

Design and implementation of a Solar Power Seed Sprayer.

This paper has been submitted to the of Department of Mechanical Engineering of **Sonargaon University, Dhaka** in partial fulfilment of the requirement for the Degree of Bachelor of Science in Department of Mechanical Engineering.

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[September, 2023]

Letter of Transmittal

20th ,September 2023
The Supervisor,
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Subject: **Submission of project report.**

Dear Sir,

Please find enclosed the project report entitled “**Design and implementation of a Solar Power Seed Sprayer**”. The study has been carried out in partial fulfillment of the requirement for the degree of Bachelor of Science in Mechanical Engineering.

In carrying out the study. We followed supervisor’s Advice and collected information from several text books, reference books, web sites and other sources. I think you will find it useful and informative. I would be glad to furnish you further explanations or clarifications if required.

Sincerely Yours,

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DECLARATION

We do hereby declare that the thesis titled “**Design and implementation of a Solar Power Seed Sprayer**” is submitted to the Department of Mechanical Engineering of **Sonargaon University** in partial fulfilment of the completion of Bachelors of Science in Mechanical Engineering. We also declare that this is our original work and was not submitted to any other places for the award of any other degree or any other publication.

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Executive Summary

This project presents the model of a solar power seed sprayer machine. It is an improved model of trainer board with some enhanced features. The overall objective of the project is to design and fabricate an efficient solar powered electric vehicle. The objective of the project thus far was to produce a detailed first iteration design with planning materials. The vehicle is to adhere to the engineering guidelines stated for the Shell Eco-Marathon Urban Division competition. This competition is based on the overall efficiency of the vehicle over a six-mile course. This type of vehicle would be suited to replace traditional combustion engines for everyday transport activities. The use of solar energy to power the vehicle allows for more applicability, and a means of using green energy. The normalization of a vehicle of this type would dramatically reduce the amount of carbon dioxide produced by vehicles and reduce the demand for oil. To accomplish this goal. Computer aided design software and supporting software were used to plan, model, simulate, and analyse the various subsystems of the vehicle. The two engineering categories the vehicle subsystems fall into are mechanical or electrical.

ABSTRACT

Today's era is marching towards the rapid growth of all sectors including the agricultural sector. To meet the future food demands, the farmers have to implement the new techniques which will not affect the soil texture but will increase the overall crop production. In this project, an attempt has been made for the "Design and Implementation of solar power seed sprayer". In this technique seeds in a hopper get sprayed by means of fan or blower directly to land without human effort. By this process the seed is fed to land at the time of plough. The main benefit of using this method is to reduce the time of seed to the land and reduced human effort. Usually the manpower is needed for sowing a seeds by using this machine there is no need for human power. This system does not require any additional power source to run the fan, because here solar panel is employed as a power source.

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CHAPTER 1

Introduction

1.1: Introduction

Agriculture has been the backbone of the Bangladeshi economy and it will continue to remain so for a long time. The government of India appointed a commission to assess the feasibility of increasing the crop productivity under prevailing Bangladesh ecological conditions. In order to develop the standard of living of small farmers we should make the machines with low cost. Then only small farmers can implement the recent modern machines for farming purposes. The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended row to row spacing, seed rate, seed to seed spacing and depth of seed placement vary from crop to crop and for different agricultural and climatic conditions to achieve optimum yields and an efficient sowing machine should attempt to fulfil these requirements. In addition, saving in cost of operation time, labor and energy are other advantages to be derived from use of improved machinery for such operations. A traditional method of seed sowing has many disadvantages. Our proposed “Solar seed sprayer machine” is used to sowing seed easily. In this project an attempt has been made to provide the low cost sowing machine and also it reduces the human effort.

I. Background Study

Our country faces the total loss of 33% of its economy from Weeds. The Losses are due to some of the following reasons, total loss of 26% from Crop Diseases, total loss of 20% from Insects and Worms, total loss of 6% from Rats. Has been surveyed. Shrinking farm lands, acute labour shortage, decreasing income per acre of cultivation, and economic frustration are some of the key factors hurting a farmer's confidence in continuing farming. Weeding control is done by: mechanical weeding, thermal weeding: flaming, biological control, chemical control, and by farming pattern. It has always been a problem to successfully and completely remove weeds and other innocuous plants. Invariably, weeds always grow where they are not wanted. This work involved the design and construction of mechanical weedier, after discovering that tools such as cutlass and hoes require high drudgery, time consuming and high labour force. As a solution to these problems, mechanical weedier was designed and constructed. The mechanical weedier was made of two implements attachment i.e. the primary cutting edge which is in front

to loose soil above and the secondary cutting edge which is behind to do cutting and lifting of weeds. The overall machine field efficiency was 98.67%. The Single Wheel Weeder being manufactured is the equipment, which is used for very special purpose when the weeding is required at narrow places or between rows. The blade is thin but very sturdy and tough besides, it is very safe to use and offers zero threat of hurting to the user, Other than the wheel, there is nothing mechanical in this single wheel weedier but, it works wonderfully under the condition where it is put into. This hassle free equipment requires no special maintenance. It is necessary to design the weedier which minimize the human effort and provide efficient work output. The solar car project was initially started in the fall of 2015. The goal of that year's team was the same as the current team's, with the Shell Eco-marathon guidelines remaining the same. A finite number of components were obtained or purchased, and connections were made with a fabrication shop nearby for welding of the frame. The list of parts obtained by the previous group is as follows:

- 9x 24' Length 1" Square Aluminium 6061 Tubing
- 1 (sealed) rack and pinion
- 2x tie rod ends
- 2x sleeves
- 2x angle adapter
- 1 steering wheel
- 1 solar panel
- 1 steering column with hardware
- 1 master cylinder
- 1 brake pedal assembly
- 4 wheels
- 1 (4') brake line

The previous team also devised a suspension response simulation, and various simulations of their designed frame. Since the frame was redesigned and a new suspension setup was augmented, these materials will no longer have any relevancy. Acquired materials will be implemented into the new design.

II. OBJECTIVES

The long-term objective of this project is to design, fabricate and assemble a fully functioning vehicle powered by solar energy, which in the future can be used to compete in the Shell Eco-Marathon. The race car competition is sponsored by Shell and takes place in Detroit, MI. The goal for this year's team is to develop a complete set of plans, design solar car's concept, and to purchase critical components within our budgetary constraints. This will consist of the following:

1. To investigation of various types of seed sowing and spraying machine
2. To development of solar powered seed sowing and seed spraying machine.
3. To testing of development of solar powered seed sowing and seed spraying machine in actual agricultural farm.
4. To extend the concept of Solar PV Technology on "Solar Sprayers" as "Energy Alternate Devices".

Frame

- Frame design, analysis, and fabrication

Powertrain

- Powertrain design
- Motor research, selection and purchase

Parametric analysis of required power

- Control research, design, and purchase

Battery research, selection, and purchase

- Management of battery life and safety
- Solar energy charging capability Steering and Suspension
- Design Steering system meeting Shell Eco-Marathon requirements
- Design Steering system mounts
- Design Suspension system
- Design Suspension system mounts

Finalization of design plans and purchase of components within the budget are to be completed by May 2017.

- To promote off-grid application of solar energy.(both SPV and Solar thermal) for meeting phase-1 target of the national solar mission.
- To create awareness and demonstrate of effective improve use of solar system for individual/ community/ institutional application.
- To encourage innovation in addressing market needs and promoting sustainable business models.
- To provide support in flexible demand driven mode to channel partners and potential beneficiaries, within the framework of boundary conditions.
- To create a paradigm shift needed for commoditization of off grid solar application.
- To support consultancy services, seminars, symposia, training, awareness campaigns, human resource development, etc.

III. METHODOLOGY

First we will design the Seed Sowing & Spray Pump system suitable to various agriculture application. We need to analyse Seed Sowing & Spray Pump system taking into consideration the applications and operational conditions. Then we will analyse the design in ANSYS for static and dynamic conditions .Theoretical: Theoretically we will compare basic and operational parameter of existing system with propose system. The most commonly adapted hybrid vehicle has sources of a solar power assisted with electric motor and an I.C. engine. In a HSV, the I.C. engine cooperates with an electric motor which has optimal usage of the engine. Especially driving in city traffic involves frequent starts and stops of the vehicle and during idling, the engine consumes more fuel without producing useful work thus it leads to higher fuel consumption, less efficiency and unnecessary emission from the exhaust. The HSV solves those problem and also no exhaust emission from the vehicle. The parallel power train runs on both, combustion engine and electric motor. The primary drive of the vehicle from solar powered and secondary drive by the combustion. These vehicles gain maximum efficiency in city during heavy traffic conditions without producing any emissions which supports to the green environment.

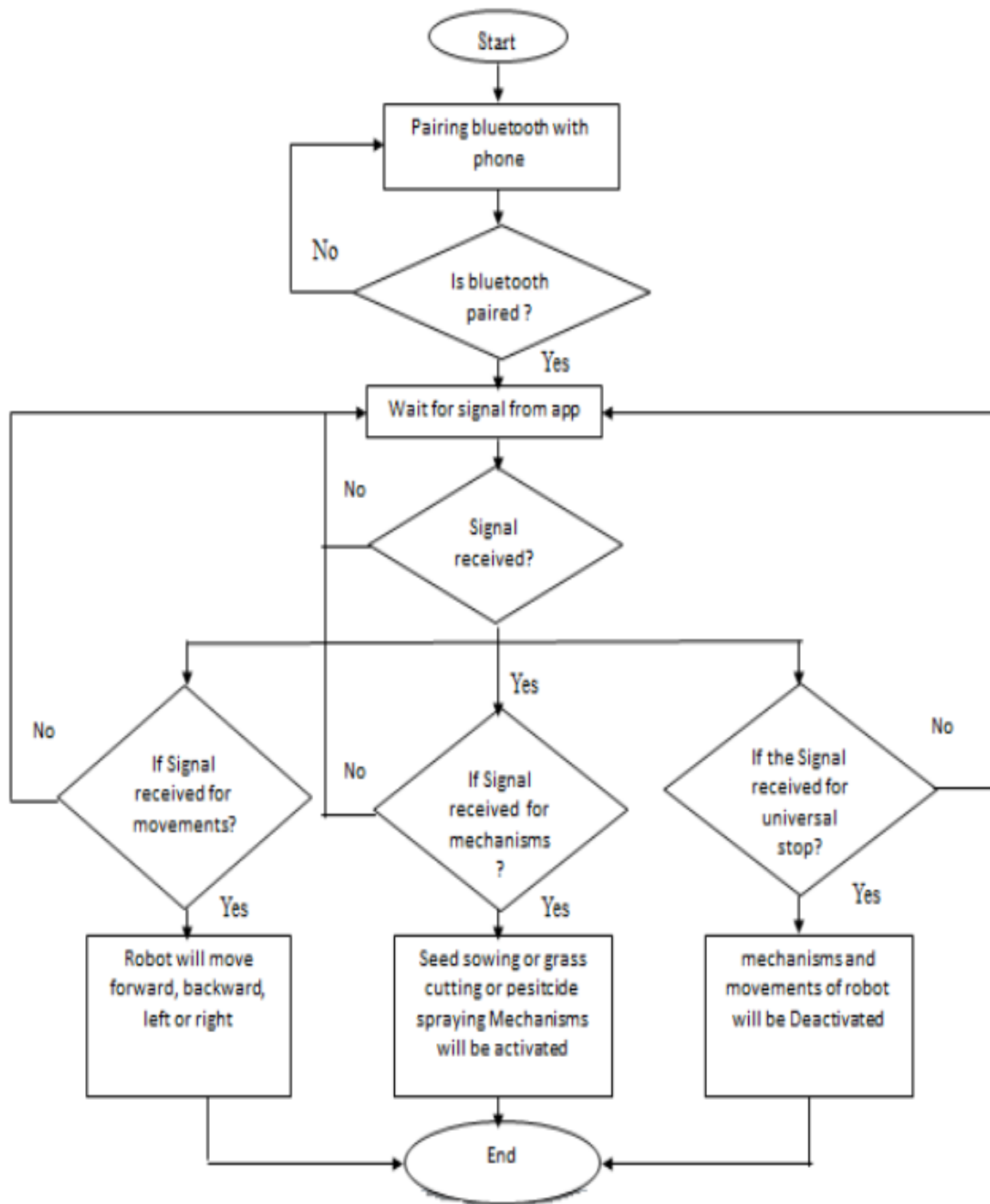


Fig-1: Methodology of the project.

CHAPTER 2

Benefits and Challenges

2.1: Benefits and Challenges

Basically, an Electric Vehicle (EV) is a vehicle that no longer relies solely on an Internal Combustion Engine (ICE) as the only propulsion mechanism, but rather uses an electric drive system as a replacement, or to enhance, the

ICE. Roughly speaking, three types of electrically propelled vehicles can be distinguished.

- A Hybrid Electric Vehicle (HEV) combines an ICE and an electric motor within the drive train. Mostly, the electric motor supports the ICE for fuel economy and/or performance. The vehicle is then either propelled by the combustion engine or the electric drive.
- A Plug-in Hybrid Electric Vehicle (Plug-in Hybrid Electric Vehicle (PHEV)) is a vehicle equipped, in general, with a larger battery compared to HEVs, that allows recharging of the battery via home outlets or at charging stations. While in most cases both the electric drive and the ICE are able to propel the vehicle, some vehicles use solely the electric drive.

In this latter case the ICE can be used to recharge the battery or directly produce electricity for the electric drive. Also, in most cases PHEVs can be used in a full electric mode if there is enough energy stored in the battery. This allows one to select when and where to release pollutants. This functionality shall be used in some applications discussed in the book.

- A Full Electric Vehicle (FEV) runs solely on an electric drive system. As with PHEVs their batteries are large and can be recharged in charging stations or at home. Since there are no pollutants released while driving, these vehicles are often marketed as zero-emission vehicles. Naturally, this is not exactly a correct terminology, since the recharging of the batteries will cause emissions depending on the actual emissions of the power generation in the country. Due to the fact that many power plants are located in less populated areas, the use of FEVs still has biennial effects on emissions in population centres. Such vehicles may be considered as filters for turning dirty into clean energy.

Of these three types, we shall distinguish PHEVs and FEVs from HEVs, and we shall denote the former as plug-in EVs, to emphasize that they continuously have to recharge their batteries.

In Figure 1.1 a graphical overview over the various EV types is given.

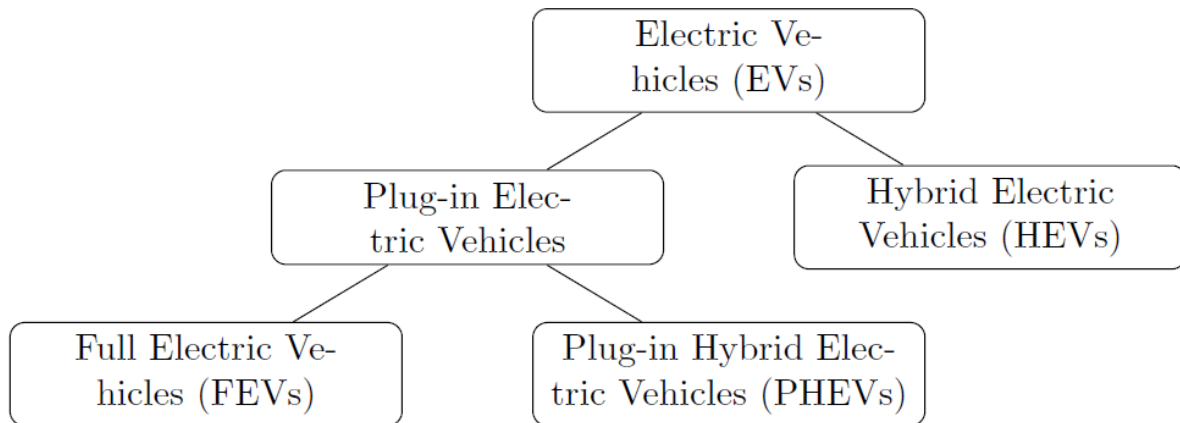


Fig-2: Classification of some different EV types

While the deployment of plug-in EVs can give rise to various environmental and health improvements, their adoption to date has been disappointing. According to initial reports [6], even in Europe, where the green agenda was well received, fewer than 12 000 EVs were sold in the first half of 2012 (of which only 1000 of these were sold in the UK). This number represented less than 0.15% of total new car sales in that year. These figures were in spite of the fact that many European governments had offered incentives for the purchase of EVs in the form of subsidies and had also invested in enabling infrastructure. There are however hints that the numbers may soon dramatically change. For instance, growing 59% year over year (YoY), approximately 12 000 electric cars were sold across the US in January 2017, accounting for approximately 1% of US auto sales¹. Similarly, the Chinese market had more than 32 000 new electric cars on the streets in March 2017, an 89% increase over the same month the previous year, with the annual growth rate at 31%².

Numbers in Europe remain contradictory, with Northern countries leading the market (e.g., in 2017 Norway has the highest per capita number of all-electric cars in the world: more than 100 000 in a country of 5.2 million people³). However, things seem to be speeding up, recently Volvo have announced that all new cars launched from 2019 onwards will be partially or completely battery powered.

The company called this step a "historic end" to building models that only have an internal combustion engine⁴. The day after the Volvo announcement,

Emmanuel Macron's government announced that France will end sales of petrol and diesel vehicles by 2040, as part of an ambitious plan to meet the targets of the Paris climate accord⁵. Only few days later, a similar plan was unveiled to ban the sale of new diesel and petrol cars by 2040 in the UK in a bid to encourage people to buy electric vehicles⁶. Despite such recent promising signals, still the percentage of traveling EV remains very low at a global scale. Some of the main factors hindering the widespread adoption of EVs from the point of view of customers are as follows:

1. Price: EVs have, to date, been expensive, even when subsidized. A major factor in the cost of such vehicles is the cost of the battery [13]. While battery costs are forecast to reduce dramatically over the next few years [27, 158], this is currently an important aspect in understanding the sales of EVs. In response to this, some companies, are proposing to lease batteries to the customer to offset some of the battery related costs.
2. Vehicle size: EVs are sometimes small with limited luggage space to reduce energy consumption, or to accommodate batteries (in some hybrid vehicles). This is sometimes a problem for potential purchasers of vehicles who, on occasion, would like to transport significant loads using their vehicles.
3. Long charging times: Charging times for plug-in EVs can be long [201]. An often cited fact by advocates of electric vehicles in response to this is that fast charging methods can service average vehicles in about 30 minutes [35, 28]. Such time-scales may be just about acceptable to a normal. Car owner. However, in the presence of queuing, 30 minutes can rapidly become several hours, and push such fast charging stations into the realm of "not acceptable". Thus, it is likely that overnight or workplace charging will be the principal method of vehicle charging for the foreseeable future. An associated issue in large cities concerns the availability of charging points. This is especially an issue in cities with large apartment block type dwellings.
4. Limited range: Maximum ranges of less than 300km in favourable conditions are not unusual for EVs, and this reduces significantly when air-conditioning or heating is switched on [49]. Hence, the range is not only limited but to a certain degree also unpredictable, which worsens the issue.

Additionally, other issues, that are a nuisance for normal ICE vehicles, are exacerbated as a result of the limited range. For example, the cost of searching for a parking space at the end of

a journey is much higher than for a conventional vehicle, because the EV's range is low and therefore energy should not be wasted searching for a parking spot. Research is ongoing to address these issues, with much of the current work focusing on new battery types, optimal vehicle charging, vehicle routing, and in vehicle energy management systems with a view to minimizing wastage of energy and thereby increasing vehicle range.

The latter two issues are often grouped together as one and discussed under the title of range anxiety [140, 180]. Further challenges that arise include the following.

1. Charging (from the perspective of generation distributors): The energy that will potentially be required to charge the large volumes of batteries of EVs will considerably increase the load on the distribution grid, and can cause power quality issues when not regulated.
2. Traffic management: While traffic management in general is an important factor, the issue becomes more pressing if EVs are present due to their limited energy availability. Hence, a traffic jam or rerouting due to road work or accidents, can have a strong impact on the energy required for the journey and in the worst case force the drivers to recharge before the end of the journey.
3. Charging Infrastructure: While momentarily most charging occurs at home during night-time, an important consideration is the availability and distribution of charging stations. This is related to the issue of limited range and long charging times, i.e. range anxiety. A major issue in this context is charge point anxiety - that is the angst associated with not being able to access a charge point when needed.
4. Electromagnetic emissions: Another issue regarding EVs concerns electromagnetic emissions. While there is no evidence that electromagnetic radiation from EVs is dangerous, this issue is a focus point for regulatory authorities (see e.g. the EU Green Car Programme) and has been raised by several research agencies [7].
5. Battery related issues: A further concern is whether enough lithium can be sourced to build batteries to construct enough vehicles to replace the existing passenger vehicle

et. Are we simply substituting one rare resource (oil) with another (lithium)? Also, the transportation of batteries is not trivial and necessitates special precautions [126, 9]. Finally, most reasonably sized batteries are not capable of realizing the range enjoyed by conventional ICE based vehicles, which comes in play in regard to the above mentioned issue of range anxiety. While this latter issue is the subject of much research, battery size and performance currently represent one of the major determinants in the design of EVs today.

CHAPTER 3

HARDWARE INSTRUMENT

3.1: HARDWARE INSTRUMENT

This chapter explains regarding the Hardware Implementation of the project. It tells about the design and working of the design with the help of circuit diagram and explanation of circuit diagram in detail. It explains the features, programming and serial communication of ATmega 32 microcontroller base Arduino module. It also explains the different modules used in this project.

ARDUINO UNO

3.1.1: Overview

Arduino Uno is a microcontroller board based on the ATmega328P ([datasheet](#)). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator (CSTCE16M0V53-R0), a USB connection, a power jack, an 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 a AC-to-DC adapter or battery to get started. You can tinker with your Uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform; for an extensive list of current, past or outdated boards see the Arduino index of boards.

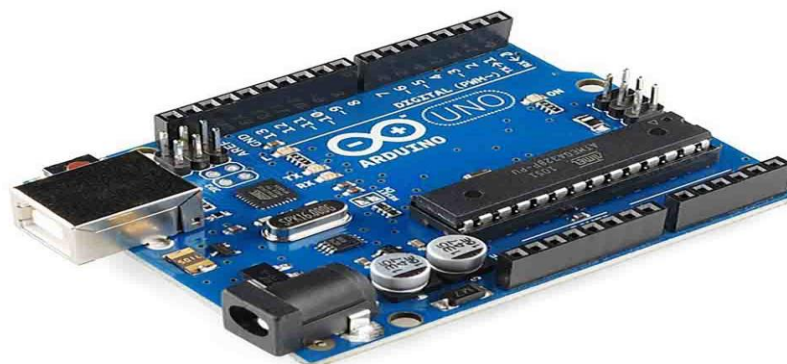


Fig-3: Arduino Uno R3

3.1.2 Tech 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
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Table-1: ARDUINO pin attribute

3.1.3 Pin Out of Arduino

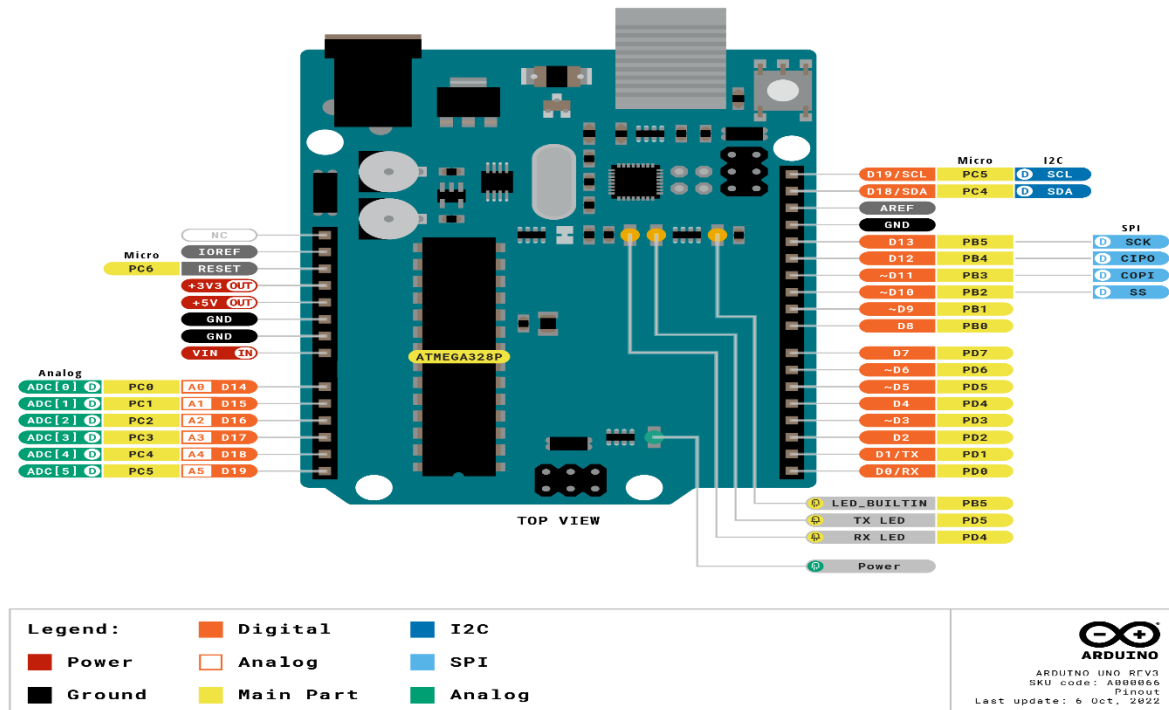


Fig-4: Pin out of Arduino

3.1.4 Programming

The Arduino Uno can be programmed with the (Arduino Software (IDE)). Select "Arduino Uno from the Tools > Board menu (according to the microcontroller on your board). For details, see the reference and tutorials.

The ATmega328 on the Arduino Uno comes preprogrammed with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

You can also bypass the boot loader and program the microcontroller through the ICSP (In-Circuit Serial Programming) header using Arduino ISP or similar; see these instructions for details.

The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available in the Arduino repository. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

- On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2.

- On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.

You can then use Atmel's FLIP software (Windows) or the DFU programmer (Mac OS X and Linux) to load a new firmware. Or you can use the ISP header with an external programmer (overwriting the DFU boot loader). See this user-contributed tutorial for more information.

3.1.5 Power of Arduino

The Arduino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.

The board can operate on an external supply from 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may become unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

The power pins are as follows:

- Vin. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. This pin outputs a regulated 5V from the regulator on the board. The board can be supplied with power either from the DC power jack (7 - 12V), the USB connector (5V), or the VIN pin of the board (7-12V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage your board. We don't advise it.
- 3V3. A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND. Ground pins.
- IOREF. This pin on the Arduino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.

3.1.6 Memory

The ATmega328 has 32 KB (with 0.5 KB occupied by the boot loader). It also has 2 KB of SRAM and 1 KB of EEPROM (which can be read and written with the EEPROM library).

3.1.7 Input and Output

See the mapping between Arduino pins and ATmega328P ports. The mapping for the Atmega8, 168, and 328 is identical.

Each of the 14 digital pins on the Uno can be used as an input or output, using `pinMode ()`, `digitalWrite ()`, and `digitalRead ()` functions. They operate at 5 volts. Each pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

In addition, some pins have specialized functions:

- **Serial:** 0 (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.
- **External Interrupts:** 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value. See the `attachInterrupt()` function for details.
- **PWM:** 3, 5, 6, 9, 10, and 11. Provide 8-bit PWM output with the `analogWrite()` function.
- **SPI:** 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication using the SPI library.
- **LED:** 13. There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- **TWI:** A4 or SDA pin and A5 or SCL pin. Support TWI communication using the Wire library.

The Uno has 6 analog inputs, labelled A0 through A5, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and the `analogReference ()` function. There are a couple of other pins on the board:

- AREF. Reference voltage for the analog inputs. Used with `analogReference()`.
- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

3.1.8 Communication

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino board, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The 16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A Software Serial library allows serial communication on any of the Uno's digital pins.

The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino Software (IDE) includes a Wire library to simplify use of the I2C bus; see the documentation for details. For SPI communication, use the SPI library.

Automatic (Software) Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino Uno board is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 Nano farad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino Software (IDE) uses this capability to allow you to upload code by simply pressing the upload button in the interface toolbar. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Uno is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB).

For the following half-second or so, the boot loader is running on the Uno. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Uno board contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labelled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

3.1.9 Revisions

Revision 3 of the board has the following new features:

- 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible with both the board that uses the AVR, which operates with 5V and with the Arduino Due that operates with 3.3V. The second one is a not connected pin that is reserved for future purposes.
- Stronger RESET circuit.
- Atmega 16U2 replace the 8U2.

3.2: Bluetooth Module (HC 05)

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. Hope it will simplify your overall design/development cycle.

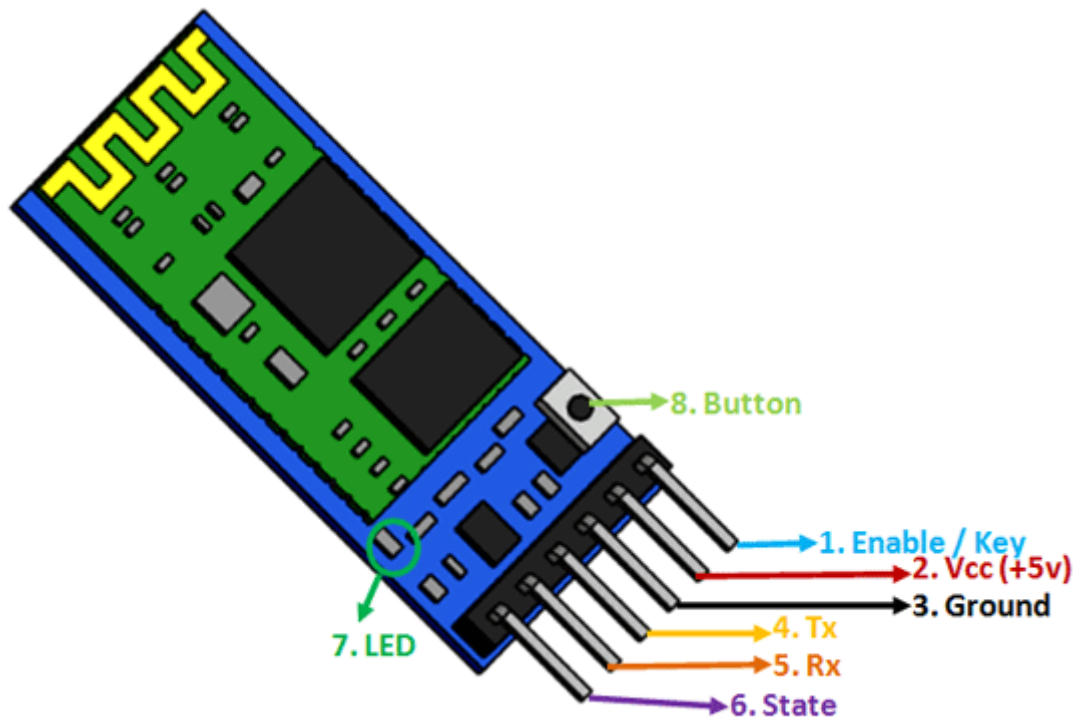


Fig-5: Bluetooth module HC 05

3.2.1: HC-05 Pinout Configuration

Pin Number	Pin Name	Description
1	Enable / Key	This pin is used to toggle between Data Mode (set low) and AT command mode (set high). By default it is in Data mode
2	Vcc	Powers the module. Connect to +5V Supply voltage
3	Ground	Ground pin of module, connect to system ground.
4	TX Transmitter	Transmits Serial Data. Everything received via Bluetooth will be given out by this pin as serial data.

5	RX Receiver	–	Receive Serial Data. Every serial data given to this pin will be broadcasted via Bluetooth
6	State		The state pin is connected to on board LED, it can be used as a feedback to check if Bluetooth is working properly.
7	LED		Indicates the status of Module <ul style="list-style-type: none"> • Blink once in 2 sec: Module has entered Command Mode • Repeated Blinking: Waiting for connection in Data Mode • Blink twice in 1 sec: Connection successful in Data Mode
8	Button		Used to control the Key/Enable pin to toggle between Data and command Mode

Table-2: Pin out of HC 05 Module.

3.2.2: HC-05 Technical Specifications

- Serial Bluetooth module for [Arduino](#) and other microcontrollers
- Operating Voltage: 4V to 6V (Typically +5V)
- Operating Current: 30mA
- Range: <100m
- Works with Serial communication (USART) and TTL compatible
- Follows IEEE 802.15.1 standardized protocol
- Uses Frequency-Hopping Spread spectrum (FHSS)
- Can operate in Master, Slave or Master/Slave mode
- Can be easily interfaced with Laptop or Mobile phones with Bluetooth
- Supported baud rate: 9600,19200,38400,57600,115200,230400,460800.

3.3: L298N Motor Driver Chip

At the center of the module is a big, black chip with a chunky heat sink – the L298N.

The L298N chip contains two standard H-bridges capable of driving a pair of DC motors, making it ideal for building a two-wheeled robotic platform.

The L298N motor driver has a supply range of 5V to 35V and is capable of 2A continuous current per channel, so it works very well with most of our DC motors.

3.3.1: Technical Specifications

Motor output voltage	5V – 35V
Motor output voltage (Recommended)	7V – 12V
Logic input voltage	5V – 7V
Continuous current per channel	2A
Max Power Dissipation	25W

Table-3: Technical Specification of L298N.

3.3.2: L298N Motor Driver Module Pinout

The L298N module has 11 pins that allow it to communicate with the outside world. The pinout is as follows:

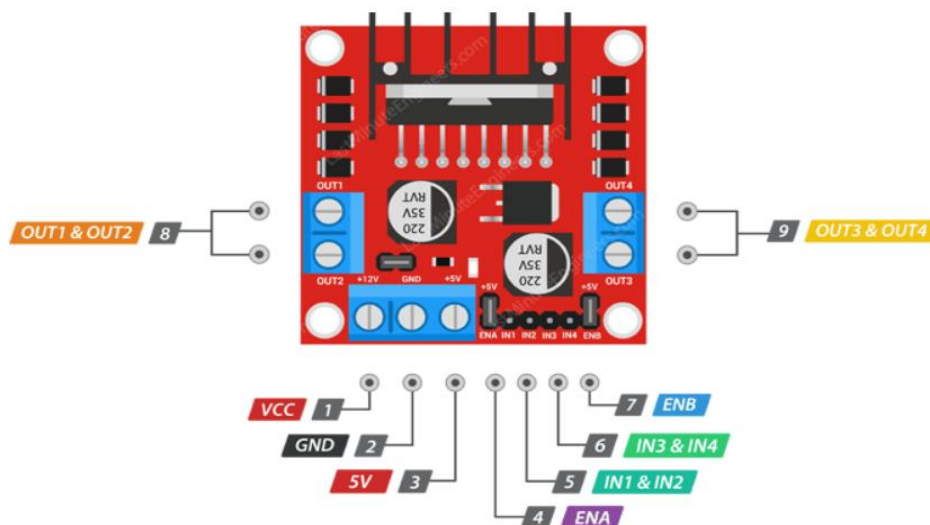


Fig-6: L298n Motor driver pin_out

3.3.3: Motor Driver Module to an Arduino

Now that we know everything about the module, we can start hooking it up to our Arduino! Let's begin by connecting the motor power supply. In our experiment, we are using DC gearbox motors, also called "TT" motors, which are often found in two-wheel-drive robots. They are rated for 3 to 12V. We will therefore connect an external 12V power source to the VS terminal. Because L298N has a voltage drop of about 2V, the motors will receive 10V and spin at a slightly lower RPM. But that's okay.

Next, we need to supply 5V to the logic circuitry of the L298N. We'll use the on-board 5V regulator to draw 5V from the motor power supply, so keep the 5V-EN jumper in place.

Now connect the L298N module's Input and Enable pins (ENA, IN1, IN2, IN3, IN4 and ENB) to the six Arduino digital output pins (9, 8, 7, 5, 4 and 3). Note that both Arduino output pins 9 and 3 are PWM-enabled.

Finally, wire one motor to terminal A (OUT1 and OUT2) and the other to terminal B (OUT3 and OUT4). You can swap out your motor's connections. There is technically no right or wrong way

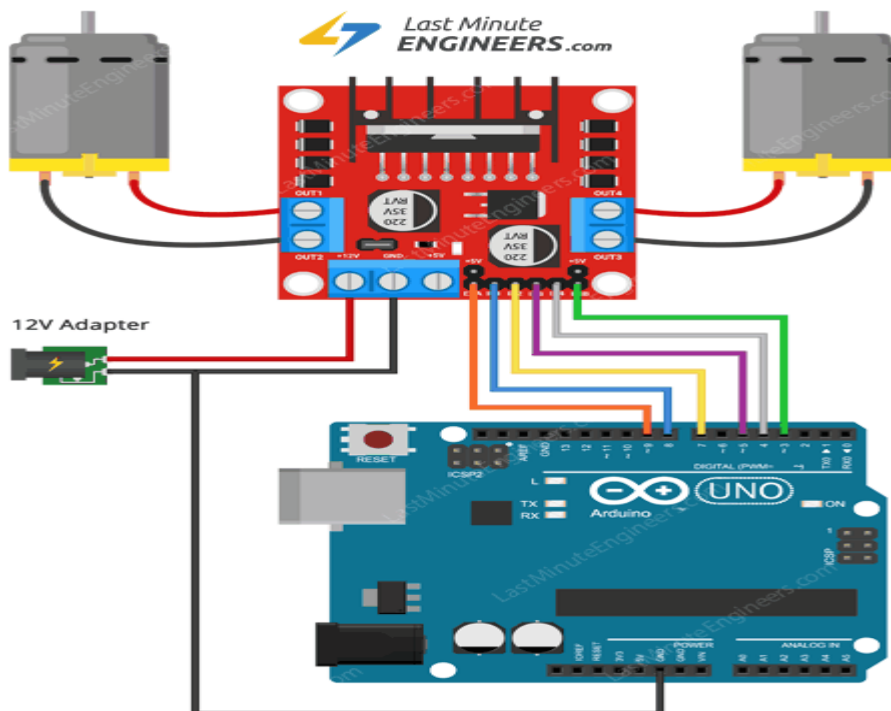


Fig-7: L298n interface with Arduino.

3.3.4: Arduino Example Code

The sketch below will show you how to control the speed and spinning direction of a DC motor using the L298N Motor Driver and can serve as the basis for more practical experiments and projects.

```
int enA = 9;
int in1 = 8;
int in2 = 7;
// Motor B connections
int enB = 3;
int in3 = 5;
int in4 = 4;

void setup() {
    // Set all the motor control pins to outputs
    pinMode(enA, OUTPUT);
    pinMode(enB, OUTPUT);
    pinMode(in1, OUTPUT);
    pinMode(in2, OUTPUT);
    pinMode(in3, OUTPUT);
    pinMode(in4, OUTPUT);

    // Turn off motors - Initial state
    digitalWrite(in1, LOW);
    digitalWrite(in2, LOW);
    digitalWrite(in3, LOW);
    digitalWrite(in4, LOW);
}

void loop() {
    directionControl();
    delay(1000);
    speedControl();
    delay(1000);
}

// This function lets you control spinning direction of motors
void directionControl() {
    // Set motors to maximum speed
    // For PWM maximum possible values are 0 to 255
```

```

analogWrite(enA, 255);
analogWrite(enB, 255);

// Turn on motor A & B
digitalWrite(in1, HIGH);
digitalWrite(in2, LOW);
digitalWrite(in3, HIGH);
digitalWrite(in4, LOW);
delay(2000);

// Now change motor directions
digitalWrite(in1, LOW);
digitalWrite(in2, HIGH);
digitalWrite(in3, LOW);
digitalWrite(in4, HIGH);
delay(2000);

// Turn off motors
digitalWrite(in1, LOW);
digitalWrite(in2, LOW);
digitalWrite(in3, LOW);
digitalWrite(in4, LOW);
}

// This function lets you control speed of the motors
void speedControl() {
    // Turn on motors
    digitalWrite(in1, LOW);
    digitalWrite(in2, HIGH);
    digitalWrite(in3, LOW);
    digitalWrite(in4, HIGH);

    // Accelerate from zero to maximum speed
    for (int i = 0; i < 256; i++) {
        analogWrite(enA, i);
        analogWrite(enB, i);
        delay(20);
    }

    // Decelerate from maximum speed to zero

```

```
for (int i = 255; i >= 0; --i) {  
    analogWrite(enA, i);  
    analogWrite(enB, i);  
    delay(20);  
}  
  
// Now turn off motors  
digitalWrite(in1, LOW);  
digitalWrite(in2, LOW);  
digitalWrite(in3, LOW);  
digitalWrite(in4, LOW);  
}
```

3.4.: Gear Motor

A gear motor is an all-in-one combination of a motor and gearbox. The addition of a gear head to a motor reduces the speed while increasing the torque output. The most important parameters in regards to gear motors are speed (rpm), torque (lb-in) and efficiency (%). In order to select the most suitable gear motor for your application you must first compute the load, speed and torque requirements for your application. ISL Products offers a variety of Spur Gear Motors, Planetary Gear Motors and Worm Gear Motors to meet all application requirements. Most of our DC motors can be complemented with one of our unique gearheads, providing you with a highly efficient gear motor solution.



Fig-8: Dc gear motor with wheel.

CHAPTER 4

Charging Method

4.1: Power System Management

The most important thing in an electric vehicle is its battery power. If it stays on, the rest will work normally. Otherwise, you are facing various problems. The most important aspect of this project is the power management system. Because here we have used a battery pack which will provide 12 volts. Normally a lithium ion battery is 3.7 volts. But if sufficiently charged it can be up to 4.1 volts. So the battery pack we have made consists of 3 batteries.

Because 12 volt charge is enough for the solar powered electric car we are going to make. It is going to be a demo car that can be charged by solar and direct electricity simultaneously.

Because of which we need to keep a close eye on battery management. So that we don't have to face any kind of problem while running on the road or while charging the car.

4.2: Battery Management System (BMS)

A battery management system is any electronic system that manages a rechargeable battery, such as by protecting the battery from operating outside its safe operating area, monitoring its state, calculating secondary data, reporting that data, controlling its environment, authenticating it and / or balancing it.

4.2.1: Electric vehicle systems: energy recovery

- The BMS will also control the recharging of the battery by redirecting the recovered energy (i.e., from regenerative braking) back into the battery pack (typically composed of a number of battery modules, each composed of a number of cells).

Battery thermal management systems can be either passive or active, and the cooling medium can either be air, liquid, or some form of phase change. Air cooling is advantageous in its simplicity. Such systems can be passive, relying only on the convection of the surrounding air, or active, using fans for airflow. Commercially, the Honda Insight and Toyota Prius both use active air cooling of their battery systems.^[2] The major disadvantage of air cooling is its inefficiency. Large amounts of power must be used to operate the cooling mechanism, far more

than active liquid cooling.^[3] The additional components of the cooling mechanism also add weight to the BMS, reducing the efficiency of batteries used for transportation.

Liquid cooling has a higher natural cooling potential than air cooling as liquid coolants tend to have higher thermal conductivities than air. The batteries can either be directly submerged in the coolant or coolant can flow through the BMS without directly contacting the battery. Indirect cooling has the potential to create large thermal gradients across the BMS due to the increased length of the cooling channels. This can be reduced by pumping the coolant faster through the system, creating a trade-off between pumping speed and thermal consistency

4.2.2: Protection

A BMS may protect its battery by preventing it from operating outside its safe operating area, such as:

- Over-charging
- Over-discharging
- Over-current during charging
- Over-current during discharge
- Over-voltage during charging, especially important for lead–acid, Li-ion and LiFePO₄ cells
- Under-voltage during discharging, especially important for Li-ion and LiFePO₄ cells
- Over-temperature
- Charging while under low temperature
- Over-pressure (NiMH batteries)
- Ground fault or leakage current detection (system monitoring that the high voltage battery is electrically disconnected from any conductive object touchable to use like vehicle body)

The BMS may prevent operation outside the battery's safe operating area by:

- Including an internal switch (such as a relay or mosfet) which is opened if the battery is operated outside its safe operating area
- Requesting the devices to which the battery is connected to reduce or even stop using or charging the battery.

- Actively controlling the environment, such as through heaters, fans, air conditioning or liquid cooling

4.2.3: Battery connection to load circuit

A BMS may also feature a recharge system allowing a safe way to connect the battery to different loads and eliminating the excessive inrush currents to load capacitors.

The connection to loads is normally controlled through electromagnetic relays called contactors. The recharge circuit can be either power resistors connected in series with the loads until the capacitors are charged. Alternatively, a switched mode power supply connected in parallel to loads can be used to charge the voltage of the load circuit up to a level close enough to battery voltage in order to allow closing the contactors between battery and load circuit. A BMS may have a circuit that can check whether a relay is already closed before recharging (due to welding for example) to prevent inrush currents to occur.

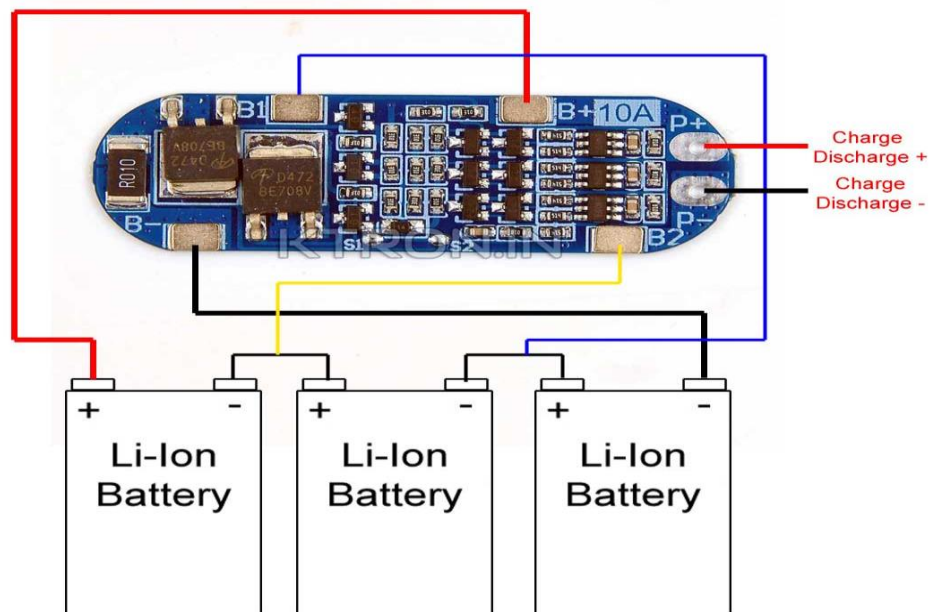


Fig-9: 12v & 10A BMS module.

4.2.4: Balancing

Distributed Battery Management system

In order to maximize the battery's capacity, and to prevent localized under-charging or over-charging, the BMS may actively ensure that all the cells that compose the battery are kept at the same voltage or State of Charge, through balancing. The BMS can balance the cells by:

- Wasting [energy](#) from the most charged cells by connecting them to a [load](#) (such as through passive [regulators](#))
- Shuffling energy from the most charged cells to the least charged cells ([balancers](#))
- Reducing the charging current to a sufficiently low level that will not damage fully charged cells, while less charged cells may continue to charge (does not apply to Lithium chemistry cells)

CHAPTER 5

Solar Panel

5.1: Solar Panels

A **solar cell panel**, **solar electric panel**, **photo-voltaic (PV) module**, **PV panel** or **solar panel** is an assembly of photovoltaic solar cells mounted in a (usually rectangular) frame, and a neatly organised collection of PV panels is called a photovoltaic system or **solar array**. Solar panels capture sunlight as a source of radiant energy, which is converted into electric energy in the form of direct current (DC) electricity. Arrays of a photovoltaic system can be used to generate solar electricity that supplies electrical equipment directly, or feeds power back into an alternate current (AC) grid via an inverter system.

When the sun shines onto a solar panel, energy from the sunlight is absorbed by the PV cells in the panel. This energy creates electrical charges that move in response to an internal electrical field in the cell, causing electricity to flow.

5.1.1: Monocrystalline solar panels

Also known as single-crystal panels, these are made from a single pure silicon crystal that is cut into several wafers. Since they are made from pure silicon, they can be readily identified by their dark black color. The use of pure silicon also makes monocrystalline panels the most space-efficient and longest-lasting among all three solar panel types.

However, this comes at a cost — a lot of silicon is wasted to produce one monocrystalline cell, sometimes reaching over 50%. This results in a hefty price tag.



Fig-10: Monocrystalline solar panel.

5.1.2: Polycrystalline solar panels

As the name implies, these come from different silicon crystals instead of one. The silicon fragments are melted and poured into a square mold. This makes polycrystalline cells much more affordable since there is hardly any wastage, and gives them that characteristic square shape.

However, this also makes them less efficient in terms of energy conversion and space, since their silicon purity and construction are lower than monocrystalline panels. They also have lower heat tolerance, which means they are less efficient in high-temperature environments.

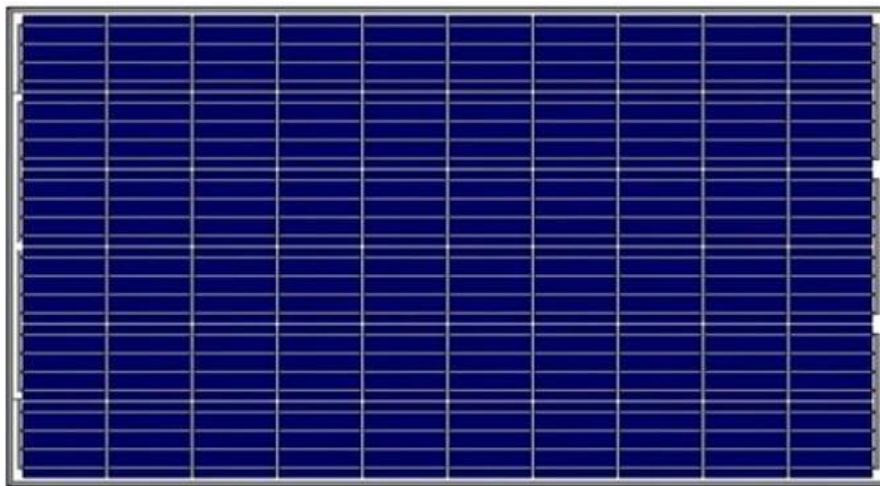


Fig-11: Polycrystalline solar panel.

5.1.3: Thin-film solar panels

Thin-film panels are characterized by very fine layers that are thin enough to be flexible. Each panel does not require a frame backing, making them lighter and easier to install. Unlike crystalline silicon panels that come in standardized sizes of 60, 72, and 96-cell counts, thin-film panels can come in different sizes to suit specific needs. However, they are less efficient than typical silicon solar panels.



Fig-12: Thin-flim Solar panel.

5.1.4: Solar Panel Types by Efficiency

Among all panel types, crystalline solar panels have the highest efficiency.

- Monocrystalline panels have an efficiency rating over 20%.
- PERC panels add an extra 5% efficiency thanks to their passivation layer.
- Polycrystalline panels hover somewhere between 15-17%.

In contrast, thin-film panels are usually 2-3% less efficient than crystalline silicon. On average:

- CIGS panels have an efficiency range of 13-15%.
- CdTe ranges between 9-11%.
- a-Si have the lowest efficiency at 6-8%.

Panel type	Efficiency
PERC	Highest (5% more than monocrystalline)
Monocrystalline	20% and up
Polycrystalline	15-17%
Copper indium gallium selenide (CIGS)	13-15%
Cadmium telluride (CdTe)	9-11%
Amorphous silicon (a-Si)	6-8%

Table-4: Efficiency of different type of solar panel.

5.1.5: Solar Panel Types by Power Capacity

Monocrystalline cells have the highest power capacity, thanks to their single-crystal construction that allows a higher output rating in a smaller package. Most monocrystalline panels can generate up to 300w of power capacity.

Recent advances in solar technology have allowed polycrystalline panels to bridge the gap. A standard 60-cell polycrystalline panel is now capable of producing between 240-300w. However, monocrystalline panels still beat polycrystalline in terms of power capacity per cell. Because thin-film panels don't come in uniform sizes, there is no standard measure of power capacity, and the capacity of one thin-film panel will differ from another based on its physical size. In general, given the same physical footprint, conventional crystalline panels output more power than a thin-film panel of the same size.

5.1.6: Solar Panel Types by Cost

Monocrystalline panels (or modules as they are technically known) carry a hefty price tag, due to its energy-intensive and inefficient manufacturing process with only a 50% yield for every silicon crystal.

Polycrystalline modules are cheaper because they make use of the crystal fragments leftover from monocrystalline production, which results in a simpler manufacturing process and lower production costs. Among thin-film solar panels, CIGS is the most expensive, followed by Cadet and amorphous silicon. Apart from the lower acquisition cost, thin-film modules can be easier to install thanks to their lighter weight and flexibility, which lowers the cost of labour.

While the total cost of residential systems has declined by more than 65% over the last decade, the soft cost of a system has actually risen from 58% of total system cost in 2014 to 65% in 2020. For more information about soft costs, check out our article on the soft costs in the solar industry, and what's being done to reduce them.

Panel (Module) type	Average Cost per Watt
PERC	\$0.32-\$0.65
Monocrystalline	\$1 – \$1.50
Polycrystalline	\$0.70 – \$1
Copper indium gallium selenide (CIGS)	\$0.60 – \$0.70
Cadmium telluride (CdTe)	\$0.50 – \$0.60
Amorphous silicon (a-Si)	\$0.43 – \$0.50

Table-5: Different type solar panel cost.

Note that these figures don't include the cost of installation and labor. With labor and other overhead factors, the total can rise to \$2.50 to \$3.50 per watt.

5.2: Other Factors to Consider

5.2.1: Temperature

The temperature of a solar panel can affect its ability to generate energy. This loss of output is reflected through the temperature coefficient, which is a measure of the panel's decrease in power output for every 1°C rise over 25°C (77°F).

Monocrystalline and polycrystalline panels have a temperature coefficient between -0.3% / °C to -0.5% / °C, while thin-film panels are closer to -0.2% / °C. This means that thin-film panels can be a good option for hotter environments or places that experience more sunlight throughout the year.

5.2.2: Fire rating

The updated International Building Code of 2012 requires solar panels to match the fire rating of the roof where they are installed. This is to ensure that the modules do not accelerate

the spread of flames in the event of a fire. (California goes one step further by requiring the whole PV system, which includes the racking system, to have the same fire rating).

As such, solar panels now carry the same classification rating as roofs:

Class A

- effective against severe fire test exposure
- flame spread should not exceed 6 feet
- required for wildland-urban interface areas, or areas with high fire severity and wildfire risk

Class B

- effective against moderate fire test exposure
- flame spread should not exceed 8 feet

Class C

- effective against light fire test exposure
- flame spread should not go beyond 13 feet

5.2.3: Hail rating

Solar panels are also tested for hail impacts.

UL 1703 and UL 61703 standards address hail storms, by dropping 2-inch solid steel spheres on solar panels from a height of 51 inches, and by firing 1-inch ice balls on PV panels with a pneumatic cannon to simulate hail impacts.

Because of their thicker construction, crystalline panels can withstand hail hitting at speeds of up to 50mph, while thin-film solar panels carry a lower rating due to their thin and flexible nature.

5.2.4: Hurricane rating

While there is no formal solar classification rating for hurricanes, the Department of Energy recently expanded its recommended design specifications for solar panels to safeguard against severe weather.

The new recommendations include:

- Modules with the highest ASTM E1830-15 rating for snow and wind loading in both the front and back.
- Fasteners with true locking capability based on DIN 65151 standard
- The use of through-bolting modules with locking fasteners instead of clamping fasteners
- The use of 3-frame rail systems for improved rigidity and support against twisting
- Tubular frames over open-shaped C channels
- Perimeter fencing around PV systems to slow down wind forces

5.3: Light-Induced Degradation (LID)

LID is a performance loss commonly seen in crystalline panels during the first few hours of sun exposure. This happens when sunlight reacts with oxygen traces left over from the manufacturing process, which affects the silicon lattice structure.

The LID loss is directly tied to the manufacturing quality and can range from 1-3%.

Summary: Solar Panel Types Compared

	Monocrystalline	Polycrystalline	Thin-film
Initial Cost	High	Middle	Highest to lowest: CIGS CdTe a-Si
Efficiency	20% and up	15-17%	CIGS: 13-15% CdTe: 9-11%

			a-Si: 6-8%
Appearance	Black with rounded edges	Blue with square edges	Depends on the thin-film variant
Advantages	Less expensive alternative to PERC panels without the passivating layer	Middle option in terms of cost, efficiency and power capacity	Lowest cost Easier to install
Disadvantages	High initial cost Low yield in the manufacturing process	Low heat tolerance, not suitable in hot environments	Shorter lifespan than crystalline panels requires more space Least efficient

Table-6: Summary of solar panels.

5.3.1: So, Which Solar Panel Type Should You Use?

As crystalline and thin-film panels have their own pros and cons, **the choice of solar panel ultimately comes down to your specific property and condition settings.**

5.3.2: Limited Space

Those living in a dense area with limited space should opt for highly efficient monocrystalline modules to make the most of the physical space and maximize utility savings. If budget permits, going for PERC panels can lower energy generation costs even more in the long run.

5.3.3: Large Properties

Those with a sufficiently larger property can save on upfront costs by using polycrystalline solar panels, where a bigger panel footprint can offset the lower panel efficiency. However, a

larger footprint could also mean added labor costs, so it's not necessarily cheaper to get a higher quantity of less expensive panels. While the initial cost may be low, it may eventually be offset by reduced efficiency and higher operating expenses in the long term.

As for thin-film solar panels, these are best suited for locations where the heavy and labor-intensive installation of crystalline silicon is not feasible. Such locations can include commercial buildings with tight spaces or thin roofs; compact spaces such as recreational vehicles and watercraft; and areas that require flexible installation instead of rigid paneling.

Keep in mind that solar panels are designed for long-term installation, which can be as long as 25 years. So whatever type you choose to go with, make sure to do your homework to ensure that it's the best option for your needs.

CHAPTER 6

Solar charging Method

6.1: Solar view in This Project

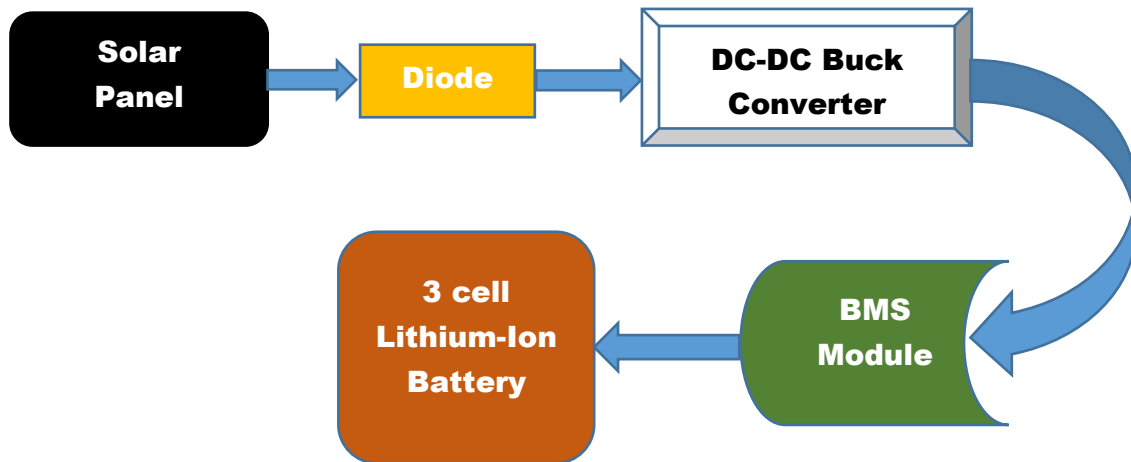


Fig-13: Solar Power management of the project

According to the design calculation and torque requirements, 8 watts solar panel has been selected in this work. Four panels of 6 watts capacity each were used. All the materials were effectively utilised to avoid energy losses.

Solar charge controller controls the voltage received from the panel to the battery. It is generally used to convert non-linear energy form into linear energy form. It is used to prevent the short circuiting of the components.

6.2: Charging of Batteries

The power supply to the electric motor comes from batteries. When driving a vehicle on electric motor, the stored energy in the batteries gets used up quickly. Batteries of a HSV are charged by solar power. The solar energy is an efficient way to save more energy. Charging the battery using solar power will be a challenge but can turn out to be a good scope for further development as solar power is freely available.

There are some of the important results inferred from the study.

PROPERTY	HOT ROLLED STEEL	COLDROLLED STEEL	ALUMINIUM
Density	7.77g/cc	7.8g/cc	2.7g/cc
Bulk modulus	140Gpa	140Gpa	76Gpa
Shear modulus	80Gpa	70Gpa	26Gpa
Elongation in brake	15%	20%	17%
Reduction of area	40%	50%	55%

Table-7: Material properties

Cold rolled steel has the highest elongation in brake when compared to the other materials. It also has a considerable reduction of area of 50%. It is also commercially available in the market. Considering all these reasons, we used cold rolled steel and fabricated the chassis frame.

- Calculation of the required torque for the selection of engine

Max. Load needs to be pulled= 600 gm

Width of the frame = 12cm

W.K.T Torque = load * perpendicular distance

= 0.60* 12

= 7.2 kg-cm

- So we selected a 150cc engine which has a maximum torque of 13.4 Nm and a maximum output power of 13.8 Bhp. Since the required torque is less than the design torque, the design is safe.
- We have selected 48V, 1000 Watts BLDC motor and used in this vehicle. The output torque of the motor with respect to speed and current are plotted.

6.3: Motor Speed Calculation

SPEED (KM/HR)	SPEED (RPM)	TORQUE (NM)
10	208.97	3.58
20	417.94	1.79
30	626.91	1.19
40	835.88	0.897

Table-8: Motor output torque with respect to speed

- Calculations for obtaining speed and torque:
 Speed in rpm= (speed in km/hr*1000)/ (2*pi* radius*60)
 Torque = power/ (speed in rpm)

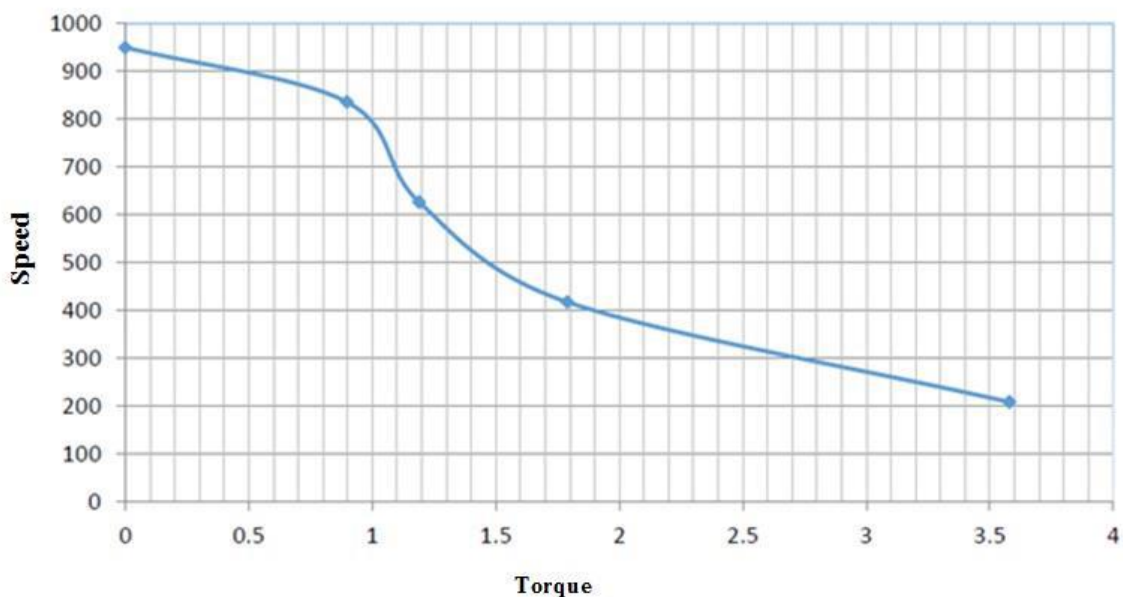


Fig-14: Mechanical charateristic of motor

From the above obtained value in the graphs and calculations, a motor of 1000watts-48V was selected.

Fig. 14 shows the torque versus speed of the motor which indicates the mechanical characteristics.

Selected motor gives the maximum output torque of 14.2 Nm thus more than satisfying than the required torque of 7.2 kg/cm. The design is safe as the required torque is less than the maximum output torque of the motor. Fig-15 depicts current versus speed, known as electrical characteristics which indicate, at the maximum load conditions while increasing the speed of the vehicle the required input current increases. The required input current for the motor, calculated as per design is only 20Amps. The selected motor can produce an output of 14.3Nm when the maximum input current of 31Amps is provided.

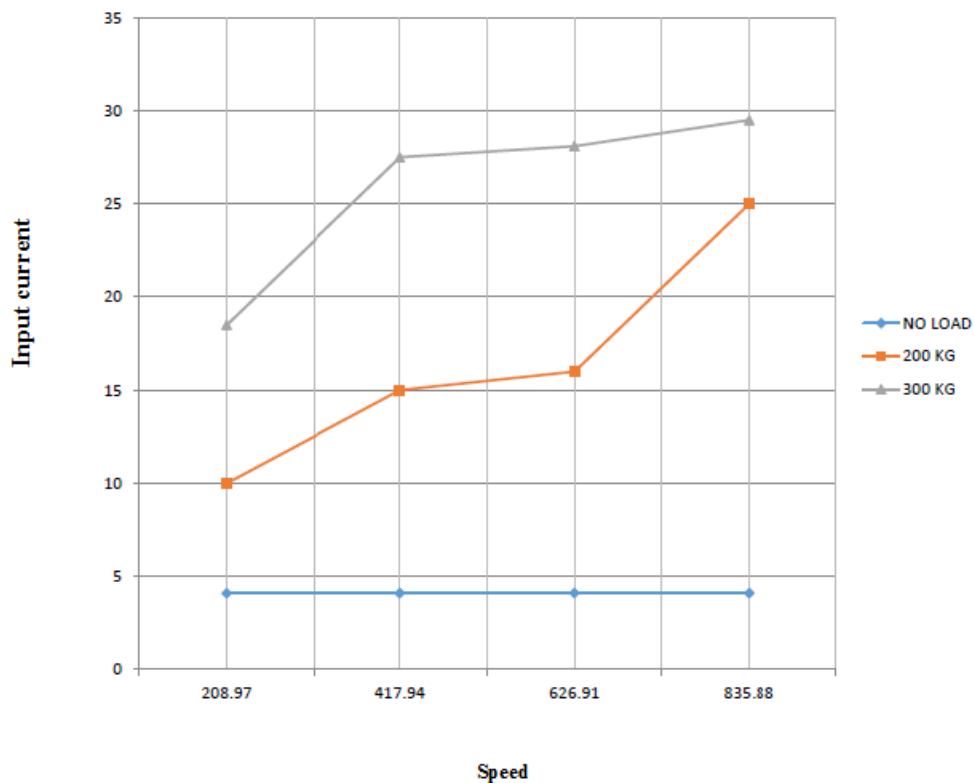


Fig-15: Electrical characteristics of motor.

DISCUSSION

In the course of developing this project we have achieved the following milestones. The android guided arduino car has been created successfully and testing has been done for all the known cases regarding the usage of project. We had successfully connected an android application that will provide user an interface to interact with the arduino powered car. The interface is easy to use and provide feedback from the arduino microprocessor through the bluetooth after giving instruction to arduino for various actions through interface via bluetooth module. An appropriate program in the arduino microprocessor to interact with the android controller has been created successfully. The program has been successfully compiled through arduino IDE to the arduino microprocessor & loaded in to it after proper checking of logic to decrease any loss/damage of hardware. The project has completed its aim to designing an arduino bot and write program in to the arduino microprocessor. Arduino car contains arduino microcontroller with basic mobility features. Arduino programs contains instructions mediating between android controller and Arduino car. Android mobile controller uses different mobile sensors to supervise motion.

Conclusion

In this work solar powered hybrid vehicle has been successfully fabricated built in with internal combustion engine. Generally, the electric hybrid vehicles are disadvantageous during long distance travels also required periodic plug in of their batteries. These kinds of problems have been solved using hybrid solar vehicle which gives a car, self-charging potential from the solar panels. The efficiency of the solar panels which is used is 15-20%, but there are various means to increase the efficiency of the panels by changing their silicon materials. The future of energy sector lies solely on alternative energy resources. The cost of HSVs is more than the conventional cars but they are more efficient and cause less exhaust emissions. This challenge now can turn out to be a good scope for further development of a pollution free vehicle.

The project titled Bluetooth Car using Arduino is an application based on popular open source technology - Android and Arduino The aim of the project was to create an arduino integrated car that has to be controlled through an application that runs on the android operating system. The project has been completed with success with the utmost satisfaction. The constraints square measure met and overcome with success. The system styled /is meant/ is intended

as find it irresistible was set within the design section. Validation checks iatrogenic have greatly reduced errors. Provisions are created to upgrade the code. The applying has been tested with live information and has provided a prosperous result. Thence the code has proven to figure expeditiously. The system created met its objectives, by being straightforward to use, implement and secure. This code is developed with measurability in mind. Further modules may be simply other once necessary. The code is developed with standard approach. All modules within the system are tested with valid information and invalid information and everything work with success.

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CHAPTER 7

APPENDIX

7.1: Hardware Implementation

RC module is the main working unit of this system. This unit consists of the Arduino chip, the motor drivers, and a Bluetooth module connected to the circuit. L298N Motor driver are used to control the dc motors. The Arduino Uno, which is a small android chip, resides at the center of the unit. It is responsible for communicating with android smartphone, using the Bluetooth module and controls the motors using the motor driver. The RC unit is powered using 6V battery connected to this Arduino chip. It is used another Arduino chip, temperature sensor for sensing the temperature and humidity of the atmosphere. The Paper on Android Controlled Arduino based Robotic Car for controlling the module is received using Bluetooth module HC-05.

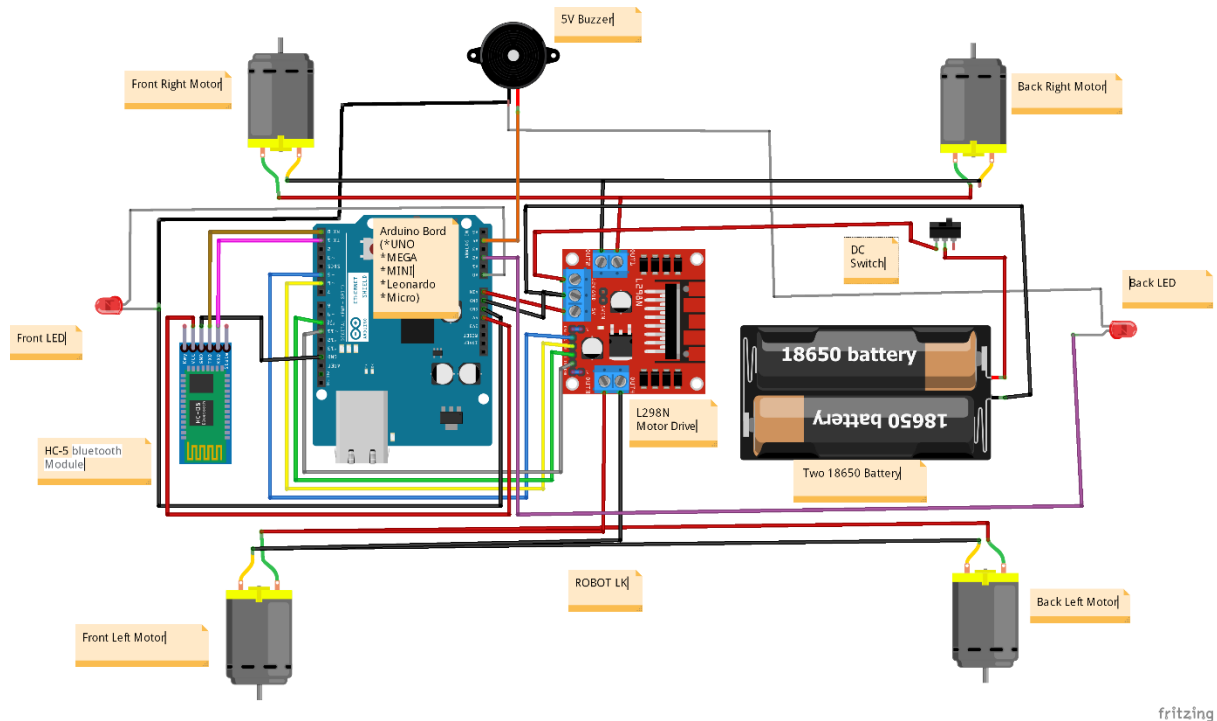


Fig-16: circuit diagram of the Rc car.

After simulating the circuit connections, we have programmed the arduino uno. Connections were made as per the circuit diagram and the file of the code of arduino was attached to the Arduino uno. An appropriate program in the arduino microprocessor to interact with the android controller has to be created. The program has been successfully compiled through arduino IDE to the arduino microprocessor & loaded in to it after proper checking of logic to decrease any loss/damage of hardware.

The project has completed its aim to designing an android interface, arduino bot and write program in to the arduino microprocessor. Arduino car contains arduino microcontroller with

basic mobility features. Arduino programs contains instructions mediating between android controller and Arduino car. The project has completed its aim to designing an android interface, arduino bot and write program in to the Arduino microprocessor. Arduino car contains arduino microcontroller with basic mobility features. Arduino programs contains instructions mediating between android controller and Arduino car.

The project has been completed with success with the utmost satisfaction. The constraints square measure met and overcome with success. The system styled /is meant/ is intended as find it irresistible was set within the design section. The system is extremely versatile and versatile. This code encompasses an easy screen that permits the user to use with none inconvenience. Validation checks iatrogenic have greatly reduced errors. Provisions are created to upgrade the code. The applying has been tested with live information and has provided a prosperous result. Thence the code has proven to figure expeditiously. The system created met its objectives, by being straightforward to use, implement and secure. This code is developed with measurability in mind. Further modules may be simply other once necessary. The code is developed with standard approach. All modules within the system are tested with valid information and invalid information and everything work with success.

7.2 DC Battery

Model name: Sealed lead acid battery 6DFM8.

Weight= 2.5 kg Capacity = 12 volts, 8 Ah

Charging current = 2.4 A (Max)

Standby use: 13.5 V - 13.8 V

Cyclic use: 14.5 V - 14.9 V

Nozzle discharge rate is 2.9 lit/min

1. According to Spraying Capacity & Discharge Capacity of Spray pump

Is Selected Type: Centrifugal Pump. .

Liquid Discharge: 0.5lit/min to 1lit/min.

Speed: 1500 rpm.

Suction Head (hs) = 0.5m.

Discharge Head (hd) = 3m.

Suction pipe Diameter: 12mm = 12×10^{-3} m.

Discharge pipe Diameter: 8mm = 8×10^{-3} m

Overall Efficiency of the Pump $\eta = \frac{W * H_m}{1000 * S.P.}$

Where, S.P = Power Required To Drive The Pump.

Hm = Monometric Head (in m)

η = Overall Efficiency Of The Pump (Assume it is 60%)

$$\eta = \frac{\rho * g * Q * H_m}{1000 * S.P}$$

$$\eta = \frac{(1000 * 9.81 * 8.10^{-3} * H_m)}{1000 * S.P}$$

Where, Q= 1lit/min= 1.66×10^{-5} m³/sec.

Assume Overall Efficiency of Pump $\eta = 60\%$

Hm= Manometric Head.

$$H_m = (P_o / \rho * g + V_o^2 / 2 * g + Z_o) - (P_i / \rho * g + V_i^2 / 2 * g + Z_i)$$

Where , $P_o / \rho * g$ = Pressure head at outlet of pump (hd) = 3m.

$V_o^2 / 2 * g$ = Velocity head at outlet of pump = $V_o^2 / 2 * g$

$P_i / \rho * g$ = Pressure head at inlet of pump (hs) = 0.5m.

V_d (Velocity at Discharge) = Discharge Area of Delivery pipe = $1.66 \times 10^{-5} \pi 4 * 8 \times 10^{-3} = 2.16 \times 10^{-3}$ m/sec. V_s (Velocity at Suction) =)

= Discharge Area of Delivery pipe = $1.66 \times 10^{-5} \pi 4 * 12 \times 10^{-3}$

= 1.76×10^{-3} m/sec. $H_m = 3 + \frac{(2.16 \times 10^{-3})^2}{2 * 9.81} - 0.5 + \frac{(1.76 \times 10^{-3})^2}{2 * 9.81}$

$H_m = 14.71 - 2.45$

$H_m = 12.26$ meter. We know that,

Overall Efficiency of the pump

$$\eta = \frac{W * H_m}{1000 * S.P.}$$

putting the above value in the equation, we get the power of pump. Rearrangement of Above equation

$$\begin{aligned}
 S.P &= W \cdot H_m / 1000 \cdot \eta \\
 &= 1000 \cdot 9.81 \cdot 1.66 \cdot 10^{-5} \cdot 12.26 / 1000 \cdot 0.60 \\
 &= 3.327 \cdot 10^{-3} = 0.00327 \cdot 10^3 \\
 &= 3.27 \text{ Watte} \sim 3.50 \text{ Watte} . \\
 \text{Power required to the pump is } &3.50 \text{ Watte}
 \end{aligned}$$

2) According To Pump Operating Power Battery Is Selected Type:

Lead Acide Battery.

Voltage : 12 V

Current : 7 Amp

$$\begin{aligned}
 \text{Power} &= \text{Voltage} \cdot \text{Current} = 12 \cdot 7 \\
 &= 84 \text{ Watt (Maximum power when the ckt is open)}
 \end{aligned}$$

When the circuit is short then,

Voltage: 12 v

Current: 1.5 Amp

$$\begin{aligned}
 \text{Power} &= \text{Voltage} \cdot \text{Current} \\
 &= 12 \cdot 1.5 \\
 &= 18. \text{Watte}
 \end{aligned}$$

3) According To Battery Output Power Solar Panel Is Selected

Power: 20 watt

Dimension: 397*278*25 mm

Weight: 1.6 kg

Open Circuit Voltage: 21.5 volt

Short Circuit Current: 0.82Amp

Operating Current: 12 Amp.

When the Battery is connected to the Solar Panel through Charge Controller then some amount of load is applied on solar Panel (that is short ckt)

$$\begin{aligned}
 \text{Actul power of Solar Pane l} &= \text{voltage} \cdot \text{short circuit current} \\
 &= 21.5 \cdot 0.82 = 17.63 \text{ Watte.}
 \end{aligned}$$

Theoretical calculation of current and charging time of the battery.

(i).The current produced by the solar panel (I) was calculated by knowing the maximum power (P) of the solar panel and the voltage rating (V) of the battery that is given by $I = P/V$

Therefore, $I = 20/12 = 1.66$ Amp (ii).

Charging time (T) was computed by taking the ratio rating of battery in ampere hour (Ah) to the total current supplied by the solar panel. $T = \text{battery rating in ampere hour} / \text{total current consumed by the solar panel}$ Therefore,

$$T = 7/1.66 = 4.21 \text{ Hrs.min}$$

7.3: Source Code

```
#define in1 5 //L298n Motor Driver pins.
#define in2 6
#define in3 10
#define in4 11

#define light_FR 14 //LED Front Right pin A0 for Arduino Uno
#define light_FL 15 //LED Front Left pin A1 for Arduino Uno
#define light_BR 16 //LED Back Right pin A2 for Arduino Uno
#define light_BL 17 //LED Back Left pin A3 for Arduino Uno
#define horn_Buzz 18 //Horn Buzzer pin A4 for Arduino Uno
int command; //Int to store app command state.
int Speed = 204; // 0 - 255.
int Speedsec;
int buttonState = 0;
int lastButtonState = 0;
int Turnradius = 0; //Set the radius of a turn, 0 - 255 Note:the robot
will malfunction if this is higher than int Speed.
int brakeTime = 45;
int brkonoff = 1; //1 for the electronic braking system, 0 for normal.
boolean lightFront = false;
boolean lightBack = false;
boolean horn = false;
void setup() {
  pinMode(in1, OUTPUT);
  pinMode(in2, OUTPUT);
  pinMode(in3, OUTPUT);
  pinMode(in4, OUTPUT);
  pinMode(light_FR, OUTPUT);
  pinMode(light_FL, OUTPUT);
  pinMode(light_BR, OUTPUT);
  pinMode(light_BL, OUTPUT);
  pinMode(horn_Buzz, OUTPUT);

  Serial.begin(9600); //Set the baud rate to your Bluetooth module.
}

void loop() {
  if (Serial.available() > 0) {
    command = Serial.read();
```

```

    Stop(); //Initialize with motors stoped.

if (lightFront) {digitalWrite(light_FR, HIGH); digitalWrite(light_FL,
HIGH);}
if (!lightFront) {digitalWrite(light_FR, LOW); digitalWrite(light_FL,
LOW);}
if (lightBack) {digitalWrite(light_BR, HIGH); digitalWrite(light_BL,
HIGH);}
if (!lightBack) {digitalWrite(light_BR, LOW); digitalWrite(light_BL,
LOW);}
if (horn) {digitalWrite(horn_Buzz, HIGH);}
if (!horn) {digitalWrite(horn_Buzz, LOW);}
switch (command) {
  case 'F':
    forward();
    break;
  case 'B':
    back();
    break;
  case 'L':
    left();
    break;
  case 'R':
    right();
    break;
  case 'G':
    forwardleft();
    break;
  case 'I':
    forwardright();
    break;
  case 'H':
    backleft();
    break;
  case 'J':
    backright();
    break;
  case '0':
    Speed = 100;
    break;
  case '1':
    Speed = 140;
    break;
  case '2':
    Speed = 153;
    break;
  case '3':
    Speed = 165;
    break;
  case '4':
    Speed = 178;
    break;
  case '5':
    Speed = 191;
    break;
  case '6':
    Speed = 204;
    break;
}

```

```

    case '7':
        Speed = 216;
        break;
    case '8':
        Speed = 229;
        break;
    case '9':
        Speed = 242;
        break;
    case 'q':
        Speed = 255;
        break;
        case 'W':lightFront = true;break;
case 'w':lightFront = false;break;
case 'U':lightBack = true;break;
case 'u':lightBack = false;break;
case 'V':horn = true;break;
case 'v':horn = false;break;
    }
    Speedsec = Turnradius;
    if (brkonoff == 1) {
        brakeOn();
    } else {
        brakeOff();
    }
}
}

void forward() {
    analogWrite(in1, Speed);
    analogWrite(in3, Speed);
}

void back() {
    analogWrite(in2, Speed);
    analogWrite(in4, Speed);
}

void left() {
    analogWrite(in3, Speed);
    analogWrite(in2, Speed);
}

void right() {
    analogWrite(in4, Speed);
    analogWrite(in1, Speed);
}

void forwardleft() {
    analogWrite(in1, Speedsec);
    analogWrite(in3, Speed);
}

void forwardright() {
    analogWrite(in1, Speed);
    analogWrite(in3, Speedsec);
}

void backright() {
    analogWrite(in2, Speed);
    analogWrite(in4, Speedsec);
}
}

```

```

void backleft() {
  analogWrite(in2, Speedsec);
  analogWrite(in4, Speed);
}
void Stop() {
  analogWrite(in1, 0);
  analogWrite(in2, 0);
  analogWrite(in3, 0);
  analogWrite(in4, 0);
}
void brakeOn() {
  //Here's the future use: an electronic braking system!
  // read the pushbutton input pin:
  buttonState = command;
  // compare the buttonState to its previous state
  if (buttonState != lastButtonState) {
    // if the state has changed, increment the counter
    if (buttonState == 'S') {
      if (lastButtonState != buttonState) {
        digitalWrite(in1, HIGH);
        digitalWrite(in2, HIGH);
        digitalWrite(in3, HIGH);
        digitalWrite(in4, HIGH);
        delay(brakeTime);
        Stop();
      }
    }
    // save the current state as the last state,
    //for next time through the loop
    lastButtonState = buttonState;
  }
}
void brakeOff() {
}

```