

E-BIKE SPEED CONTROL SYSTEM

A Project Report Phase – II

Submitted in partial fulfilment of the requirements for the award of Bachelor of

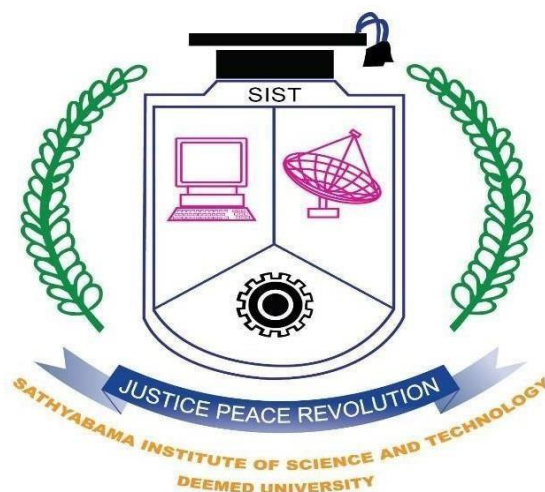
Engineering degree in Electronics and Communication

Engineering

by

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

SCHOOL OF ELECTRICAL AND ELECTRONICS

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

Accredited with Grade “A” by NAAC

JEPPIAR NAGAR, RAJIV GANDHI SALAI, CHENNAI - 600 119

APRIL – 2023



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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the Bonafide work of **C.H.S.S.R CHANDRAYYA(39130095), B.RAMAKRISHNA REDDY(39130083)**, who carried out the project entitled "**E-BIKE SPEED CONTROL SYSTEM**" under the supervision of **Dr.S.Barani, M.E., Ph.D.**, from November 2022 to April 2023.

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DECLARATION

We, CH.S.S.R CHANDRAYYA (39130095) and B. RAMAKRISHNA REDDY (39130083) hereby declare that the Project Report entitled “**E-BIKE SPEED CONTROL SYSTEM**” done by us is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering Degree in **ELECTRONICS AND COMMUNICATION ENGINEERING**.

DATE: 27.04.23

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ACKNOWLEDGEMENT

We are pleased to acknowledge our sincere thanks to **Board of Management of SATHYABAMA** for their kind encouragement in doing this project and for completing it successfully. We are grateful to them.

We convey our thanks to **Dr. N.M. NANDHITHA, M.E., Ph.D.**, Dean, School of Electrical Electronics and Engineering and **Dr. T. RAVI, M.E., Ph.D.**, Head of the Department, Dept. of Electronics and Communication Engineering for providing us necessary support and details at the right time during the progressive reviews.

We would like to express our sincere and deep sense of gratitude to our Project guide **Dr.S. Barani, M.E., Ph.D** for her valuable guidance, suggestions and constant encouragement paved way for the successful completion of our project work.

we wish to express our thanks to all Teaching and Non-Teaching staff members of the **Department of Electronics and Communication Engineering** who were helpful in many ways for the completion of the project.

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ABSTRACT

E-bike is designed with Turbo boost BLDC Motors that can be operated at higher speeds. Suspension systems must support both road holding/handling and ride quality which are at odds with each other. The tuning of suspensions involves finding the right compromise. It is important to control speed based on the bumpy roads for the suspension to keep the road wheel in contact with the road surface as much as possible because all the road or ground forces acting on the vehicle do so through the contact patches of the tires. Our Project, The Springless Suspension System Combines a differential mechanism and an oscillating system that will support the E-bikes with relative speed control in bumpy and terrain areas. A differential is a gear train with three drive shafts that have a property such that the rotational speed of one shaft is the average speed of the others or a fixed multiple of that average, and Oscillation is the repetitive or periodic variation of an object. The Frame of the system is mostly made of Mild steel. The frame that holds the tires oscillates freely. The same frame is connected to the differential. A motor is connected to a gear in the differential mechanism, thereby making it the driving gear. The driving gear is connected by a bevel gear on both sides. Each gear is connected to two wheels on each side. Each wheel is driven by an individual motor. The motor makes sure that the gears and the wheels are in motion and the oscillating property makes sure that the vehicle is moving forward even in rough terrain. Through this Differential auto bevel mechanism speed control with load balance on E-bikes can be maintained.

CHAPTER 1

INTRODUCTION

All are living in the future. With time, technology has improved our lives. Nowadays, most countries are using electric bicycles. The use of cycles over vehicles is always green for the environment, but an E-bike is the biggest adoption of green transportation of the decade. Just think of E-bikes in place petrol operated scooters rather than normal bikes. An E-bike uses rechargeable batteries that can travel up to 25 to 45 Kmph. As a result, it is faster than the normal cycle to reach your destination quicker and in better shape. In this blog, we are going to learn about E-bike technology, its types, and its advantages There are two main types of E-bikes- throttle assist and pedal assist.

An E-bike motor works by automatically switching on the (quiet) motor when you pedal or throttle. A pedal-operated E-bike is the most popular option. As you pedal the bike, the motor gets powered, and it works. In comparison, a throttle-assist E-bike is similar to a normal motorbike. It operates as you accelerate the throttle. Electric bicycles are available in many styles, from commuter bikes to full-suspension mountain bikes. The power output of these pedal-operated motors is typically governed by regulations. Mostly, they are available with an output power of around 250 watts. Bikes fitted with a throttle-based motor system have slightly different output regulations. It can be available with a maximum power of around 200 watts, while speed remains limited to 25 kmph.

In transportation we have developed quite a lot by the range of hi-tech vehicles we have, still the importance of bicycle cannot be neglected. Bicycle is popular in all groups because it is easy to handle by its light weight, and do not cost money to operate as it does not require fuel to run, still very efficient in small distant traveling. It has many distinct qualities, which make it even special over other vehicles, like they do not require registration fees, insurance, or driving license. Similarly it has less prone to heavy casualties, thereby making it a safer transportation. Besides it has health benefits, just the same way as in any physical exercises. Similar to this, e-bike on the other hand is a modified version of the same. In e-bikes the difference comes by the application of the motor system, use of the controller to control the

motor system, and also with battery to Power it. The motor is used in order to give external power to make the ride comfortable. E-bike is better than the normal bike because rider can get additional power when it is required, if it is used like that. In this the rider has the choice when he is less of power and unable to drive forward easily, usually when there appears an uphill or strenuous long road, he can switch on the battery, and thereby activates the motor. Then motor compensates the required power and this way ride becomes smoother all the way. It is up to the rider as when he wants to switch on the power. He can choose motor to propel all the way for his support, or use it when he actually needs. There are again various levels which the rider can choose depending upon the condition of the road, and the amount of speed that is desired in riding. Similarly, there is throttle to make riding adjustable, either compensating speed for less strain, or get speed for high strain, this is absolutely on the choice of the riders' strength and selection. When we try to address the best feature of e-bike, then we can say that as there is almost no strain while riding e-bike that we notice in normal bike driving uphill, therefore it is easy to sum up that when there is less strain, rider can travel a long distance very easily, there is also less perspiration making user tidier again, giving possibilities for wide range users. We should understand, e-bike has a standard specification to meet, so that it does not come in the same category as a motorbike. The standard is varied from place to place, but in Europe especially Sweden, the present limit is 250 W maximum continuous power and 40 kg/88 lb. maximum weight with no limit on the peak power¹. Whereas in the United States this limitation is 750 W. Though the use of e-bike is a new concept in Europe, but in India and China it is growing quite fast, just in China, e-bike at this time has increased by the amount that it is outnumbering cars by four to one.

Electric bikes, or e-bikes, are a form of bicycle that are powered by an electric motor. The motor assists the rider in pedaling, making it easier to travel long distances or climb hills. The e-bike system control is the brain of the electric bike, managing the motor, battery, and other components to provide a smooth and efficient riding experience.

The e-bike system control typically consists of several components, including the motor, battery, controller, sensors, and display. These components work

together to provide power to the motor and control the speed and performance of the e-bike.

Smart cities represent a hot research topic both for academia and industry. The main purpose of smart cities is to make use of city facilities (buildings, infrastructure, transportation, energy, etc.) in order to improve people's quality of life while creating a sustainable environment. In this context, smart transportation, as a fundamental dimension of smart cities, relates to both intelligent and "green" transportation solutions. Cycling is considered to be one of the most sustainable and green forms of transportation. Therefore, it is not surprisingly that cycling occupies an important place among smart transportation initiatives in particular and smart cities initiatives in general. For instance, promoting cycling is listed as main objective of initiative on smart cities. In recent times, the permanent magnet synchronous motors have been increasingly employed to substitute brush DC motors as actuators for scooters.

However, the latter possess many merits, such as simple in motor structure and power converter, better control technology, having excellent torque generating capability etc. Storing of energy is the key factor in EV or HEV model, so appropriate secondary batteries must be opted as they are the main source of energy for successful operation of EV's. These days, bi-directional converter used in electric vehicles offer energy storing in battery as well as charging feature. The non-isolated converters are classified into buck, boost and buck boost types, which are economical, compacted, without transformer and simple control mechanism since it has a common ground. With proper selection of current controller time delay and the corner frequency of PI controller can be determined. For proper operation, the rotor frequency must be designed to be working in the specified range. By tuning controller parameters, the range of the operating speed can be appropriately implemented, not only speed up the design but also reduces the time in implementing speed controller E-bike is an Eco-friendly electric and power-assisted bike. It is one of the fastest-growing technology of the bicycle industry. We all are living in the future. With time, technology has improved our lives. Nowadays, most of the countries are using electrical bicycles. The use of cycle than vehicles is always green to the environment, but an E-bike is the

biggest adoption of green transportation of the decade. Just think of E-bike in place petrol operated scooters rather than a normal bike. An E-bike uses rechargeable batteries which can travel up to 25 to 45 kmph. As a result, it is faster than the normal cycle to reach your destination quicker and in better shape. In this blog, we are going to learn about E-bike technology, its types and advantages. E-bike is an electric and power-assisted bike which is one of the fastest-growing technology of the bicycle industry. This bicycle uses an electric motor to help you along. So you can ride it like a normal bicycle, but with less effort. There are two main types of E-bike- throttle assist and pedal assist. An E-bike motor works by automatically switching on the (quiet) motor when you pedal or throttle. A pedal-operated E-bike is the most popular option. As you pedal the bike, the motor gets powered, and it works. In comparison, a throttle-assist E-bike is similar to a normal motorbike. It operates as you accelerate the throttle. Electric bicycles are available in many styles, from commuter bikes to full-suspension mountain bikes. The power output of these pedal-operated motors is typically governed by regulations. Mostly, they are available with an output power of around 250 watts. Bikes fitted with a throttle based motor system has slightly different output regulations. It can be available. Here, we're going to compare an E-bike to a regular bike rather than a motorbike. In this article, we will look at how E-bike differs from the regular bike. An E-bike is an eco-friendly bike. It is just like our normal bicycle. However, E-bike runs on electricity rather than liquid fuel; it doesn't produce any harmful emissions into the atmosphere. For the same reason, electric bikes don't generate more noise. If you are using a pedal-operated E-bike, then it is very healthy. When you turn the pedals, your whole body works. So you are getting exercise when you ride an E-bike. You can ride the E-bike with speeds up to 25 kmph in motor assistance mode. This speed is quite enough to ride on city streets and everywhere else. This is the maximum speed allowed by government law; otherwise, the bike will ride too fast. You can reach the fast speed as per the motor power, but motor manufacturers limit the speed for you. The "Speed Pedelecs" e-bikes are faster. They can go up to 30 miles per hour, or more but you need to register for that. A normal E-bike system can take the current starts from 10 Amp, increasing along with the motor capacity. Generally, in E-bike, lithium-ion batteries are used. Depending on the battery and charger, it

can take around 3 to 8 hours to recharge fully. If the battery gets discharged while using it in a pedal-assisted E-bike, you can still ride it just like riding a normal bicycle through continuing pedalling. It will not stop like fuel operated bikes. Use of a battery is necessary for throttle assisted E-bike. Riding up hills or mountains is difficult for an inactive person. Therefore, one of the main advantages of an e-bike is that it is easy to ride when climbing hills or mountains. An electric bike can easily tackle those nasty headwinds. bikes are available in various types with several brands. Nowadays, almost all regular bicycle manufacturers produce electric bikes too. So, you will all types of bicycles in the market from both regular to special ones. E-bikes are available as city bikes, road bikes, mountain bikes, folding bikes, cargo, and family bikes, and many others. The weight of an E-bike is more than a normal bike. It is around up to 25 kg or more. The heavier part of the E-bike is the motor and battery, but it is not difficult to work. However, these bikes are harder to transport because of their weight. Generally, Electric bicycles don't require any maintenance. To keep it clean, lubricate the drive system and regularly check the chain and wheels. But still, if you get any problem, it is easy to repair as like our ordinary bicycle. You don't need a license to ride the E-bike. Also, there is no tax on this. Only, you have to comply with motor law, though as you would riding a regular bicycle. If your bike is more powerful or faster, you will need to register for a license and other documents.

CHAPTER 2

LITERATURE SURVEY

The following shows a survey done for an E-Bike speed control system based on three modes of operation with an algorithm for real-time environmental automation through Self-recording of data while operating in real-time Through this brief survey, we have gained a huge layout of designing our system architecture. Most of the content we gathered here is based on artificial intelligence for Real-time traffic control system

Kumar, Binod, and H. Oman Electric bicycles powered with today's nickel-metal hydride batteries offer a 100-km range between recharges, and have a potential of 300 km when polymer batteries become available. These vehicles, when implemented by installing power kits on existing bicycles, can offer low-cost, pollution free transportation for bringing education, health, and communication to remote areas in developing nations Furthermore, solar-photovoltaic battery charging can avoid fuel cost. A controller for an electric bicycle must supply power that varies from zero to the propulsion-motor's rated peak at motor speeds corresponding to bicycle speeds from zero to 18 km per hour (30 mph). With direct current propulsion motors, power can be controlled with pulse-width modulated transistors. AC motors need variable frequency Requirements for electric bicycle control were postulated and we developed controller configurations.

Morichin, William C. The usual battery powered electric bicycle has a conventional bicycle-frame, pedals, cranks, chain and freewheel assembly, Electric propulsion replaces or supplements muscle power. An electric motor, gear reducer, battery and power controls were added. Average travel William C. Morichin, President Electric Bicycle Company speed compared to pedaled bicycles can be increased the order of 8 to 10 km/h (5 mph). Regenerative braking, which in automobiles would capture the potential energy of descending slopes is not required. Bicyclist rarely uses brakes while coasting

down paved hills E hikes powered with today's nideel-metal hydride batteries give a 100-km range between recharges and have a potential of 300 km when polymer batteries become available. The electric bicycle normally will not require registration, license or operator qualification. Unlike the gasoline powered bicycle it can be used to travel trails reserved for bicycles

In 1995 Oman, Henry, William C. Morchin, and Frank Jamerson Introduced a paper in which they said, In a human-powered hybrid electric vehicle (HPHEV) the travel distance available from a single battery charge can be lengthened with power from another source, the cyclist's leg muscles in a battery-powered electric bicycle the propulsion power goes mostly into 18 km per hour (11) males per hour) this drag represents 200 watts at the bre-to- road interface for a typical cyclist's shape and clothing Today's usual electric bicycle is propelled by a high-speed de motor which is powered from a lead- acid battery. The combined efficiency of the motor and its speed overcomes aerodynamic drag. For example, at reducing gears is 50 to 65 percent. In this paper we calculate available travel distances, asa function of speed, grade, and the battery energy content as measured in watt-hours per kg. We show the effects of hattery cost and charge or discharge cycle life on travel cost in terms of cents per kilometer travelled.

Lemonova, E. A. The paper discusses the generic mechanical, electromechanical, electromagnetic, control design and test approaches leading to the system integration, design solutions and physical implementation of electrically assisted bicycle as a result of the co-operative research work done by the Dutch Company ID Hike and Technical University of Eindhoven,

In 2016 Dumitrache, Florin, Marius Catalin Carp and Gheorghe Pana said that. The electric vehicles industry is continuously evolving A such electric vehicle is the electric bicycle (e-bike). Electric bicycles, like another electric vehicles, implementa BLDC motor (Brushless Direct Current Motor]. This

paper presents a way of designing and using an electronic module for an e-Bike. The paper shows how a low power, 8-bit micro-controller can be used to drive such a motor and also manage other useful functions on an e-Bike

Kumar et al. performed experimental studies on Electric Bike which has an alternative source of battery operated cycle. They found that the design of E-bike was more efficient than normal Bicycle. Electric bike was the hybrid one so it was electrically operated and also pedal operated.

Mahadik et al. introduce the concept of electric bike. He converted the normal bicycle in to electrical one with an innovative approach. Charging of Battery was provided by three ways i.e by means of wall charging, solar charging and by mechanical pedal. Main focus of concept was on System Architecture, operational Concept and Battery Management. Use of PIC15F72 controller was used for over current protection and under current protection which is helpful.

Paladini et al.[9], introduce an alternative powertrain in which electric vehicle was powered by fuel cell. Power train behaviour was developed on MATLAB/SIMULINK. As per the powertrain during acceleration power is demanded from battery, during deacceleration battery is being charged. Powertrain was selected on certain parameters such as varying for input parameter, fuel cell efficiency, battery minimum state of charge, number of fuel cell active area, From this they obtain good fuel economy and final battery state of charge. Evtimov et al.[10], they studied consideration of energy efficiency on an experimental bicycle. the bicycle was fitted with board computer to store information about motion and energy consumption. Experiment was carried for three types of city routes. Without regeneration of energy the electric bicycle could go up to 35 km studies show that use of electric bicycle could reduce the pollution up to 10 times compared to conventional vehicles.

Trevedi et al. [14], they identify the need of E-Bike in recent time. They beat the issue of the pollution in view of all class of society. It was not sensible to purchase scooters, mopeds and motorcycle for everyone. Thus combination of both issues environmental as well as economically affordable option would be the best solution. Objective of there research was to explore the acceleration speed and electric powered bicycle under balance.

Sousa et al.[15], Experimentally designed the described traction system for a self driving vehicle. The presented system consisted two different power sources. One was based on batteries and another on supercapacitors. They described using both the power sources at same time. They used a battery pack along with a super capacitor for traction system. In this system super capacitor were also used for storing the energy.

Matsuda et al.[16], described the experimental examples regarding practicality of EV-MC. They explain developments of prototypes and assess them by the practical view of the MC usage. They shows the Mechanical protection of the battery's with the design concepts and the actual methods. They designed the other electric components and showed the experimental results by the practical point of view.

Choi et al. they briefly explain about the RT lab and Simulink software and with help of this software they designed and simulated the electric bike. They discuss about the how to solve the problem on real simulation using this method. They described how to simulate an each major part of electric bike system using the RT-Lab, Simulink and Bike sim software. Sim Power System was used for modelling and simulation of power components. Simulink was used for modelling every major electric component of E-Bike. Actual experimental results were compared for evaluating the performance of hardware in the loop simulator.

Slater et al. restored a 1996 Kawasaki ninja 250R and converted a traditional gasoline motorcycle into an electric motorcycle. He compared both the traditional gasoline bike as well as the electric bike on the basis of their performance characteristics such as top speed, miles per charge and watts to charge etc. The main goal behind conducting this experiment was to identify the best version of bike for environment and economy

Machedon-Pisu, M., & Borza, P. N. (2020). Are Personal Electric Vehicles Sustainable? A Hybrid E-Bike Case Study. *Sustainability*, 12(1). <https://doi.org/10.3390/su12010032> The results of this study found that e-bikes consume less energy and produce dramatically less pollution during their lifespans than traditional vehicles. Researchers built their own e-bike and compared e-bikes to 1) cars, trains, trams, trucks, and buses; 2) medium and heavy duty EVs; 3) motorcycles, big scooters, and mopeds; and 4) motorbikes and small scooters with respect to air pollution and energy consumption. The study accounted for emissions and energy use during production, use, disposal, and refueling/charging of each vehicle.

Li, T. Z., Qian, F., & Su, C. (2014). Energy Consumption and Emission of Pollutants from Electric Bicycles. *Applied Mechanics and Materials*, This study analyzed the energy consumption and pollution emissions at different stages of the ebike life cycle (production, use, maintenance, and recycling). Results revealed that most energy consumption by e-bikes occurs during the use stage. The emissions of pollutants by e-bikes per person per kilometer are several times lower than emissions from motorcycles and cars, equivalent to buses, and higher than traditional bicycles. These results suggest that shifts from personal vehicles can help reduce overall emissions and pollutants.

McCarren, T., & Carpenter, N. (2018). Electric bikes: Survey and energy efficiency analysis. Efficiency Vermont. [papers/efficiency-vermontelectric-bike-white-paper.pdf](#) This survey asked 90 e-bike owners from Vermont questions about their e-bike use and general travel behaviors. Results revealed that the average respondent displaced 760 miles of driving annually with an e-bike. This suggests that increased e-bike adoption can significantly reduce overall emissions by enabling users to switch from personal vehicles.

Weiss, M., Dekker, P., Moro, A., Scholz, H., & Patel, M. K. (2015). On the electrification of road transportation—A review of the environmental, economic, and social performance of electric two-wheelers. Transportation Research. Part D, Transport and Environment, Researchers reviewed e-bike (with a maximum assisted speed of 25km/hr), electric moped, and electric motorcycle performance on several factors including energy and emissions. The study found that e-bike adoption can reduce human exposure to polluting emissions compared to internal combustion engine vehicles. It also found that e-bikes resulted in 50-90% energy savings compared to gas-burning mopeds and motorcycles.

Nielson, T., Palmatier, S. M., & Proffitt, A et.al. The goal of this literature review was to inform policy discussions and decisions for the quickly growing e-bike market in four of Colorado's northern Front Range open space programs. Boulder County, Colorado's literature review identified no significant difference in effects to wildlife or trail surfaces between traditional bicycles and e-bikes. The review stated, "Given that e-bikes are very similar to traditional bicycles in terms of noise, trail effect, and speed, it is fair to say that their effect on wildlife habitats would be similar to other non-motorized bicycles" based on a study of recreational disturbance of deer and elk. The literature review also found that trail users were likely to have concerns about noise and trail degradation caused by e-bikes. However, since the literature review authors found few impacts from e-bikes, the review observed that "public perception

surrounding e-bikes' [noise, trail surface, and speed] effect[s] may be at odds with observed effects."

Patel et al., designed a hybrid two Wheeler. He modified a 127 cc Gensat engine by combining with a 24V, 120 A heavy duty DC electric servo motor commanded by aurdino Mega 2560. The main functionality of model was to prove increased efficiency of traditional motor scooter. Chan.[4], they observed about a reality of the electric vehicle. And developing the advancement of electric vehicles (EV) and half electric vehicles (HEV). EVs and HEVs were easily available in the market. The paper shows current condition of electric and hybrid vehicles around the world and their cutting edge technology, with importance on the building logic, innovations and improvement of EV and HEV.

Asaei et al. fabricated hybrid electric motor cycle with the help of a general integrated procedure. A model was designed and simulated on ADVISOR 2002 and the model was exported to MATLAB/SIMULINK. The Hybrid electric motorcycle was driven by a 125 cc IC engine and a BLDC motor attached in front wheel using CVT drive. In this experiment it was observed that motorcycle performance was improved.

Wani et al. developed the prototype of a hybrid electric two wheeler vehicle. The design was more suitable motorcycle and fulfil the requirement of hybrid design concept. The Innovative packing of component ensured as much space for pillion and the rider. They showed the experimental result of tested vehicle and it was found to deliver mileage of 107.5 km.

Chavez, D., Winter, P., & Bass, J. (1993). This study analyzed responses from a telephone survey of recreation land managers across the United States regarding perceptions of mountain biking and effect on trail surfaces. While many respondents reported moderate to extensive mountain bike use in their

resource areas, most did not have designated mountain bike areas. About one-third reported resource degradation attributable to mountain bike use. Few reported having management plans specifically related to mountainbiking. This study did not address e-bikes specifically; however, it revealed a need for greater awareness and planning by land managers for emerging modes of recreation.

Newsome, D., & Davies, C. (2009) Researchers developed a rapid assessment tool which used GPS and GIS technology to quantify the total amount of land effected by mountain bike use at a recreational park in Australia. The study did not measure specific environmental effects, but the tool effectively quantified the area effected by the creation of mountain bike-specific informal trails and trail modifications The study also did not involve e-bikes, but mapping tools like the kind developed in this study may be useful in assessing short- to long-term effects of e-bikes and e-mountain bikes outside designated natural surface or paved trails.

Dawson, A. (2019). E-Bike Battery Explodes, Burning 79-Year-Old Cyclist and Causing Bushfire. *Bicycling*. This anecdotal news article describes an incident of a lithium e-bike battery igniting while the cyclist was riding on a roadway and caused a fire in dry vegetation adjacent to the road. The battery had been added to a traditional bicycle through an after-market third party. These aftermarket devices, which can be used to modify traditional bikes may pose an additional fire risk.

Johnson, M. (2015). *riders* This study includes a literature review on perceptions of safety, a review of the current infrastructure design standards, and a survey of e-bike riders exploring their experiences and perceptions of safety. The survey found that hill climbing capability and spot speed are two potential e-bike performance capabilities that are different from traditional bikes in terms of how a rider interacts with on-road and off-road infrastructure. A spot speed is the speed at a specific location (e.g., at an uphill section) as

opposed to average speed. There is no significant difference between e-bike and traditional bike riders in perceptions of comfort, including safety. rider's perspective of cycling infrastructure. E-bike were found to be older riders with less riding experience, finding that "almost four in ten female e-bike riders had not been cyclists before purchasing or riding an e-bike." When compared to using a traditional bicycle, e-bike riders generally felt as safe on loose gravel surfaces, that they accelerate faster, that they could ride at higher speeds, and that it is not harder to stop

Langford, B., Chen, J., Cherry, C., (2015). Risky riding: Naturalistic methods comparing safety behavior from conventional bicycle riders and electric bike riders. *Accident Analysis & Prevention*, 82. This is the first study to rely on naturalistic GPS data for bicycle and e-bike safety. A study was conducted using the pilot bikeshare implemented at the University of Tennessee that offered six traditional bicycles and 14 Class 1 e-bikes. Riders of e-bikes travel at higher speeds than traditional bicycles on roadways (about 2.9 kph). Riders of traditional bicycles travel at higher speeds than ebikes on shared-use paths (about 1.6 kph). Speed on natural surface trails were not identified in the study. Over the course of the pilot, the data showed that e-bike riders exhibit nearly identical safety behavior for wrong-way riding, stop sign compliance, and traffic signal compliance, as traditional bike riders. However, all cyclists had a poor compliance rate at stop signs (about 80% when traveling at 6 kph and about 40% when traveling at 11 kph) and at traffic signals (about 70%)

Petzoldt, T., Schleinitz, K., Jeilmann, S., Gehlert, T. (2016). This study examined if there are differences between traditional cyclists and e-bike riders with regard to the probability to be involved in a traffic conflict. The study investigated the circumstances under which conflicts occur to identify potential differences in risk. Researchers equipped the personal bicycles of 80 participants (31 traditional cyclists and 49 e-bike riders) with a data acquisition system that included two cameras and a speed sensor. Four weeks of "normal" cycling were recorded for each participant. The analysis showed no difference

between bicycles and e-bikes with regard to their overall involvement in traffic conflicts. One notable exception were intersections, where the risk of being involved in a conflict was twice as high for e-bikes as for traditional bicycles. The speed immediately preceding a conflict was higher for riders of ebikes compared to traditional bicycles, a pattern that was also found for mean speed.

Nielson, T., Palmatier, S., Proffitt, A., Marotti, M. (2019). This report highlighted the results of two studies, an intercept survey and a speed observation study, conducted for the e-bike pilot program allowing Class 1 and Class 2 e-bikes on certain 30 county open space trails in Boulder County, Colorado. The speed study included 12 identified e-bikes out of 503 total bike observations. People on traditional bikes travelled faster than e-bikes on downhill sections (15 mph vs 13.5 mph) and people on e-bikes travelled faster than traditional bikes on uphill sections (13.8 mph vs 12.9 mph).

Weber, T., Scaramuzza, G., Schmitt, K. (2014). The study analyzed police-recorded crashes during 2011 and 2012 involving a total of 504 e-bikers and 871 traditional bicyclists along urban and rural roadway and bicycle infrastructure (the study did not state if crashes along recreational, natural surface paths were included). Most e-bikers who sustained a crash were 40–65 years old and only a few crashes with e-bikers below 23 years of age were reported. E-bikers in the urban area sustained less single and crossing crashes and more turning and other crashes compared to e-bikers in the rural area.

Schepers, P., Fishman, E., den Hertog, P., Wolt, K., & Schwab, L. (2014). This case–control study compared the likelihood of crashes for which treatment at an emergency department is needed and injury consequences for e-bike and traditional bicycle crash incidents in the Netherlands among users 16 years and older. Data were gathered through a survey of victims treated at emergency departments. Additionally, a survey of cyclists without any known crash experience, drawn from a panel of the Dutch population acted as a

control sample. The results suggest that, after controlling for age, gender, and amount of bicycle use, e-bike users are more likely to be involved in a crash that requires treatment at an emergency department due to a crash. When they occur, crashes with e-bikes are about equally as severe as crashes with traditional bicycles. The study did not state if crashes along recreational, natural surface paths were included.

Ma, C., Zhou, J., Yang, D., Fan, Y. (2019). This paper obtained 350 survey responses from e-bike riders along a roadway when the rider was asked to stop to participate in our survey. Eight individual attributes were used as potential influencing factors of rider speed choice: rider's gender, age, education level, years of experience riding an e-bike, rider's personality characteristic (melancholic, phlegmatic, sanguine, and choleric temperament),

CHAPTER 3

PROBLEM STATEMENT

E-bike requires E stations that must be maintained with a proper power source. GPS tracking system must be installed in all cases of the units to solve the connectivity issues in case of battery failure. This would also increase the productivity of the battery cells which exhaust the natural resource of renewable energy. In the case of energy service these bikes must be taken under proper tech persons to sort the problems. These kinds of non-gear bikes can only be designed with BLDC motor which is expensive in the market.

OBJECTIVES

1. To auto-control the speed of E-bikes through differential bevel gears.
2. To increase the system suspension differential balance between the cob joint during speed control.
3. To increase friction activity during sudden speed control.
4. To main the data log of the road activity during speed control on the regular road study.
5. To analyze the behavior and physical parameter of the road to initiate turbo start.

CHAPTER 4

EXISTING SYSTEM AND PROPOSED METHODOLOGY

4.1 EXISTING SYSTEM OF E-BIKE SPEED CONTROL

No Proper Battery Suge current calculations are made during Mode switching. Speed control is manual not on sensor data. Data log is not maintained for battery service and fuel ability calculation. CAN-based centralized controllers are not specially designed which is even our projects' future scope to handle day-to-day data. GPS tracking is not powered by free energy we can modulate the mode speed to recharge the system based on the reverse suspension effect.

4.2 PROPOSED SYSTEM OF E-BIKE SPEED CONTROL

Here we developed this project with 24v solar panel which acts as a storage device for electricity and power that is regenerated with solar panel is stored in the 12v rechargeable batteries. Previously the project is dependent on single 12battery, now we had used two 12v rechargeable batteries which havethe capacity to store more power. In previously they used gear to control speed. But in our project we use certain speed .By this way we reduse the battery usage and increase the capacity and it will help to increase the millageof e-bike

Advantages of the Proposed System

Upcoming key points are the current drawbacks that still exist in the following methods. In our proposal, we came across sorting out the listed errors

1. Segregation process is only implemented in our system
2. Bundling and package part will be developed in our future plans
3. Monitoring of data on the cloud required the power of the internet and separated server space
4. But when compared to the entire profit of the project this system loss is negligible
5. 24x7 power backup must be maintained for proper updates

4.3 BLOCK DIAGRAM OF PROPOSED E-BIKE SPEED

CONTROL:

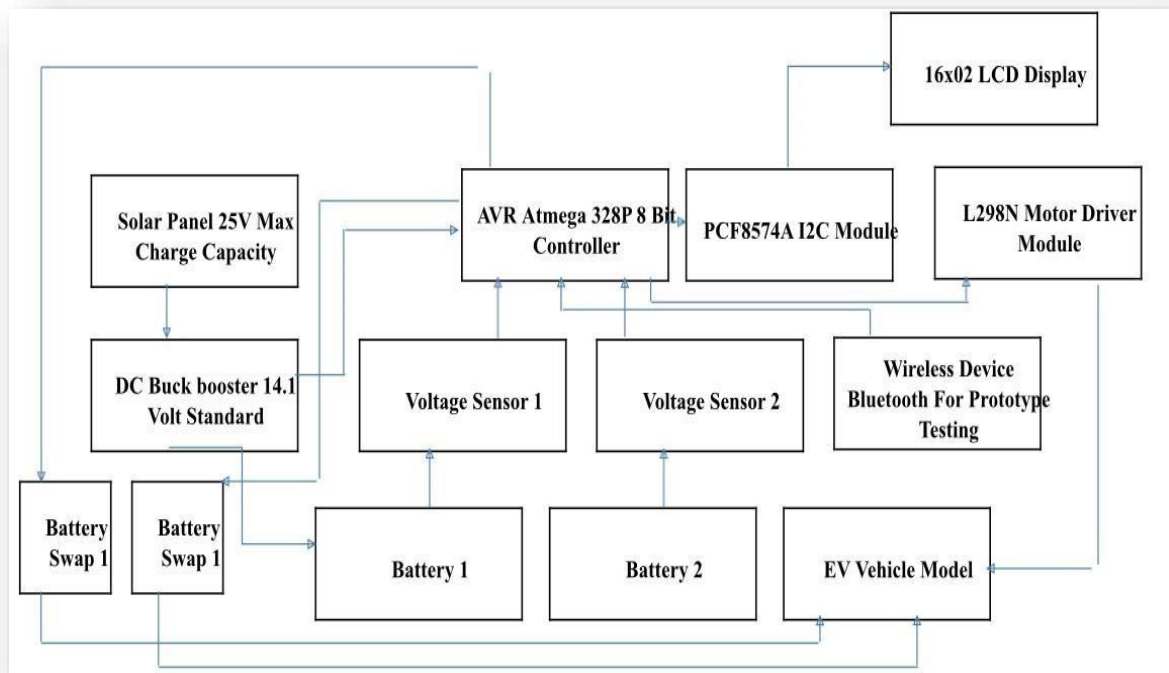


Fig 4.1 BLOCK DIAGRAM

Algorithm of Our Working Model:

PHASE 1 – E-Bike BLDC PWM Tooth Generator

- This Phase deals with the BLDC Rotation control from the bevel connectors
- Based on the Duty cycles released from the throttle the modes can be changed into three operations such Normal mode, Economy, and Sports Mode.
- Based on this mode selection BLDC will be coupled with the internal Centrifugal load transmitters
- Without proper PWM signals mode selection is not possible to rotate the gears
- As per our approximation system speed varies from 30kmp – 120kmp

PHASE 2 – Vibration Sensor Activity Log Calculator

- Based on the Road Condition data log will be generated for a safe ride.
- Sport mode will not be activated in the vibration data from the CAN bus is high.
- This prominently helps us to increase the stability of the system.

PHASE 3 – Battery Charge Cut-off

- On Manual tripping this engine system can attain full load and full speed
- Bevel transmissions will not take into data activity
- In such cases high usage of the battery will reduce the battery life and create a lot of system failures
- So, it is mandated to check the battery drain rate based on the consumption ratio

Architecture

In gear transmissions, vibration causes noise and malfunction. In actual applications, misalignments contribute to intensifying the destructive effect of vibrations. In this project, the nonlinear dynamics of a spiral bevel gear pair, with a small helix angle, considering different misalignments, are deeply investigated. Axial misalignment, radial misalignment, and the combination of these two types are considered in this study. The governing equation is numerically solved through an implicit Runge–Kutta scheme. Since the main goal of this study is the analysis of the dynamic scenario, the mesh stiffness of the gear pair is obtained from the literature. The dynamical system is nonlinear and time-varying; it is analyzed through time responses, phase portraits, Poincare maps, and bifurcation diagrams. Results show that among the considered three cases with different types of misalignments, the spiral bevel gear with axial misalignment is the worst destructive case; aperiodic, subharmonic, and multiperiod responses are observable for this case. It is interesting that the chaotic responses for the case, having both types of

misalignments, are less likely for the case with axial misalignment. These are the list of alternatives that must be changed to control the speed of BLDC motors based on the Physical Road conditions.

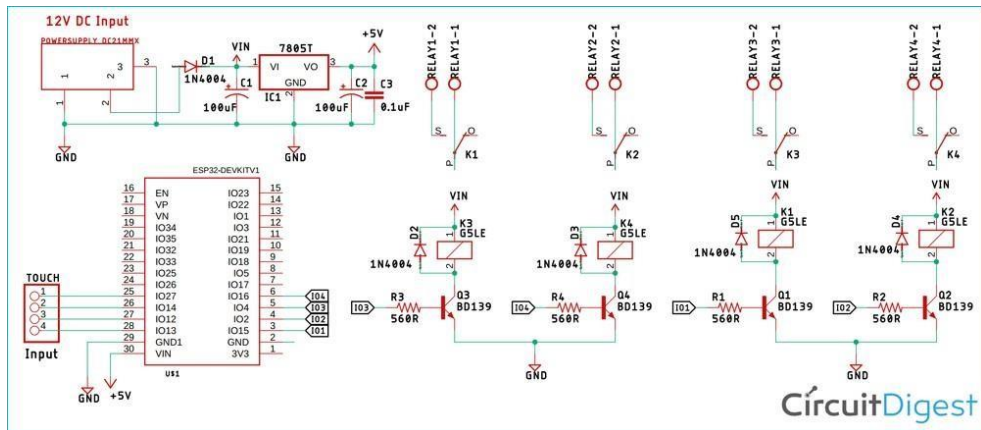


Fig 4.2 – Architecture of Mode Switching on E-Bike

CHAPTER 5 HARDWARE COMPONENTS

5.1 Hardware Required

- AVR Atmega 328P 8-bit Controller
- DC Buck booster 14.1 volt
- Battery Swap 1,2
- Voltage Sensor 1,2
- 16*2 LCD Display
- PCF8574A 12C Module
- Wireless Bluetooth Device
- L298N Motor Driver Module
- Solar Panel 25v
- 12v Rechargeable Batteries

AVR Atmega 328P 8-bit Controller:

ATmega328 8-Bit AVR MCUs are low-power, CMOS 8-bit microcontrollers based on the AVR® enhanced RISC architecture. The devices execute instructions in a single clock cycle to achieve CPU throughput approaching one million instructions per second (MIPS) per megahertz. This allows for optimizing power consumption versus processing speed.

Features:

- High performance, low power AVR® 8-Bit Microcontroller family
- Advanced RISC architecture
 1. 131 powerful instructions – most single clock cycle execution
 2. 32 x 8 general-purpose working registers

3. Fully static operation
 4. Up to 20 MIPS throughput at 20MHz
 5. On-chip 2-cycle multiplier
- High endurance non-volatile memory segments
 1. 4/8/16/32KBytes of in-system self-programmable Flash program memory
 2. 256/512/512/1KBytes EEPROM
 3. 512/1K/1K/2KBytes internal SRAM
 4. Write/erase cycles 10,000 Flash/100,000 EEPROM
 5. Data retention 20 years at 85°C/100 years at 25°C(1)
 6. Optional boot code section with independent lock bits
 - In-system programming by an on-chip boot program
 - True read-while-write operation
 - Programming lock for software security
 - QTouch® library support
 1. Capacitive touch buttons, sliders, and wheels
 2. QTouch and QMatrix™ acquisition
 3. Up to 64 sense channels
 - Peripheral features
 1. Two 8-bit timer/counters with separate prescaler and compare mode
 2. One 16-bit timer/counter with separate prescaler, compare mode, and capture mode
 - Real-time counter with separate oscillator
 1. Six PWM channels
 2. 8-channel 10-bit ADC in TQFP and VQFN package
 - Temperature measurement
 1. 6-channel 10-bit ADC in SPDIP package

- Temperature measurement
 1. Programmable serial USART
 2. Master/slave SPI serial interface
 3. Byte-oriented 2-wire serial interface (Philips I²C compatible)
 4. Programmable watchdog timer with separate on-chip oscillator
 5. On-chip analog comparator
 6. Interrupt and wake up on Pin change
- Special microcontroller features
 1. Power-on reset and programmable brown-out detection
 2. Internal calibrated oscillator
 3. External and internal interrupt sources
 4. Six sleep modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby, and Extended Standby
- I/O and packages
 1. 23 programmable I/O lines :28-pin SPDIP, 32-lead TQFP, 28-pad VQFN, and 32-pad VQFN
- Operating voltage
 1. 1.8 - 5.5V
- Temperature range
 1. -40°C to 85°C
- Speed grade
 1. 0-4MHz at 1.8-5.5V, 0-10MHz at 2.7-5.5.V, 0-20MHz at 4.5-5.5V
- Power consumption at 1MHz, 1.8V, 25°C
 1. Active mode 0.2mA
 2. Power-down mode 0.1μA

- Power-save mode 0.75 μ A (including 32kHz RTC)

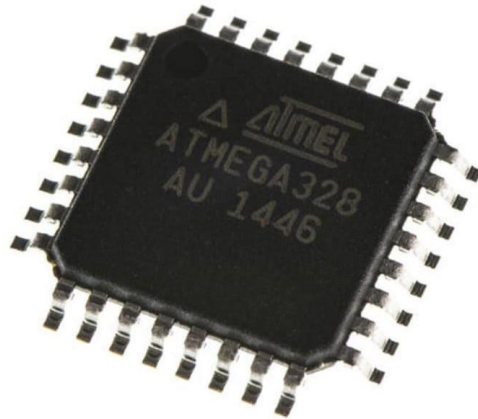


Fig 5.1 ATmega328p

DC buck booster 14.1 volt

The **buck–boost converter** is a type of DC to DC Converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is equivalent to a flyback converter using a single inductor instead of a transformer. Two different topologies are called buck–boost converter. Both of them can produce a range of output voltages, ranging from much larger (in absolute magnitude) than the input voltage, down to almost zero.

In the inverting topology, the output voltage is of the opposite polarity than the input. This is a switch mode power supply with a similar circuit topology to the boost converter and the buck converter. The output voltage is adjustable based on the of the switching duty cycle transistor. One possible drawback of this converter is that the switch does not have a terminal at ground; this complicates the driving circuitry. However, this drawback is of no consequence if the power supply is isolated from the load circuit (if, for example, the supply is a battery) because the supply and diode polarity can simply be reversed. When they can be reversed, the switch can be on either the ground side or the supply side.

When a buck (stepdown) converter is combined with a boost (stepup) converter the output voltage is typically of the same polarity of the input, and can be lower or

higher than the input. Such a non-inverting buck-boost converter may use a single inductor which is used for both the buck inductor mode and the boost inductor mode, using switches instead of diodes, sometimes called a "four-switch buck-boost converter, it may use multiple inductors but only a single switch as in the SEPIC and Cuk topologies.



Fig 5.2 Buck boost Converter

5.2 Voltage Sensor

Generally, a sensor is an electrical device used to detect as well as respond to a particular type of signal like optical or electrical. Implementation of sensor techniques in voltage or current has become an outstanding option toward the measurement of voltage & current methods. The advantages of sensors over conventional methods for measuring mainly include less size and weight, high safety, high accuracy, non-saturable, eco-friendly, etc. It is feasible to merge both the current and voltage measurement into a physical device with tiny and solid dimensions. This article discusses an overview of the voltage sensor and its working.

- This sensor is used to monitor, calculate and determine the voltage supply. This sensor can determine the AC or DC voltage level. The input of this sensor can be the voltage whereas the output is the switches, analog voltage signal, a current signal, an audible signal, etc. Some sensors provide sine waveforms or pulse waveforms like output & others can generate outputs like AM (Amplitude Modulation), PWM (Pulse Width Modulation) or FM

(Frequency Modulation). The measurement of these sensors can depend on the voltage divider.

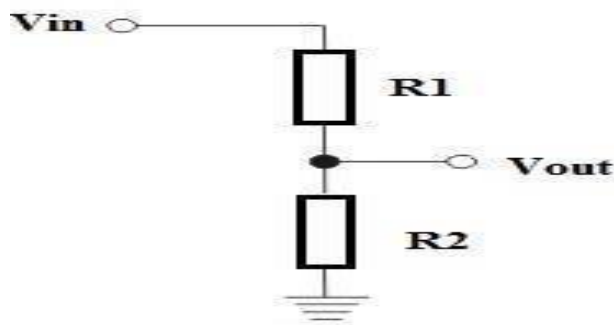
- This sensor includes input and output. The input side mainly includes two pins namely positive and negative pins. The two pins of the device can be connected to the positive & negative pins of the sensor. The device positive & negative pins can be connected to the positive & negative pins of the sensor. The output of this sensor mainly includes supply voltage (Vcc), ground (GND), analog o/p data

Types of Voltage Sensors

These sensors are classified into two types like a resistive type sensor and capacitive type sensor.

1) Resistive Type Sensor

This sensor mainly includes two circuits like a voltage divider & bridge circuit. The resistor in the circuit works as a sensing element. The voltage can be separated into two resistors like a reference voltage & variable resistor to make a circuit of the voltage divider. A voltage supply is applied to this circuit. The output voltage can be decided by the resistance used in the circuit. So the voltage change can be amplified.



2) Capacitor Type Sensor

This type of sensor consists of an insulator and two conductors within the center. As the capacitor is power-driven with 5 Volt, then the flow of current will be there in the capacitor. This can create revulsion of electrons within the capacitor. The difference in capacitance indicates the voltage and the capacitor can be connected within the series.

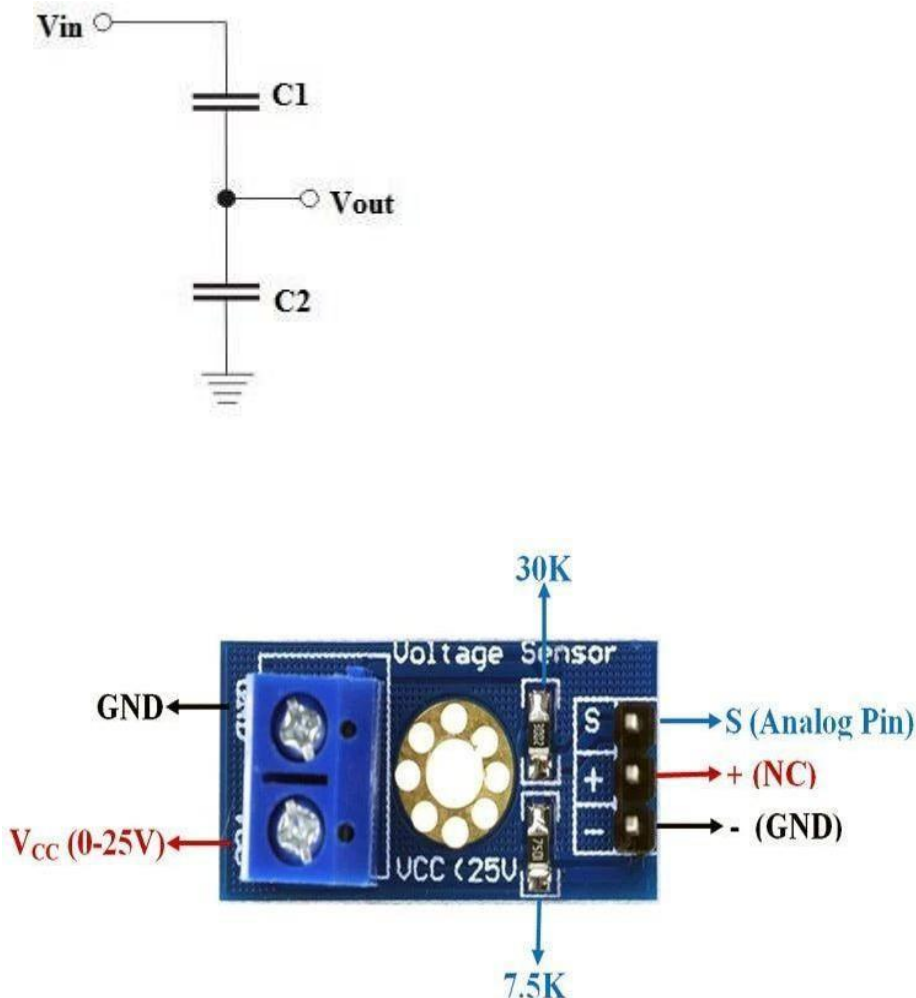


Fig 5.3 Voltage Detection Sensor

16x2 LCD Display

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. But the most used one is the 16*2 LCD, hence we are using it here.

All the above mentioned LCD display will have 16 Pins and the programming approach is also the same and hence the choice is left to you. Below is the **Pinout and Pin Description of 16x2 LCD Module**:

The LCD can work in two different modes, namely the 4-bit mode and the 8-bit mode. In **4 bit mode** we send the data nibble by nibble, first upper nibble and then lower nibble. For those of you who don't know what a nibble is: a nibble is a group of four bits, so the lower four bits (D0-D3) of a byte form the lower nibble while the upper four bits (D4-D7) of a byte form the higher nibble. This enables us to send 8 bit data.

Whereas **in 8 bit mode** we can send the 8-bit data directly in one stroke since we use all the 8 data lines.

Now you must have guessed it, Yes 8-bit mode is faster and flawless than 4-bit mode. But the major drawback is that it needs 8 data lines connected to the microcontroller. This will make us run out of I/O pins on our MCU, so 4-bit mode is widely used. No control pins are used to set these modes. It's just the way of programming that change.

Read and Write Mode of LCD:

As said, the LCD itself consists of an Interface IC. The MCU can either read or write to this interface IC. Most of the times we will be just writing to the IC, since reading will make it more complex and such scenarios are very rare. Information like position of cursor, status completion interrupts etc. can be read if required, but it is out of the scope of this tutorial.



Fig 5.4 16x2LCD Display

PCF8574A 12C Module

KEY FEATURES OF PCF8574 I2C I/O EXPANSION MODULE:

- 8 bi-directional data lines
- Loop-thru feature allows expansion of up to 8 modules / 64 data lines
- I2C interface with jumper adjustable addresses
- Interrupt output capability
- 3.3V and 5V compatible.

A common requirement when working with MCUs is the need to add more digital I/O than the device supports natively. The PCF8574 is one of the more popular methods of adding lines as it uses the I2C bus that requires only 2 lines on the MCU. It provides 8 additional digital I/O lines which are easily expandable up to 64.

I2C Interface

The base I2C address of the modules is 0x20.

There are three address jumps (A0-A2) the determines which I2C address to use. As shipped, these jumpers are all set to the '-' side which is ground or LOW as shown in the picture. The '+' side is Vcc or HIGH.

This puts the module at the base address of 0x20. The jumpers can be moved in a binary fashion to increase the address, so the address can range from 0x20 to 0x27 as shown in the table below.

If you daisy-chain the modules, you will need to set a different address for each of the modules.

Address (Hex)	A2	A1	A0
0x20	LOW	LOW	LOW
0x21	LOW	LOW	HIGH
0x22	LOW	HIGH	LOW
0x23	LOW	HIGH	HIGH
0x24	HIGH	LOW	LOW
0x25	HIGH	LOW	HIGH
0x26	HIGH	HIGH	LOW
0x27	HIGH	HIGH	HIGH

You may run into devices with the PCF8574A part installed. If that happens, don't panic. These just use a different starting I2C address of 0x38. This part is offered by the mfr so that if both A and non-A parts are used together in a system, the

number of modules can be increased up to a maximum of 16 providing at total of 128 digital lines. The 'T' marking on the devices just denote that it is a surface mount device.

If there is ever a doubt about the I2C address of this or any device, just hook it up to the I2C bus and apply power and ground and then run the [I2C scanner software](#).

I/O Functionality

The I/O is defined as quasi-bidirectional. A quasi-bidirectional I/O is either an input or output port without using a direction control register. When set as inputs, the pins act as normal inputs do. When set as outputs, the PCF8574 device drives the outputs LOW with up to 25mA sink capability but when driving the outputs HIGH, they are just pulled up high with a weak internal pull-up. That enables an external device to overpower the pin and drive it LOW.

The device powers up with the 8 data lines all set as inputs.

When using the pins as inputs, the pins are set to HIGH by the MCU, which turns on a weak 100 uA internal pull-up to Vcc. They will read as HIGH if there is no input or if the pin is being driven HIGH by an external signal but can be driven LOW by an external signal that can easily override the weak pull-up.

If used as outputs, they can be driven LOW by the MCU by writing a LOW to that pin. A strong pull-down is turned on and stays on to keep the pin pulled LOW. If the pin is driven HIGH by the MCU, a strong pull-up is turned on for a short time to quickly pull the pin HIGH and then the weak 100uA pull-up is turned back on to keep the pin HIGH.

If the pins are set to be outputs and are driven LOW, it is important that an external signal does not also try to drive it HIGH or excessive current may flow and damage the part.

Whenever the internal register is read, the value returned depends on the actual voltage or status of the pin.

The I/O ports are entirely independent of each other, but they are controlled by the same read or write data byte.

5.3 Interrupt Output

The interrupt open drain output pin is active LOW. It is normally pulled HIGH using a pull-up resistor and is driven low by the PCF8574 when any of the inputs change state. This signals the MCU to poll the part to see what is going on. If connecting this pin, enable the internal pull-up resistor on the MCU or add an external pull-up of 10K or so.

If using interrupts with multiple modules, since they are open drain they can be tied together if a single interrupt back to the MCU is desired.

Module Connections

The connections to the module are straight forward.

1. Supply 3.3 or 5V power and ground.
2. Connect I2C SCL and SDA lines to same on the MCU.
3. If used, connect the INT line to an interrupt input on the MCU and use a pull-up resistor.

1 x 4 Header (Male & Female)

- **VCC** = Vcc (2.5V – 6V) typically connects to uC 3.3V or 5V
- **GND** = Ground connects to uC ground
- **SDA** = I2C SDA connects to uC I2C SDA
- **SCL** = I2C SCL connects to uC I2C SCL

1 x 9 Header

- **P0** = I/O Pin 0
- **P1** = I/O Pin 1
- **P2** = I/O Pin 2
- **P3** = I/O Pin 3

- **P4** = I/O Pin 4
- **P5** = I/O Pin 5
- **P6** = I/O Pin 6
- **P7** = I/O Pin 7
- **INT** = Interrupt Output – connects to MCU interrupt pin. Active LOW

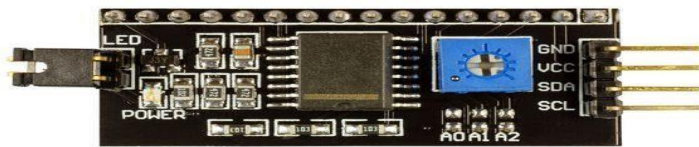


Fig 5.5 PC8574A 12C Module

L298N Motor Driver Module

This **L298N Motor Driver Module** is a high power motor driver module for driving DC and Stepper Motors. This module consists of an L298 motor driver IC and a 78M05 5V regulator. **L298N Module** can control up to 4 DC motors, or 2 DC motors with directional and speed control.

L298N Module Pinout Configuration

Pin Name	Description
IN1 & IN2	Motor A input pins. Used to control the spinning direction of Motor A
IN3 & IN4	Motor B input pins. Used to control the spinning direction of Motor B
ENA	Enables PWM signal for Motor A
ENB	Enables PWM signal for Motor B

OUT1 & OUT2	Output pins of Motor A
OUT3 & OUT4	Output pins of Motor B
12V	12V input from DC power Source
5V	Supplies power for the switching logic circuitry inside L298N IC
GND	Ground pin

Features & Specifications

- Driver Model: L298N 2A
- Driver Chip: Double H Bridge L298N
- Motor Supply Voltage (Maximum): 46V
- Motor Supply Current (Maximum): 2A
- Logic Voltage: 5V
- Driver Voltage: 5-35V
- Driver Current: 2A
- Logical Current: 0-36mA
- Maximum Power (W): 25W
- Current Sense for each motor
- Heatsink for better performance
- Power-On LED indicator

Alternate Driver Modules: [TMC2209](#), [DRV8825](#), [A4988](#), L9110S, DRV8711

Related Components: LM298 Motor Driver IC, 78M05 Voltage Regulator, [Capacitors](#), [Resistors](#), [Heat Sink](#)

Brief about L298N Module

The L298N Motor Driver module consists of an L298 Motor Driver IC, 78M05 Voltage Regulator, resistors, capacitor, Power LED, 5V jumper in an integrated circuit.

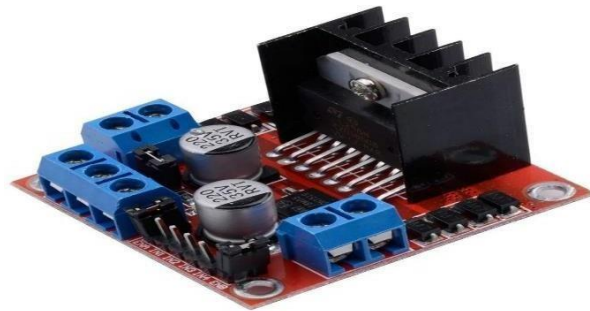


Fig 5.6 L298N Motor Driver

78M05 Voltage regulator will be enabled only when the jumper is placed. When the power supply is less than or equal to 12V, then the internal circuitry will be powered by the voltage regulator and the 5V pin can be used as an output pin to power the microcontroller. The jumper should not be placed when the power supply is greater than 12V and separate 5V should be given through 5V terminal to power the internal circuitry.

ENA & ENB pins are speed control pins for Motor A and Motor B while IN1& IN2 and IN3 & IN4 are direction control pins for Motor A and Motor B.

Solar Panel

Form of sunlight and convert that light into electricity which can then be used to provide power for electrical loads. Solar panels are comprised of several individual solar cells which are themselves composed of layers of silicon, phosphorous (which provides the negative charge), and boron (which provides the positive charge). Solar panels absorb the photons and in doing so initiate an electric current. The

resulting energy generated from photons striking the surface of the solar panel allows electrons to be knocked out of their atomic orbits and released into the electric field generated by the solar cells which then pull these free electrons into a directional current. This entire process is known as the Photovoltaic Effect. An average home has more than enough roof area for the necessary number of solar panels to produce enough solar electricity to supply all of its power needs excess electricity generated goes onto the main power grid, paying off in electricity use at night.

In a well-balanced grid-connected configuration, a solar array generates power during the day that is then used in the home at night. Net metering programs allow solar generator owners to get paid if their system produces more power than what is needed in the home. In off-grid solar applications, a battery bank, charge controller, and in most cases, an inverter are necessary components. The solar array sends direct current (DC) electricity through the charge controller to the battery bank. The power is then drawn from the battery bank to the inverter, which converts the DC current into alternating current (AC) that can be used for non-DC appliances. Assisted by an inverter, solar panel arrays can be sized to meet the most demanding electrical load requirements. The AC current can be used to power loads in homes or commercial buildings, recreational vehicles and boats, remote cabins, cottages, or homes, remote traffic controls, telecommunications equipment, oil and gas flow monitoring, RTU, SCADA, and much more.



Fig.5.7 Solar Panel

Arduino uno

The Arduino UNO is a standard board of Arduino. Here UNO means 'one' in Italian. It was named as UNO to label the first release of Arduino Software. It was also the first USB board released by Arduino. It is considered as the powerful board used in various projects. Arduino.cc developed the Arduino UNO board.

Arduino UNO is based on an ATmega328P microcontroller. It is easy to use compared to other boards, such as the Arduino Mega board, etc. The board consists of digital and analog Input/Output pins (I/O), shields, and other circuits. The Arduino UNO includes 6 analog pin inputs, 14 digital pins, a USB connector, a power jack, and an ICSP (In-Circuit Serial Programming) header. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

ATmega328 Microcontroller- It is a single chip Microcontroller of the ATmel family. The processor code inside it is of 8-bit. It combines Memory (SRAM, EEPROM, and Flash), Analog to Digital Converter, SPI serial ports, I/O lines, registers, timer, external and internal interrupts, and oscillator.

ICSP pin - The In-Circuit Serial Programming pin allows the user to program using the firmware of the Arduino board.

Power LED Indicator- The ON status of LED shows the power is activated. When the power is OFF, the LED will not light up.

Digital I/O pins- The digital pins have the value HIGH or LOW. The pins numbered from D0 to D13 are digital pins.

TX and RX LED's- The successful flow of data is represented by the lighting of these LED's.

AREF- The Analog Reference (AREF) pin is used to feed a reference voltage to the Arduino UNO board from the external power supply.

Reset button- It is used to add a Reset button to the connection.

USB- It allows the board to connect to the computer. It is essential for the programming of the Arduino UNO board.

Crystal Oscillator- The Crystal oscillator has a frequency of 16MHz, which makes the Arduino UNO a powerful board.

Voltage Regulator- The voltage regulator converts the input voltage to 5V.

GND- Ground pins. The ground pin acts as a pin with zero voltage.

Vin- It is the input voltage.

Analog Pins- The pins numbered from A0 to A5 are analog pins. The function of Analog pins is to read the analog sensor used in the connection. It can also act as GPIO (General Purpose Input Output) pins.

The technical specifications of the Arduino UNO are listed below:

There are 20 Input/Output pins present on the Arduino UNO board. These 20 pins include 6 PWM pins, 6 analog pins, and 8 digital I/O pins.

The PWM pins are Pulse Width Modulation capable pins.

The crystal oscillator present in Arduino UNO comes with a frequency of 16MHz.

It also has a Arduino integrated WiFi module. Such Arduino UNO board is based on the Integrated WiFi ESP8266 Module and ATmega328P microcontroller.

The input voltage of the UNO board varies from 7V to 20V.

Arduino UNO automatically draws power from the external power supply. It can also draw power from the USB.

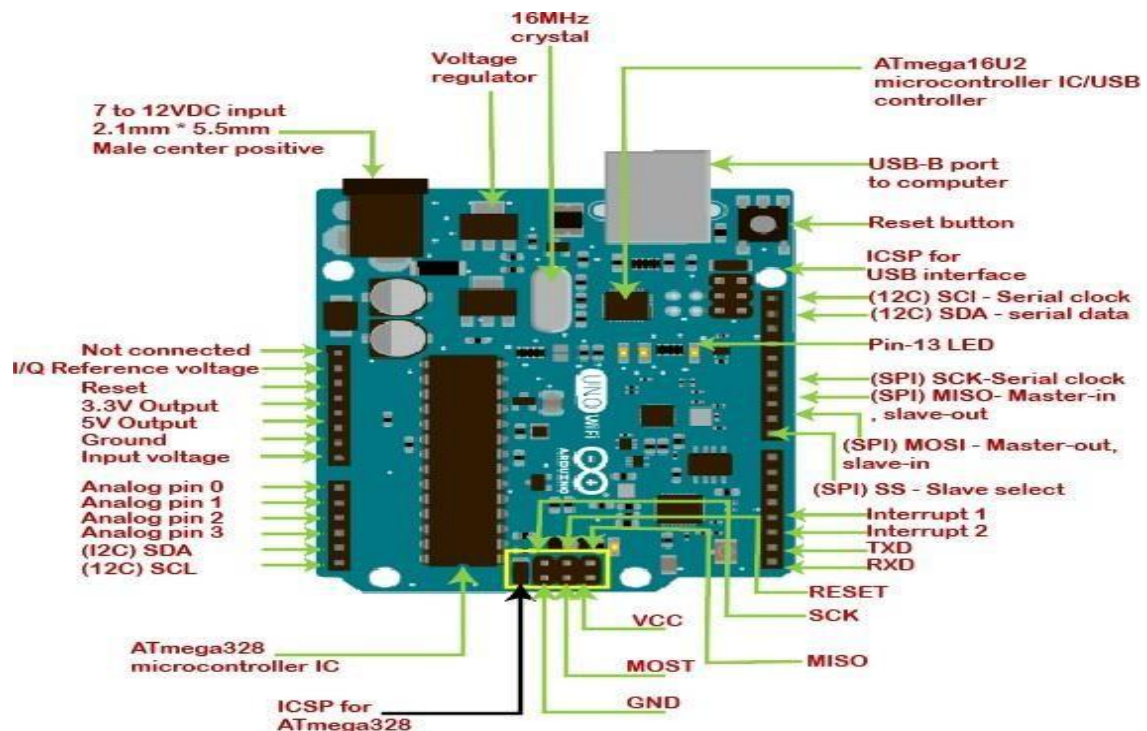


Fig 5.8 Arduino Uno

Bluetooth Module

The HC05 bluetooth module is used as UART serial converter module and can easily transfer the UART data through the wireless bluetooth. The Bluetooth module has a Frequency: 2.4GHz ISM band, PIO control and comes with an integrated antenna and edge connector.

HC-05 Bluetooth Module

HC-05 is a Bluetooth device used for wireless communication with Bluetooth enabled devices (like smartphone). It communicates with microcontrollers using serial communication (USART).

Default settings of HC-05 Bluetooth module can be changed using certain AT commands. As HC-05 Bluetooth module has 3.3 V level for RX/TX and microcontroller can detect 3.3 V level, so, there is no need to shift TX voltage level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.

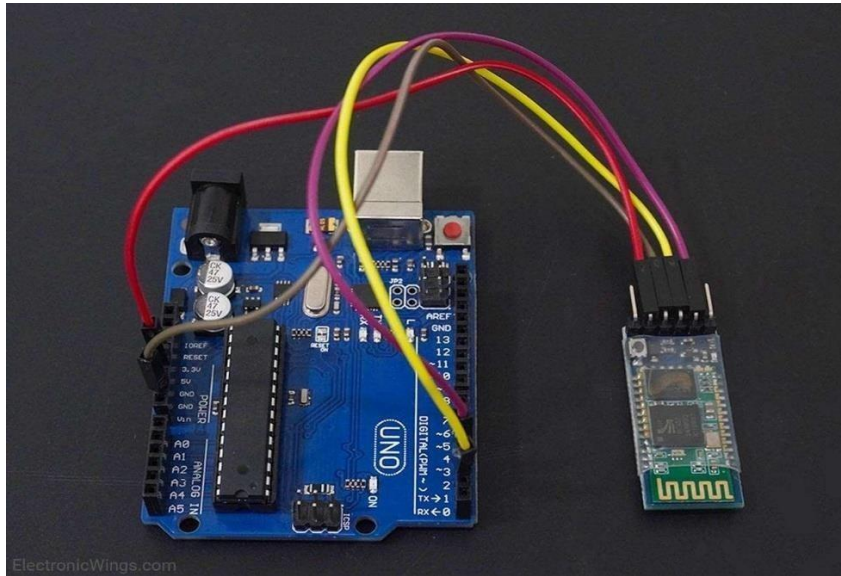


Fig 5.9 Bluetooth Module

CHAPTER 6

APPLICATIONS

Applications

- They are used for traveling long distances.
- They are the future mode of transport and they can even replace other pollution-causing mobility systems like Petrol Engine Bikes and Diesel Engine Cars too.
- Electric Bicycles are better for older people due to its less pedal force applications.
- They are used in large industries and manufactures to travel across industry area

Advantages

- Allows seniors or those physically unable to far travel longer distances.
- The downtube battery keeps weight low and Enhances balance.
- It is compact and requires very little maintenance.
- Allows you to travel faster than a regular bike(especially when going uphill).
- Easy to maintain, it's just an ordinary bike with an added battery and motor.
- Very useful for commuting quickly and avoiding traffic.
- If the battery is empty, you can just cycle normally, which may help you lose weight.

Disadvantages

- High mobility & versatility - overcomes off-road, dirt, snow.
- It's heavy, which makes it difficult to store and very difficult to pedal up a hill if you run out of battery power
- Short battery life and long charging time, should you buy a 10 Ah 36 V battery, you are likely limited to around 50 km (36 mi)

- Double the price of a standard bicycle
- Electric Bikes May Cost More Than Traditional Bicycles
- Electric Bikes Can Be Hefty
- Electric Bike Riding Rules Aren't Always Clear
- Electric Bike Batteries Can Be a Hassle

Constraints

There are several limitations to consider when it comes to the speed control of an electric bike project:

Motor and Battery Capabilities: The speed control of an electric bike project is limited by the motor and battery capabilities. If the motor is not powerful enough or the battery does not provide enough voltage or current, the speed of the electric bike will be limited.

Legal Regulations: There are legal regulations that govern the speed of electric bikes in different countries. In some countries, electric bikes are limited to a certain speed limit, and exceeding that limit may result in legal penalties.

Safety: Speed control is also important for safety reasons. The faster an electric bike goes, the greater the risk of accidents and injuries. It is essential to ensure that the speed control mechanism is working correctly to prevent accidents.

Cost: The cost of the speed control mechanism can be a limiting factor for some electric bike projects. Some high-end speed control systems can be expensive, and this may make them unaffordable for some projects.

Environmental factors: The speed control of an electric bike may also be affected by environmental factors such as wind resistance, terrain, and temperature. These factors can affect the performance of the motor and the battery, and ultimately limit the speed of the electric bike.

Standards

IEEE 158-2011: Standard for Electric Power Systems in Recreational Vehicles. This standard provides guidelines for the design and installation of electric power systems in recreational vehicles, including electric bikes.

IEEE 2030.1-2017: Guide for Electric Power System Communications: Connectivity Options for Distributed Energy Resources. This standard provides guidance on communication protocols for electric power systems that incorporate distributed energy resources, which could include electric bikes.

IEEE 1547-2018: Standard for Interconnecting Distributed Energy Resources with Electric Power Systems. This standard specifies the requirements for the interconnection of distributed energy resources with electric power systems, which could include electric bikes used as a form of distributed energy resource.

IEEE 299-1997: Recommended Practice for the Evaluation of Large Vertical Axis Wind Turbine Components. While not specific to electric bikes, this standard provides guidance on the testing and evaluation of components for renewable energy systems, which could include electric bike motors and batteries.

CHAPTER 7

CONCLUSION

In conclusion, the E-bike speed control system is an essential component of electric bicycles that helps riders maintain a safe and comfortable speed while riding. The system employs various technologies, such as torque sensors, pedal-assist sensors, and throttle controls, to regulate the motor's speed and power output. The E-bike speed control system offers several benefits to riders, including increased safety, improved battery life, and enhanced performance. With the increasing popularity of electric bicycles, the development of more advanced and efficient E-bike speed control systems is expected to continue, improving the overall riding experience, and making E-bikes an even more viable alternative to traditional bicycles and motorized vehicles.

In addition to enhancing the overall riding experience, the E-bike speed control system also plays a critical role in ensuring compliance with local regulations and laws. The system enables manufacturers to set maximum speed limits for their electric bicycles to meet the legal requirements of different regions. By adhering to these speed limits, riders can avoid potential fines or legal consequences for violating local laws. Moreover, the speed control system's ability to regulate the motor's output makes E-bikes more accessible to a broader range of riders, including those who may not have the strength or ability to ride a traditional bicycle. As such, the E-bike speed control system represents a significant advancement in personal transportation technology, providing a safer, more eco-friendly, and efficient alternative to traditional modes of transportation.

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