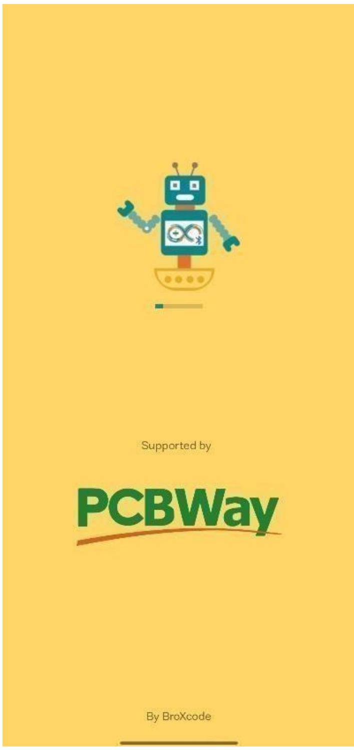

Fig 6.1.User Interface

The app usually features a user-friendly interface where users can input commandsor select predefined actions to be executed by the Arduino. It may also provide options for configuring Bluetooth connections, selecting paired devices, and adjusting communication settings. Additionally, some Arduino Bluetooth controller apps offer advanced features such as data logging, real-time monitoring, and remote control capabilities, enabling users to interact with their Arduino projects from a distance.

Overall, an Arduino Bluetooth controller app serves as a convenient and versatile tool for controlling and communicating with Arduino-based projects wirelessly, making it easier for hobbyists, makers, and developers to create interactive and remotely controllable systems.

6.2. Vehicle Controller

Hardware Setup: First, you need to set up the hardware components for your vehicle and connect them to an Arduino board. This typically includes motors for propulsion (e.g., DC motors or servo motors), motor drivers to control the motors, and any additional sensors or modules required for navigation or feedback (e.g., ultrasonic sensors for obstacle avoidance).

Arduino Programming: Write a program (sketch) for the Arduino board that defines how it should interpret incoming commands from the Bluetooth module and translate them into specific actions for controlling the vehicle. This program will typically involve reading data from the Bluetooth module, parsing the received commands, and executing corresponding motor control commands based on the input.

Bluetooth Module Configuration: Set up and configure a Bluetooth module (such as HC-05 or HC-06) to establish a wireless communication link between the Arduino board and the mobile device running the Arduino Bluetooth controller app. Pair the Bluetooth module with the mobile device and ensure that it is properly connected to the Arduino.

App Interface Design: Develop or use an existing Arduino Bluetooth controller app with a user-friendly interface that allows users to input commands for controlling the vehicle's movement. The app interface may include buttons, sliders, or other input elements for specifying the direction, speed, and other parameters of the vehicle's movement.

Wireless Communication: Use the Arduino Bluetooth controller app to establish a connection with the Arduino board via Bluetooth. Once connected, the app can send commands to the Arduino, which will interpret these commands and execute corresponding actions to control the vehicle's movement.

Vehicle Control: Users can use the app to send commands for controlling the vehicle's movement, such as forward, backward, left turn, right turn, stop, or speed adjustments. The Arduino board receives these commands, processes them according to the programmed logic, and activates the motors or other actuators accordingly to move the vehicle as desired.

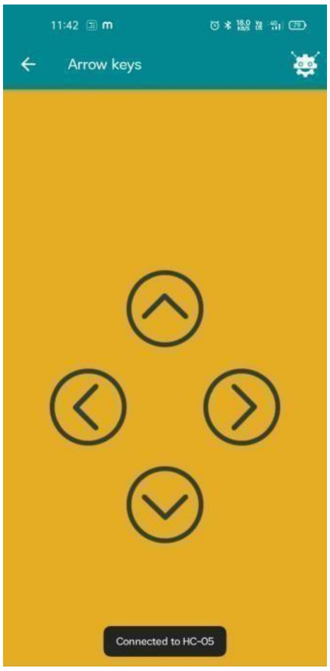

Fig 6.2.Direction Controller

6.3. OUTPUT

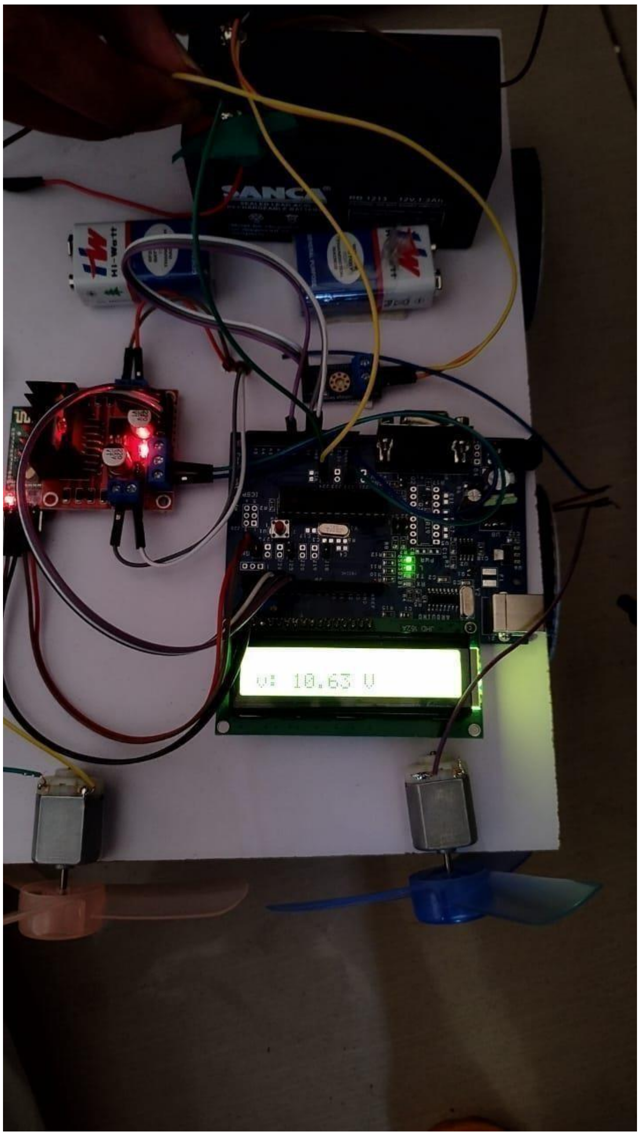

Fig 6.2.Output

CHAPTER 7
CONCLUSION

7.1. Conclusion

The development of a solar and wind-powered hybrid energy vehicle represents a significant step forward in addressing the dual challenges of energy sustainability and environmental preservation. By integrating renewable energy sources such as solar photovoltaic systems and wind turbines into the vehicle charging infrastructure, this hybrid model offers a promising solution to mitigate the detrimental effects of fossil fuel consumption and vehicle emissions.

The hybrid system's ability to harness solar energy during the day and wind energy at night optimizes energy generation and ensures continuous availability of clean power for charging electric vehicle batteries. This not only reduces reliance on finite fossil fuels but also minimizes greenhouse gas emissions, contributing to the global efforts to combat climate change and air pollution.

7.2. Future Scope

Efficiency Optimization: Continued research and development efforts should focus on optimizing the efficiency of the hybrid energy system. This includes improving the energy conversion efficiency of solar panels and wind turbines, as well as enhancing the charging and discharging efficiency of the battery storage system.

Energy Management Strategies: Developing advanced energy management strategies is essential for maximizing the utilization of available energy sources and optimizing system performance. Intelligent algorithms can be implemented to dynamically control the charging process based on real-time energy availability, load demand, and battery state of charge.

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APPENDICES

CODING

```
#include <LiquidCrystal.h> // includes the LiquidCrystal Library

LiquidCrystal lcd(13, 12, 11, 10, 9, 8);

#define LM1 2       // left motor
#define LM2 3       // left motor
#define RM1 4       // right motor
#define RM2 5
char command;
float volt;
  char x,msg[8];
  int i;
void setup() {
  // put your setup code here, to run once:
Serial.begin(9600);
  pinMode(LM1, OUTPUT);
  pinMode(LM2, OUTPUT);
  pinMode(RM1, OUTPUT);
  pinMode(RM2, OUTPUT);

 // Serial.println("Measuring voltage and current with INA219 ...");
  lcd.begin(16, 2);     // USING 16X2 LCD
  lcd.setCursor(0,0); //SET THT CURSOR ON COLM 0 & ROW 0
  lcd.print(" SOLAR & WIND "); //LCD DISPLAY
  lcd.setCursor(0,1); //SET THT CURSOR ON COLM 0 & ROW 0
  lcd.print(" CHARGING "); //LCD DISPLAY 1.
```

```
  delay(1000);
    UCSR0B = (1<<RXEN0)|(1<<TXEN0);
/* Set frame format: 8data, 2stop bit */
UCSR0C = (1<<USBS0)|(3<<UCSZ00);
}

void loop() {

   volt = analogRead(A0);

  volt = volt/204.6;
  volt = volt*5;
// lcd.setCursor(10,1);
//  lcd.print("V: ");
//  lcd.print(volt);
// lcd.print(" V");

 // lcd.clear();
  lcd.setCursor(0,1);
  lcd.print("v: ");
  lcd.print( volt);
  lcd.print(" V");    Serial.println("v");
  Serial.println(volt);
   delay(1500);
    delay(2000);
    if(volt<2)
    {
      Serial.print("sensornewgsm.php?client=iot2k24077&s1=");
```

```
Serial.print("LOW_VOLTAGE");
Serial.print("&s2=NA&s3=NA&s4=NA&s5=NA&sms=YES&msg=LOW_VOL
TAGE#");
  delay(1000);
    }

 do
  {
    x=USART_Receive();
  }while(x!='#');
  i=0;

  do
  {
    x=USART_Receive();
    msg[i]=x;Serial.println(x);
   // lcd.print(x);
    i++;
  }while(x!='~');
delay(100);
if(msg[0]=='a')
  {
    digitalWrite(LM1, HIGH);
    digitalWrite(LM2,  LOW);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, LOW);
  }
 if(msg[1]=='c')
  {
```

```
 digitalWrite(LM1, LOW);
    digitalWrite(LM2, HIGH);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, HIGH);
  }
if(msg[2]=='e')
  {
   digitalWrite(LM1, HIGH);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, LOW);
  }
 if(msg[3]=='g')
  {
   digitalWrite(LM1,  LOW);
    digitalWrite(LM2,LOW);
    digitalWrite(RM1, HIGH);
    digitalWrite(RM2, LOW);
  }
 if(msg[4]=='i')
  {
    digitalWrite(LM1, LOW);
    digitalWrite(LM2, LOW);
    digitalWrite(RM1, LOW);
    digitalWrite(RM2, LOW);
  }


 Serial.print("sensornewgsm.php?client=iot2k24077&s1=");
```

```
Serial.print(volt);

Serial.print("&s2=NA&s3=NA&s4=NA&s5=NA&sms=NO&msg=NA#");
delay(1000);
}
void USART_Transmit( unsigned char data )        // function for usart transmiter
{
/* Wait for empty transmit buffer */
while ( !( UCSR0A & (1<<UDRE0)) );
/* Put data into buffer, sends the data */
UDR0 = data;
}

unsigned char USART_Receive( void )
{
/* Wait for data to be received */
while ( !(UCSR0A & (1<<RXC0)) );
/* Get and return received data from buffer */
return UDR0;
}
```