PERSONAL MICRO-MOBILITY SYSTEM

A REPORT

JEC1832: PROJECT WORK PHASE - 2

IV YEAR / VIII SEM

R2019

Submitted by

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in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING
in

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

JERUSALEM COLLEGE OF ENGINEERING
(An Autonomous Institution, Affiliated to
Anna University, Chennai)
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APRIL 2023

BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We express our sincere and profound thanks to our respectful Chairperson, Professor **Dr. M. MALA** for supporting us with all the facilities and resources required to complete our project successfully. We would like to thank the principal of our college **Dr. RAMESH S** for supporting and motivating us.

We would like to express our immense gratitude to **Dr. P. GNANASIVAM**, Professor and Dean - IR and TBI, Department of Electronics and Communication Engineering, for his timely advice and suggestions while doing the project. We also express our gratitude to **Dr. SHEEJA V FRANCIS**, Professor and HOD, Department of Electronics and Communication Engineering, whose advice and guidance helped us to do the study with understanding and complete the project successfully.

We would like to express our gratefulness to our project mentor **Ms. G.T. BHARATHY**, Associate Professor, Department of Electronics and Communication Engineering for providing the opportunity of doing this project under her supervision and advice. We also thank all the faculty members and lab instructors of the Department for their timely help.

Finally, we would like to thank our family members and friends for their moral support and encouragement during our studies.

ABSTRACT

Micro-mobility transportation systems for individual usage have grown in popularity recently, with the "Hoverboard" device being the most well- liked [1]. These systems are flexible, small, and efficient for personal transportation in a range of settings. With the use of an Accelerometer sensor, an Arduino UNO, an Arduino Nano, a 12V battery, and a Wiper motor, this project will construct a personal micro- mobility system electric vehicle in the shape of a rectangular grid. Two folding pads make up this rectangular grid, which when opened forms a platform for seating. The system also includes a seating configuration. With the sensor imprinted on gloves, the operator may control the system's speed and direction by making hand gestures. The goal of this project is to create and manage a straightforward, inexpensive self- transportation system.

Keywords - Micro-mobility, Accelerometer sensor, Arduino Nano, Wiper motor, Hand-gestures

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. It can be powered by a collector system, with electricity from extravehicular sources, or it can be powered autonomously by a battery (sometimes charged by solar panels, or by converting fuel to electricity using fuel cells or a generator). EVs include, but are not limited to, road and rail vehicles, surface and underwater vessels, electric aircraft and electric spacecraft. For road vehicles, together with other emerging automotive technologies such as autonomous driving, connected vehicles and shared mobility, EVs form a future mobility vision called Connected, Autonomous, Shared and Electric (CASE) Mobility.

EVs first came into existence in the late 19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing a level of comfort and ease of operation that could not be achieved by the gasoline cars of the time. Internal combustion engines were the dominant propulsion method for cars and trucks for about 100 years, but electric power remained commonplace in other vehicle types, such as trains and smaller vehicles of all types.

In the 21st century, EVs have seen a resurgence due to technological developments, and an increased focus on renewable energy and the potential reduction of transportation's impact on climate change, air pollution, and other environmental issues. Project Drawdown describes electric vehicles as one of the 100 best contemporary solutions for addressing climate change.

Government incentives to increase adoption were first introduced in the late 2000s, including in the United States and the European Union, leading to a growing market for the vehicles in the 2010s. Increasing public interest and awareness and structural incentives, such as those being built into the green recovery from the COVID-19 pandemic, is expected to greatly increase the electric vehicle market. During the COVID-19 pandemic, lockdowns have reduced the amount of greenhouse gases from gasoline or diesel vehicles. The International Energy Agency said in 2021 that governments should do more to meet climate goals, including policies for heavy electric vehicles. Electric vehicle sales may increase from 2% of global share in 2016 to 30% by 2030. As of July 2022, global EV market size was $280 billion and it is expected to grow to $1 trillion by 2026. Much of this growth is expected in markets like North America, Europe, and China; a 2020 literature review suggested that growth in use of electric 4-wheeled vehicles appears economically unlikely in developing economies, but that electric 2-wheeler growth is likely. There are more 2- and 3-wheel EVs than any other type.

Micro mobility refers to a range of small, lightweight vehicles operating at speeds typically, below 25km/h (15mph) and driven by users personally.

Micromobility is a wheeled type of transportation that is low-speed, operated by a single person, and meant for travel over a short distance. Micromobility can include both human powered and electric vehicles, though electric vehicles cannot have internal combustion engines or travel over 45km/h (25m/h) to remain classified as micromobility. Micromobility can be both privately owned or available as rental vehicles, often in the form of dock less sharing.

Therefore, A vehicle that uses one or more electric motors for propulsion is referred to as an electric vehicle (EV). It can be run on electricity from extravehicular sources, a collector system, or a battery to run on its own. Or, to put it another way, electric vehicles do not have internal combustion engines; they have electric motors. Micro-mobility vehicles fall under the L category of vehicles in the EU. Micro-mobility is the term for a variety of small, lightweight vehicles that are operated by individuals and travel at speeds typically under 25 km/h (15 mph) (unlike rickshaws). Bicycles, e-bikes, electric scooters, electric skateboards (hoverboards), shared bicycle fleets, and electric pedal assisted bicycles are examples of Micro-mobility equipment [2]. This project aims in producing a gesture controlled electric vehicle that can be managed by the hand gestures. This needs a small transmitting device in the hand, including an acceleration meter to transmit an appropriate command to the vehicle so that it can move wherever required. This serves as the Personal Micro-Mobility System's guiding philosophy [13].

1.1 BACKGROUND STUDY

The automotive industry has become one of the most important world-wide industries, not only at economic level, but also in terms of research and development. Increasingly, there are more technological elements that are being introduced on the vehicles towards the improvement of both passengers and pedestrians' safety. In addition, there is a greater number of vehicles on the roads, which allows for us to move quickly and comfortably. However, this has led to a dramatic increase in air pollution levels in urban environments (i.e., pollutants, such as PM, nitrogen oxides (NO_X), CO, sulphur dioxide (SO_2), etc.) [4].

In addition, and according to a report by the European Union, the transport sector is responsible for nearly 28% of the total carbon dioxide (CO_2) emissions, while the road transport is accountable for over 70% of the transport sector emissions. Therefore, the authorities of most developed countries are encouraging the use of Electric Vehicles (EVs) to avoid the concentration of air pollutants, CO_2, as well as other greenhouse gases. More specifically, they promote sustainable and efficient mobility through different initiatives, mainly through tax incentives, purchase aids, or other special measures, such as free public parking or the free use of motorways. Evs offer the following advantages over traditional vehicles:

- Zero emissions: this type of vehicles neither emit tailpipe pollutants, CO_2, nor nitrogen dioxide (NO_2). Also, the manufacture processes tend to be more respectful with the environment, although battery manufacturing adversely affects carbon footprint.
- Simplicity: the number of Electric Vehicle (EV) engine elements is smaller, which leads to a much cheaper maintenance. The engines are simpler and more compact, they do not need a cooling circuit, and neither is necessary for incorporating gearshift, clutch, or elements that reduce the engine noise.
- Reliability: having less, and simpler, components make this type of vehicles have fewer breakdowns. In addition, Evs do not suffer of the inherent wear and tear produced by engine explosions, vibrations, or fuel corrosion.
- Cost: the maintenance cost of the vehicle and the cost of the electricity required is much lower in comparison to maintenance and fuel costs of

traditional combustion vehicles. The energy cost per kilometer is significantly lower in Evs than in traditional vehicles, as shown in Figure 1.1.

- Comfort: traveling in Evs is more comfortable, due to the absence of vibrations or engine noise. Efficiency: Evs are more efficient than traditional vehicles. However, the overall well to wheel (WTW) efficiency will also depend on the power plant efficiency. For instance, total WTW efficiency of gasoline vehicles range from 11% to 27%, whereas diesel vehicles range from 25% to 37%. By contrast, Evs fed by a natural gas power plant show a WTW efficiency that ranges from 13% to 31%, whereas Evs fed by renewable energy show an overall efficiency up to 70% as shown in Figure 1.1 Comparison of savings in cost per kilometer offered by vehicles powered by Gasoline.

- Accessibility: this type of vehicle allows for access to urban areas that are not allowed to other combustion vehicles (e.g., low emissions zones). Evs do not suffer from the same traffic restrictions in large cities, especially at high peaks of contamination level. Interestingly, there was a recent OECD study that suggests that, at least in terms of Particulate Matter (PM) emissions, Evs will unfortunately not improve the air quality situation.

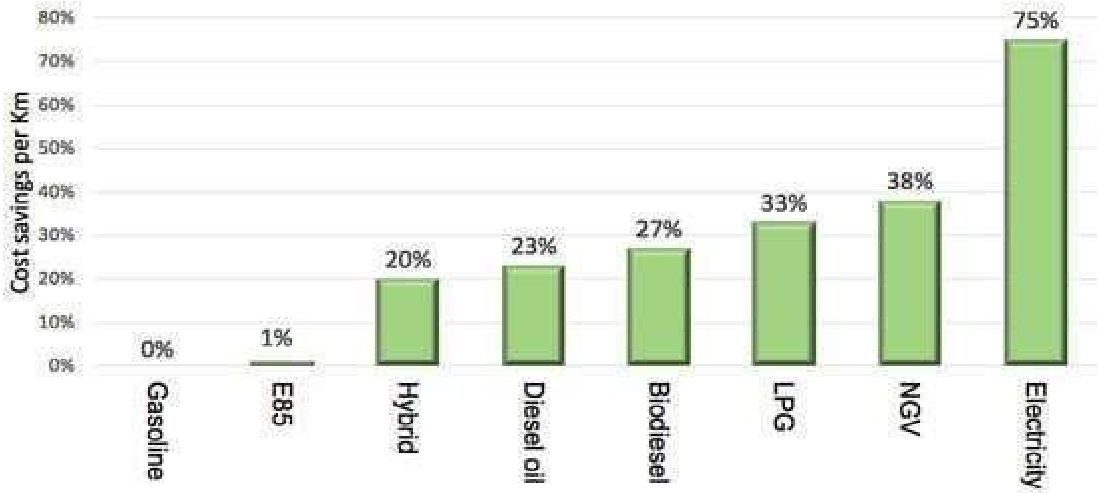

Figure 1.1 Comparison of savings in cost per kilometer offered by vehicles powered by Gasoline

Nowadays, there encounter different types of Evs, according to their engine's technology. In general, they are sorted in five types as shown in Figure 1.2 Electric vehicles classification according to their engine technologies and settings.

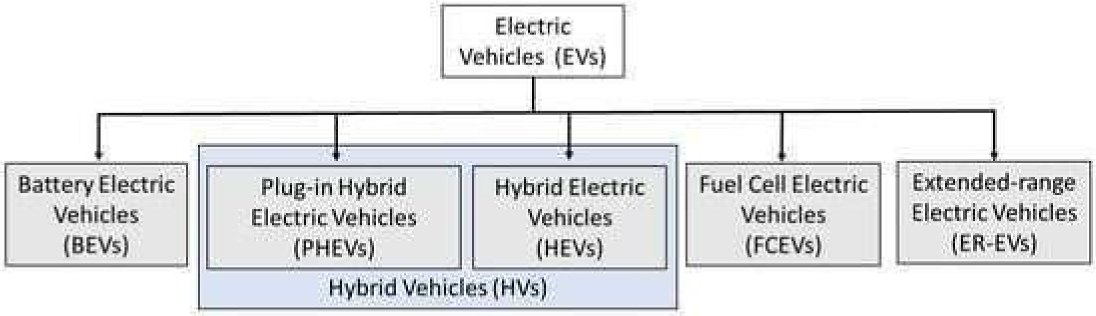

Figure 1.2 Electric vehicles classification according to their engine technologies and settings

- Battery Electric Vehicles (BEVs): vehicles 100% are propelled by electric power. BEVs do not have an internal combustion engine and they do not use any kind of liquid fuel. BEVs normally use large packs of batteries in order to give the vehicle an acceptable autonomy. A typical BEV will reach from 160 to 250 km, although some of them can travel as far as 500 km with just one charge. An example of this type of vehicle is the Nissan Leaf, which is 100% electric and it currently provides a 62-kWh battery that allows users to have an autonomy of 360 km.
- Plug-In Hybrid Electric Vehicles (PHEVs): hybrid vehicles are propelled by a conventional combustible engine and an electric engine charged by a pluggable external electric source. PHEVs can store enough electricity from the grid to significantly reduce their fuel consumption in regular driving conditions. The Mitsubishi Outlander PHEV provides a 12kWh battery, which allows it to drive around 50 km just with the electric engine. However, it is also noteworthy that PHEVs fuel consumption is higher than indicated by car manufacturers.
- Hybrid Electric Vehicles (HEVs): hybrid vehicles are propelled by a combination of a conventional internal combustion engine and an electric engine. The difference regarding PHEVs is that HEVs cannot be plugged to the grid. In fact, the battery that provides energy to the electric engine is charged thanks to the power generated by the vehicle's combustion engine. In modern models, the batteries can also be charged thanks to the energy generated during braking, turning the kinetic energy into electric energy.
- Fuel Cell Electric Vehicles (FCEVs): these vehicles are provided with an electric engine that uses a mix of compressed hydrogen and oxygen obtained from the air, having water as the only waste resulting from this process.

Although these kinds of vehicles are considered to present “zero emissions,” it is worth highlighting that, although there is green hydrogen, most of the used hydrogen is extracted from natural gas. The Hyundai Nexo FCEV is an example of this type of vehicles, being able to travel 650 km without refueling.

- Extended-range Evs (ER-Evs): these vehicles are very similar to those ones in the BEV category. However, the ER-Evs are also provided with a supplementary combustion engine, which charges the batteries of the vehicle if needed. This type of engine, unlike those provided by PHEVs and HEVs, is only used for charging, so that it is not connected to the wheels of the vehicle. An example of this type of vehicles is the BMW i3, which has a 42.2 kWh battery that results in a 260 km autonomy in electric mode, and users can benefit an additional 130 km from the extended-range mode.

1.2 NEED FOR THE STUDY

Even though the purchase price of electric vehicles is higher, when considering the internal combustion engine edition of the same vehicle model, the EV sales volume has experienced a significant growth, especially in the last years. Additionally, many countries are preparing the mobility transition, discouraging the use of fossil fuel-based cars, and stimulating electric mobility. Evidence of this is the fact that, after the Paris Agreement, there has been an increase of the public aids to this kind of vehicles.

In fact, practically all the governments of the developed countries are continuously applying new support and fostering policies for the use of electric vehicles in order to promote sustainable and environment-friendly mobility.

Based on the report from for instance, Belgium offers 4000 € of purchase aid, and these types of vehicles pay a road tax of only 74 €, instead of the 1900 € that traditional vehicles pay. In France, the users who purchase an EV receive a bonus of between 4000 € and 6000 € in the case of BEVs, and of 3500 € in the case of purchasing an PHEV. A discount between 50% and 100% is also offered in the registration fee. In the United Kingdom, an incentive of a maximum of £4500 will be offered with the purchase of an EV and, if it is worth is less than £40,000, the vehicle is exempted of circulation taxes. In Germany, buyers receive a bonus of 4000 € to purchase a BEV, and of 3000 € in the case of PHEVs. Additionally, BEVs do not pay property taxes, while PHEVs have a reduction of 50%. In the case of Spain, an aid of between 1300 € and 5500 € is offered to purchase BEVs and HEVs, according to their autonomy. In Norway, the property tax for BEVs and PHEVs is of 47 €, while, for petrol-driven cars, such tax varies from 290 € to 340 €. In addition, BEVs do not pay circulation fees or tolls, and they do not pay for parking in the preferred parking areas. Finally, in the USA, the federal government provides $2500 for purchasing electric vehicles and an additional $417 for every kWh of their batteries from 4 kWh, to a maximum of $7500.

In the manufacturing process. In the last years, there have been great advancements in the development of batteries. In addition, the worldwide production of batteries for EVs has increased 66%, which is undoubtedly directly related to the rise of number of sales of the vehicles, with the forecast predicting the demand of batteries keeps growing. In fact, it is predicted that the offer and the demand of EVs will be even bigger in the coming years [5].

- **Characteristics of the Batteries:**

Concerning the main characteristics of batteries, there can be highlights of the following:

1. Capacity: The storage difficulty and cost are one of the main problems of electric power. Currently, this results in the allocation of great amounts of money in the development of new batteries with higher efficiency and reliability, thus improving batteries' storage capacity.

The battery capacity represents the maximum amount of energy that can be extracted from the battery under certain specified conditions. This unit can be expressed in ampere hour (Ah) or in watt hour (Wh), although the latter one is more commonly used by electric vehicles. When considering that, in EVs, the capacity of their batteries is a critical aspect, since it has a direct impact in the vehicles' autonomy, the emergence of new technologies that enables the storage of a greater energy quantity in the shortest possible time will be a decisive factor in the success of this kind of vehicles

2. Charge state: Refers to the battery level regarding its 100% capacity.
3. Energy Density: Obtaining the highest energy density possible is another important aspect in the development of batteries, in other words, that with equal size and weight a battery can accumulate a higher energy quantity. The energy

density of batteries is measured as the energy that a battery can supply per unit volume (Wh/L).

4. Specific energy: The energy that a battery can provide per unit mass (Wh/kg). Some authors also refer to this feature as energy density, and it can be specified in Wh/L or Wh/kg.
5. Specific power: The power that a battery can supply per unit of weight (W/kg).
6. Charge cycles: A load cycle is completed when the battery has been used or loaded 100%.
7. Lifespan: Another aspect to consider is the batteries lifespan, which is measured in the number of charging cycles that a battery can hold. The goal is to obtain batteries that can endure a greater number of loading and unloading cycles.
8. Internal resistance: The components of the batteries are not 100% perfect conductors, which means that they offer a certain resistance to the transmission of electricity. During the charging process, some energy is dispelled in the form of heat (namely, thermal loss). The generated heat per unit of time is equal to the lost power in the resistance, so the internal resistance will have a greater impact in high power charges. Thus, more energy will be lost during quick charging processes when compared to slow ones. Therefore, it is highly important that batteries can support quick charging and higher temperatures induced due to the internal resistance. In addition, the decrease of this resistance can reduce the charging time that is required, which is one of the most important drawbacks of this type of vehicles today.
9. Efficacy: It is the percentage of power that is offered by the battery in relation to the energy charged.

1.3 EV TRENDS AND DEVELOPMENTS

1. Increased Sales: Consumers are demonstrating strong interest in EVs and increasing demand. EVs accounted for only 1.3 percent of total vehicles sold in the U.S in 2017. By third quarter 2018, that had nearly doubled to 2.5 percent; hitting 3 percent by the fourth quarter as shown in Figure 1.3 EV model in North America.

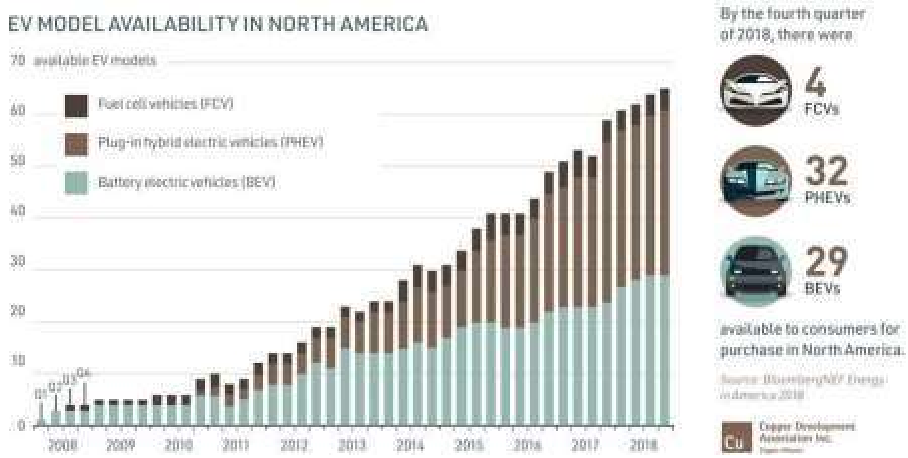

Figure 1.3 EV model in North America

2. Proactive State Policies: States continue to raise clean energy goals with states like California, New Jersey, and New York setting several new, ambitious targets and regulations. However, not all state- news is positive, as some made plans in 2018 to scale back net energy metering or renewable energy credit programs.
3. Support from Large Corporations: In 2019, companies like IKEA, HP and Unilever promised to ramp up integration of electric vehicles into their corporate fleets and to assist employees in transitioning to cleaner transportation.

1.4 OBJECTIVE

- The objective of this project is to construct a compact, personal micro-mobility vehicle based on 'Hoverboard Technology' using hand-gestures.
- To establish relation between Speed and Power, in accordance with the calculations related to Torque.
- To provide an electric vehicle with comfort, safety, cosy design architecture.
- Enabling an additional feature.

1.5 NEED FOR THE PROJECT

Hoverboards are a new and fast-growing technology for transportation purposes. The main purpose of hoverboards is to travel areas which takes much time to reach with the conventional vehicles. Hoverboards can provide transportation to areas, which is not possible with any other type of transportation technology, in terms of its portability and compactness. They are becoming a more and more important part of our busy lives to reach places quickly. They have been used in many ways like for deliveries, monitoring, commercial and help in emergency situations. The goal of this project is to create regulations that will allow hoverboards to be used in a safe way without any risks to people's lives, considering the conventional hoverboards as shown in Figure 1.4 Conventional Hoverboard [1].

Figure 1.4 Conventional Hoverboard

The hoverboard project is a solution to the problem of not being able to get ready to an area. The hoverboards are self-balanced. Hoverboards can be IR controlled or travel autonomously with hand gestures through a programmed software. They are used for many different purposes such as security, military operations, travelling, commercial. There are many types of hoverboards but the most popular one is the self-balancing hoverboard which has 2 wheels and is IR controlled. Hoverboards can be used for many purposes, such as getting data, surveillance, in hospitals or even delivering packages. The project is one of the many initiatives undertaken by the government to familiarize electric vehicles in India. The project is being undertaken as there is a need for more efficient and cheaper modes of transportation, as conventional vehicles tend to increase the risk of accidents. The electric vehicles project would help in increasing productivity and reducing costs. The main aim of this project is to use electric vehicles instead of petrol-leaded vehicles, which are expensive and less efficient than EV. The project aims to make the process of travelling more efficient and productive. This project will be beneficial in many ways. It will help users save time, save nature, and reduce their impact on the environment. The hoverboard project is one of the most important technologies to overcome the climatic issues in following sustainable development goals. It is a project that can help to solve the problem of pollution and make sure that everyone shifts to electric vehicles [2].

The Personal Micro-mobility system project can be used in three different ways:

1. To increase electric vehicle production by increasing the battery capacity.

2. To overcome the accidents that happened in conventional hoverboard systems.

3. To increase the demand for hoverboards in the market.

CHAPTER 2
LITERATURE SURVEY

Nowadays, the increasing use of private transport has had multiple effects on the urban space (for parking lots, streets) and its liability, thus presenting the account of its unsustainability. Moving and parked cars occupy valuable urban spaces useful for citizens. Therefore, traffic on the roads should be adapted to the existing urban road space with the help of public transport. Indeed, several guidelines have been developed and promoted by the European Union to encourage public transport. The unsustainability of urban transport is also affected by urban freight transport. Although urban freight transport is essential to meet citizens' needs, it has led to greater concern for the global and local environment (e.g., air pollution, noise, and vibrations) and safety and security issues. Thus, poor air quality, traffic congestion, and the growth of road crashes push towards the rising need for alternative urban mobility solutions. Hence, academics, mobility experts, and urban planners are trying to rethink people's transport mode selections by investigating less energy- intensive modes such as walking and the use of micro mobility device. Although much has been written about pedestrian mobility (definitions, methods, etc.), micro mobility is a recent topic, and a common accepted definition misses from the literature. In the United States, micro mobility refers to vehicles with a mass of no more than 350 kg and a design speed of no more than 45 km/h. In Europe, there is no univocal definition of the term, but the European Union regulation No. 168/2013 has established the L-category vehicles as a reference for the member countries. L-category vehicles are two-, three- and four-wheeled motor vehicles. The category uses power, power source, speed, length, width, and height as classification criteria. Micro mobility refers to electric-powered micro– Personal Mobility Vehicles (e-PMVs). These devices include General Electric scooters (or escooters), e-bikes, and self-balancing vehicles (in this paper, e-PMVs include only electric scooters as the e-kick scooter, Segway, hoverboard, and monowheel. Therefore, micro vehicles that can be driven standing). In the e-scooter category, the e-kick scooter is one of the most popular due to its ease of use and handling. Segway is a two-wheeled electric device that exploits the presence of the handlebar to facilitate correct posture, balance, and safe driving. Hoverboard and monowheel are one-wheeled self-balancing vehicles and exploit the weight sensors by tilting the body forward to start and backwards to brake; hence, they require the right balance and much practice to be used.

The e-PMVs are gaining popularity as an environmentally friendly transport mode in urban contexts, and their use results in several benefits. Indeed, switching towards e-PMVs may increase community relationship, possible reduction of traffic congestion (for short trips) and emission levels, and improvement of the air quality. Moreover, they can be used privately or docked- or dockless-shared. A docked device has a specific location where it can be picked up and released, while a dockless device has no fixed home location and is dropped and picked up anywhere. Finally, the e-PMVs market is expected to grow at least until the year 2024 at a compound annual growth rate of 7.0%.

The diffusion of e-PMVs in the United States since 2017 and in several European metropolises (e.g., Barcelona, Milan, and Paris) since 2018 has raised several issues related to transport and urban planning, safety, and environment that disrupted the urban transport field and captured the attention of many scholars and practitioners.

For instance, users prone to use e- PMVs devices praise their ability to provide a comfortable and fast trip, but above all their ability to make travel joyful: freedom and driving control, combining the pleasure of walking with the excitement of cycling and the comfort of skateboarding. These devices can be admitted in public spaces like roads, squares, and parks.

On the other hand, the e-PMVs are small and light vehicles (foldable and manageable). This implies that they may conflict with other road users while on the move, hindering their transit, causing serious crashes. Therefore, road safety must be considered when introducing new vehicles. Evidence from the USA shows that crashes with e-PMVs cause more injuries than all other devices because users must stand while driving, they move at relatively high speed (if compared to walking speed) and because no driving license or experience is required for their use. Finally, e-PMVs are defined as sustainable transport because they have zero emissions. However, if the entire life cycle is considered, can they be still defined as sustainable? For instance, unfavorable users to e-PMVs question sustainability [13].

By scrutinizing existing literature, this paper aims to answer all these questions to provide an overview and classification of current knowledge on e-PMVs and suggests a possible research agenda. Despite the emerging interest in the research of e-PMVs, to the best of our knowledge, there are no detailed surveys investigating all the previous questions. O'Hern & Estgfaeller provided a scient metric review to synthesize, sort rapidly, and analyse bibliographic data and display micromobility knowledge. However, the issues encountered with the introduction of e-PMVs regarding transport, urban planning, road safety, and environment were not investigated in detail. Moreover, they refer to micromobility as intended in the USA, whereas this paper focuses on e- PMVs according to the European definition. Therefore, this survey was carried out to be useful to public administrations and vehicle providers, in addition to the academia.

The types of study are distinguished among qualitative, quantitative, descriptive, and theoretical. Qualitative studies analyse the behaviour and motivations behind the use of e-PMVs. Instead, quantitative ones are based on descriptive and statistics models and examine various data on e- PMVs. Descriptive ones discuss general information on how to address the impact of e-PMVs. Theoretical studies formulate models without experimentation in real case studies.

Data sources are very similar and usually include automatic data and surveys. Automatic data can be not specified, collected via the Application Programming Interface (API), smartphone or smartwatch applications, and weight sensors. Surveys usually concern questionnaires and/or personal interviews with providers and users. Finally, reference is made to on-site observations, with manual data collection, for observations without further specifications.

Analytical tools for qualitative studies include synthesized and encoded textual interviews, travel diaries, and survey. In quantitative studies, descriptive models (simple percentages, cluster analysis, etc.), inferential models (linear regressions, structural equation models, etc.) and optimization methods are used. Descriptive studies adopt a qualitative description, while theoretical studies present different types of models.

CHAPTER 3

COMPONENTS REQUIRED

3.1 HARDWARE REQUIRED

The hardware components used in this project are listed below:

3.1.1 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 as shown in Figure 3.1 Arduino UNO. It is programmed based on IDE, which stands for Integrated Development Environment. It can run on both online and offline platforms.

The IDE is common to all available boards of Arduino.

Figure 3.1 Arduino UNO

- **Advantages of Arduino UNO over other boards**

The USB port in the Arduino board is used to connect the board to the computer using the USB cable. The cable acts as a serial port and as the power supply to interface the board. Such dual functioning makes it unique to recommend and easy to use for beginners.

3.1.2 JUMPER WIRES

Generally, jumpers are tiny metal connectors used to close or open a circuit part. They have two or more connection points, which regulate an electrical circuit board. Their function is to configure the settings for computer peripherals, like the motherboard.

Suppose your motherboard supported intrusion detection. A jumper can be set to enable or disable it. Jumper wires are electrical wires with connector pins at each end as shown in Figure 3.2 Jumper Wires.

- **Types of Jumper Wires:**

Jumper wires come in three versions:

- Male-to-male jumper
- Male-to-female jumper
- Female-to-female jumper

Figure 3.2 Jumper Wires

3.1.3 SOLDERING IRON AND LEAD

A soldering iron is a hand tool used in soldering. It supplies heat to melt solder so that it can flow into the joint between two workpieces. A soldering iron is composed of a heated metal tip (the *bit*) and an insulated handle. Heating is often achieved electrically, by passing an electric current (supplied through an electrical cord or battery cables) through a resistive heating element. Cordless irons can be heated by combustion of gas stored in a small tank, often using a catalytic heater rather than a flame. Simple irons, less commonly used today than in the past, were simply a large copper *bit* on a handle, heated in a flame. Solder melts at approximately 185 °C (365 °F). Soldering irons are designed to reach a temperature range of 200 to 480 °C (392 to 896 °F). Soldering irons are most often used for installation, repairs, and limited production work in electronics assembly. High-volume production lines use other soldering methods. Large irons may be used for soldering joints in sheet metal objects. Less common uses include pyrography (burning designs into wood) and plastic welding (as an alternative to ultrasonic welding) as shown in Figure 3.3 Soldering Iron and Lead. Solder wires are wires with a low melting point which can melt along with the soldering iron.

Figure 3.3 Soldering Iron and Lead

3.1.4 WHEELS

A wheel is a circular component that is intended to rotate on an axle bearing. The wheel is one of the key components of the wheel and axle which is one of the six simple machines. A wheel greatly reduces friction by facilitating motion by rolling together with the use of axles. For wheels to rotate, a moment needs to be applied to the wheel about its axis, either by way of gravity or by the application of another external force or torque as shown in Figure 3.4 Wheels.

Figure 3.4 Wheels

3.1.5 RELAY MODULE

A relay is an electrical switch that can be used to control devices and systems that use higher voltages. Relay modules are simply circuit boards that house one or more relays. They come in a variety of shapes and sizes, but are most commonly rectangular with 2, 4, or 8 relays mounted on them, sometimes even up to 16 relays. Relay modules contain other components than the relay unit. These include indicator LEDs, protection diodes, transistors, resistors, and other parts. In the case of module relay, the mechanism is typically an electromagnet. The relay module input voltage is usually DC. However, the electrical load that a relay will control can be either AC or DC, but essentially within the limit levels that the relay is designed for. A relay module is available in an array of input voltage ratings: It can be a 3.2V or 5V relay module for low power switching, or it can be a 12 or 24V relay module for heavy-duty systems. The relay module information is normally printed on the surface of the device for ready reference as shown in Figure 3.5 Relay Module.

Figure 3.5 Relay Module

3.1.6 ARDUINO NANO

The Arduino Nano is a small, complete, and breadboard-friendly board based on the ATmega328 (Arduino Nano 3.x). It has more or less the same functionality of the Arduino Duemilanove, but in a different package as shown in Figure 3.6 Arduino Nano.

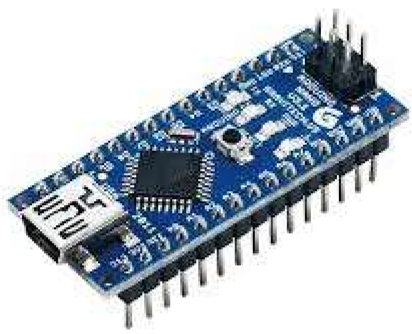

Figure 3.6 Arduino Nano

3.1.7 12 V BATTERY

Twelve-volt batteries are commonly used in RV, boat, and other automobile systems. From a technical perspective, a battery uses one or more cells to allow a chemical reaction creating the flow of electrons in a circuit. Batteries do not create energy or power on their own. Batteries simply store energy for you to use when you need it as shown in Figure 3.7 12V Battery.

Figure 3.7 12V Battery

3.1.8 9V BATTERY

The nine-volt battery, or 9-volt battery, is an electric battery that supplies a nominal voltage of 9 Volts as shown in Figure 3.8 9V Battery. Actual voltage measures 7.2 to 9.6 volts, depending on battery chemistry. Batteries of various sizes and capacities are manufactured; a very common size is known as PP3, introduced for early transistor radios. The PP3 has a rectangular prism shape with rounded edges and two polarized snap connectors on the top. This type is commonly used for many applications including household uses such as smoke and gas detectors, clocks, and toys.

Figure 3.8 9V Battery

3.1.9 WIPER MOTOR

The wiper motor is the motor used to make the wipers work and keep the car windshield clean. It is the component that powers the windshield wipers. They are a part of the wiper system and is considered a car safety component as shown in Figure 3.9 Wiper Motor.

Figure 3.9 Wiper Motor

3.10 RF MODULE

An RF module (short for radio-frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices as shown in Figure 3.10 RF Module. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio-frequency (RF) communication. For many applications, the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and a receiver. They are of various types and ranges. Some can transmit up to 500 feet. RF modules are typically fabricated using RF CMOS technology.

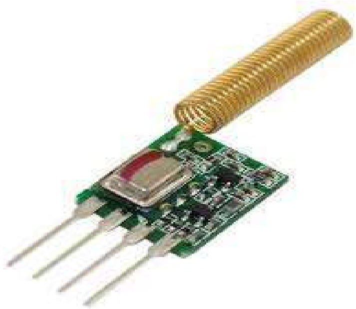

Figure 3.10 RF Module

3.11 ACCELEROMETER SENSOR

An accelerometer sensor is a tool that measures the acceleration of any body or object in its instantaneous rest frame. It is not a coordinate acceleration. Accelerometer sensors are used in many ways, such as in many electronic devices, smartphones, and wearable devices, etc. Accelerometers are used in biomedical applications, and biomedical field accelerometer sensors are mainly operated in step counting, activity monitoring [5], or motion artwork and suppression. Accelerometer sensors are easy to apply to all subjects, without much emphasis on sensor placement. These sensors are used to monitor vital signals, even for the problematic cases surrounding cardiac arrest as shown in Figure 3.11 Accelerometer Sensor.

Figure 3.11 Accelerometer Sensor

3.12 BUCK - BOOST CONVERTER

The buck–boost converter is a type of DC-to-DC converter (also known as a chopper) that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is used to “step up” the DC voltage, similar to a transformer for AC circuits. It is equivalent to a flyback converter using a single inductor instead of a transformer. Two different topologies are called buck–boost converter. DC-DC converters are also known as choppers. Here, have a look at Buck Boost converter which can operate as a DC-DC Step-Down converter or a DC-DC Step-Up converter depending upon the duty cycle, D. The input voltage source is connected to a solid-state device. The second switch used is a diode. The diode is connected, in reverse to the direction of power flow from source, to a capacitor and the load and the two are connected in parallel as shown in Figure 3.12 Buck Boost Converter.

The controlled switch is turned on and off by using Pulse Width Modulation (PWM). PWM can be time based or frequency based.

Frequency based modulation has disadvantages like a wide range of frequencies to achieve the desired control of the switch which in turn will give the desired output voltage. Time based Modulation is mostly used for DC-DC converters. It is simple to construct and use. The frequency remains constant in this type of PWM modulation.

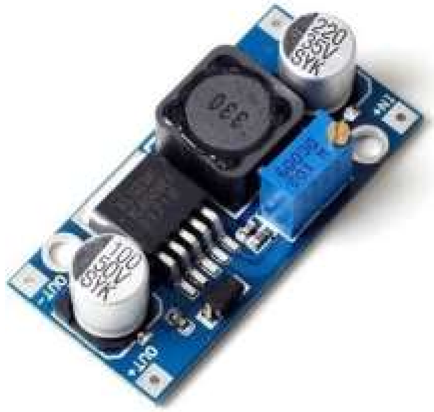

Figure 3.12 Buck Boost Converter

3.2 SOFTWARE REQUIRED

Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino hardware to upload programs and communicate with them.

Writing Sketches:

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension. ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information. The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

CHAPTER 4

SYSTEM REQUIREMENT SPECIFICATION

4.1 BLOCK DIAGRAM

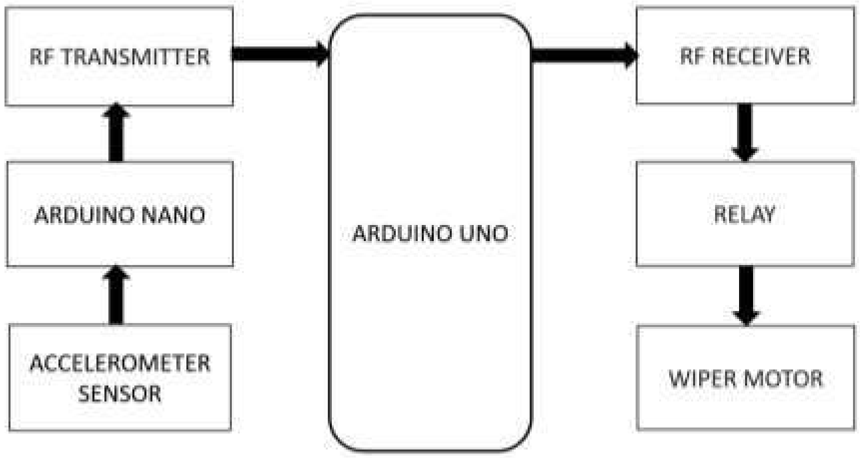

Figure 4.1 Block diagram of Personal Micro-Mobility system

The above Figure 4.1 shows the Block diagram of Personal Micro-mobility system. It consists of a central Arduino UNO, getting signals from Accelerometer, RF Module, Arduino Nano, feeding it in to the relay ultimately.

4.2 WORKING

The personal micro-mobility system is designed in such a handy manner, where a person can operate the vehicle using the control in their hand itself, enabling them to experience ride in a routine manner (just like holding and driving a bike, car, bicycle, etc.). This application is connected to the wirelessly to the RF RX module which is connected to the programmed Arduino Nano. The wheels that help the vehicle to move are connected to the *12v Wiper Motor* which is accelerated by the relay. The Wiper Motor has the power supply from batteries and reads the instructions from the Arduino UNO and follows the command given by the operator given by two methodologies.

4.3 METHODOLOGY

There are two methodologies used in this project. They are stated below:

4.3.1 HAND-GESTURES METHODOLOGY

Once the user makes hand gestures to move, accelerometer detects the state of the movement and RF transmits the state to the RF receiver as shown in Figure 4.2 Circuit diagram for Hand-Gestures.

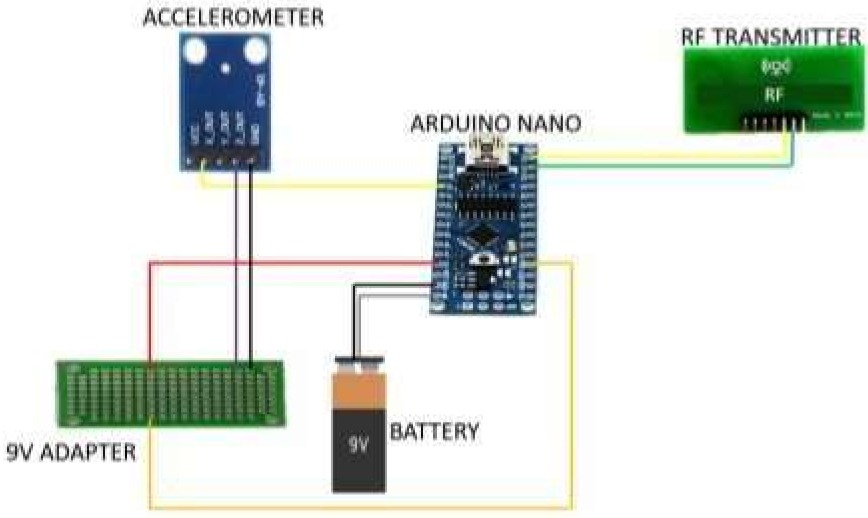

Figure 4.2 Circuit diagram for Hand-Gestures

4.3.2 MOBILITY METHODOLOGY

Once wireless signal is received, it reports to Arduino UNO, then the corresponding Right or Left or Front or Back command is sent to the motor driver, which then makes the wheels rotate in that respective direction as shown in Figure 4.3 Circuit diagram of the Personal Micro-mobility System.

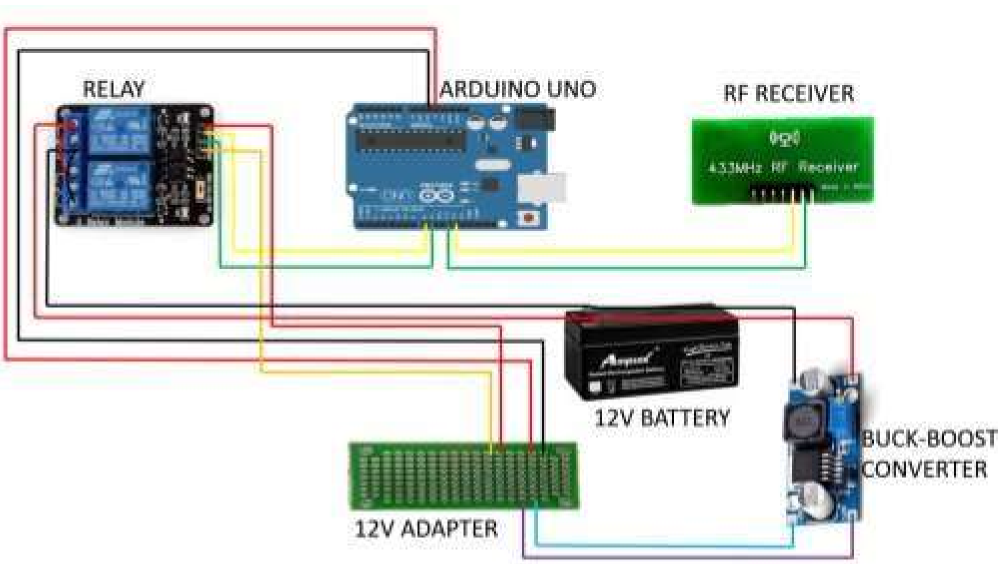

Figure 4.3 Circuit diagram of the Personal Micro-mobility System

4.4 WORK FLOW

- The main controller in this project Arduino UNO, on which the RF, Accelerometer, and the relay are all dependent to it.
- The following approaches will be used in this project:
    - Building the base.
    - Making the base foldable with latches.
    - Assembling the circuit in both the base and the gloves using the connected components.
    - Using the Arduino IDE to program.
    - Examining.

4.5 APPLICATIONS

- This can be used to travel to the grocery store and many other neighboring locations because this system can be used outdoors.
- This is suitable for those who are physically challenged especially who lost their leg.
- This project is also designed to the personally aided people just by adding some hardware components.

CHAPTER 5
SYSTEM DESIGN

12 V Li-ion battery:

- Specifications of the Lithium battery are shown in Table 5.1.

Battery Type	Lithium-ion
Nominal Voltage	25.9
Capacity	1.3Ah
Minimum Charging Time	2.5 to 3.5 hours

Table 5.1 Specifications of the Lithium battery

- Specifications of the Parameters associated with the weight of the designed vehicle are shown in Table 5.2.

OBJECT	WEIGHT (kg)
User	50
Vehicle	10

Table 5.2 Parameters associated with the weight of the designed vehicle

- RPM OF MOTOR**: 55**
- DIAMETER OF WHEELS**: 7 INCHES**
- SPEED **=1.5 km/hr**
- POWER**: 1200 WATTS**
- TORQUE**=2083 Nm**
- BATTERY LIFE= **26 Hrs**

CHAPTER 6
RESULT AND DISCUSSION

This project has aimed at building and running the Personal Micro-Mobility System and the system design process are picturized below:

- Hand gesture circuit in the glove is shown in Figure 6.1

Figure 6.1 Hand Gesture circuit in the glove

- Building the basic mobility methodology as shown in Figure 6.2

Figure 6.2 Mobility Methodology

- Final output of Personal Micro-Mobility System as shown in Figure 6.3

Figure 6.3 Final Output

CHAPTER 7
CONCLUSION AND FUTURE WORK

Maintaining balance on a hoverboard is like stabilizing a two-wheeler. The specific aim of this project is satisfying sustainable goals, building additional feature to help physically challenged, and compact design. However, this project helps in movement from place to place in a sustainable manner [4]. This system also enables the user to ride in a comfortable manner with the help of the sitting arrangement. This system is cost effective once built and later just the maintenance is required (charging).

Future work of this project is to make the system to be adaptive in nature to suit people with varied masses.

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ANNEXURE

Coding used to implement the project is given below:

/* Arduino code used for the PERSONAL MICRO-MOBILITY SYSTEM

SOURCE CODE FOR TRANSMITTER:

```
#include <SoftwareSerial.h>
SoftwareSerial HC12(11, 12); // HC-12 TX Pin, HC-12 RX Pin

int x_axis_1;

void setup()
{
 Serial.begin(9600);             // Serial port to computer

 HC12.begin(9600);               // Serial port to HC12
}

void loop()
{
  x_axis_1 = analogRead(A0);


  HC12.write('%');

  HC12.write(x_axis_1/100%10+48);
  HC12.write(x_axis_1/10%10+48);
  HC12.write(x_axis_1/1%10+48);

  HC12.print("#\r\n");

  delay(100);
}
```

SOURCE CODE FOR RECEIVER:

```
#include <SoftwareSerial.h>
SoftwareSerial HC12(11, 12); // HC-12 TX Pin, HC-12 RX Pin

const int IN1 = 9;
const int IN2 = 8;

int x_axis_1;

unsigned char inByte;

unsigned char arr[20], ii, start_flag = 0, over_flag = 0;

void setup()
{
 Serial.begin(9600);             // Serial port to computer

 HC12.begin(9600);               // Serial port to HC12

 pinMode(IN1, OUTPUT); digitalWrite(IN1, HIGH);
 pinMode(IN2, OUTPUT); digitalWrite(IN2, HIGH);
```

```
}

void loop()
{
 while(HC12.available())  // If HC-12 has data
 {
  inByte = HC12.read();

  //Serial.write(inByte);

  if(start_flag == 0)
  {
   if(inByte == '%')
   {
    ii = 0;

    start_flag = 1;
   }
  }
  else if(start_flag == 1)
  {
   if(inByte == '#')
   {
    over_flag = 1;

    start_flag = 0;
   }
   else
   {
    arr[ii++] = inByte;
   }
  }
 }

 if(over_flag == 1)
 {
  x_axis_1 = (((int)arr[ 0] - 48) * 100) + (((int)arr[ 1] - 48) * 10) + (((int)arr[ 2] - 48) * 1);

//  Serial.write(x_axis_1/100%10+48);
//  Serial.write(x_axis_1/10%10+48);
//  Serial.write(x_axis_1/1%10+48);

//  Serial.print("\r\n");


  if(x_axis_1 > 290 && x_axis_1 < 370)
  {
   //Serial.write('S');

   digitalWrite(IN1, HIGH); digitalWrite(IN2, HIGH);  //base front/back stop
  }
  else
  {
   if(x_axis_1 <= 290)
   {
```

```
  //Serial.write('R');

  digitalWrite(IN1, HIGH); digitalWrite(IN2,  LOW);  //base
 }
 else if(x_axis_1 >= 370)
 {
  //Serial.write('L');

  digitalWrite(IN1,  LOW); digitalWrite(IN2, HIGH);  //base
 }
}

over_flag = 0;
}


/*
digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW); delay(2000);
digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH); delay(2000);
digitalWrite(IN1, HIGH); digitalWrite(IN2, HIGH); delay(2000);
*/
}
```

JOURNAL PUBLISHED

International Journal of Scientific Research in Computer Science, Engineering and Information Technology
ISSN : 2456-3307 (www.ijsrcseit.com)
doi : https://doi.org/10.32628/IJSRCSEIT

Mini Hand Gesture Controlled Mobility System

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Article Info

Publication Issue :
Volume 9, Issue 1
January-February-2023

Page Number : 80-89

Article History
Accepted: 01 Jan 2023
Published: 15 Jan 2023

ABSTRACT

Micro-mobility transportation systems forindividual usage have grown in popularity recently, with the "Hoverboard" device being the most well- liked [1]. These systems are flexible, small, and efficient for personal transportation in a range of settings. With the use of a gyroscope, an Arduino UNO, an Arduino Pro-mini, a lithium battery, and a BLDC motor, this project will construct a personal micro- mobility system electric vehicle in the shape of a rectangular grid. Two folding pads make up this rectangular grid, which when opened forms a semicircle. The system also includes a seating configuration. With the sensor imprinted on gloves, the operator may control the system's speed and direction by making hand gestures. The goal of this project is to create and manage a straightforward, inexpensive self- transportation system.

Keywords - Micro-mobility, Gyroscope, Arduino Pro- mini, BLDC motor, Hand-gestures.

I. INTRODUCTION

An electric vehicle is a vehicle that is propelled by one or more electric motors (EV). It can be powered by extravehicular sources of electricity, a collector system, or a battery to function independently. Or, to put it another way, electric vehicles have electric motors instead of internal combustion engines. In the EU, micro-mobility vehicles are classified as L vehicles. The phrase "micro-mobility" refers to a range of small, lightweight vehicles driven by persons and moving at rates of under 25 km/h (15 mph) (unlike rickshaws). Examples of Micro-mobility equipment include bicycles, e-bikes, electric scooters, electric skateboards (hoverboard), shared bicycle fleets, and electric pedal assisted bicycles [1] – [5].

The goal of this project is to create an electric vehicle that can be operated by hand gestures. For the vehicle to receive the proper instruction and travel in the desired direction, a small transmitting device in the hand that includes an acceleration metre is necessary. This serves as the overarching principle of the Personal Micro-Mobility System.

II. OBJECTIVES

- The objective of this project is to construct a

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A. Conference at Sri Sairam Institute of Technology:


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