HAND GESTURE CONTROLLED SMART CAR USING IMAGE PROCESSING

Project report submitted in partial fulfillment of the requirement for the degree of Bachelor of Technology

In

Computer Science and Engineering/Information Technology

By

Pranjal Bansal (191503)

Under the supervision of

Dr. Vikas Baghel

Dr. Monika Bharti

to

Department of Computer Science & Engineering and Information Technology

Jaypee University of Information Technology Waknaghat, Solan-173234, Himachal Pradesh

Candidate's Declaration

I hereby declare that the work presented in this report entitled **" Hand Gesture Controlled Smart Car using Image Processing"** in partial fulfilment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology Waknaghat is an authentic record of our own work carried out over a period from January 2023 to May 2023 under the supervision of **Dr. Vikas Baghel** (Assistant Professor (SG), ELECTRONICS & COMMUNICATION ENGINEERING) and **Dr. Monika Bharti** **(**Assistant Professor(SG),COMPUTER SCIENCE & ENGINEERING AND INFORMATION TECHNOLOGY).

I also authenticate that we have carried out the above mentioned project work under the proficiency stream **Data Science.**

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

Pranjal Bansal
191503

This is to certify that the above statement made by the candidate is true to the best of my knowledge.

Dr. Vikas Baghel	Dr. Monik Bharti
Assistant Professor(SG)	Assistant Professor(SG)
Electronics & Communication Engineering	Computer Science & Information Technology
Dated:	Dated:

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

PLAGIARISM VERIFICATION REPORT

Date: …………………………..

Type of Document (Tick): PhD Thesis | M.Tech Dissertation/ Report | B.Tech Project Report | Paper

Name: ________________________ __Department: _______________ Enrolment No ________

Contact No. __________________________E-mail. _________________________________

Name of the Supervisor: ____

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): _____________________

____

____

UNDERTAKING

I undertake that I am aware of the plagiarism related norms/ regulations, if I found guilty of any plagiarism and copyright violations in the above thesis/report even after award of degree, the University reserves the rights to withdraw/revoke my degree/report. Kindly allow me to avail Plagiarism verification report for the document mentioned above.

Complete Thesis/Report Pages Detail:

- Total No. of Pages =
- Total No. of Preliminary pages =
- Total No. of pages accommodate bibliography/references =

(Signature of Student)

FOR DEPARTMENT USE

We have checked the thesis/report as per norms and found **Similarity Index** at ………………..(%). Therefore, we are forwarding the complete thesis/report for final plagiarism check. The plagiarism verification report may be handed over to the candidate.

(Signature of Guide/Supervisor) **Signature of HOD**

FOR LRC USE

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Excluded	Similarity Index (%)	Generated Plagiarism Report Details (Title, Abstract & Chapters)	
	• All Preliminary Pages • Bibliography/Images/Quotes • 14 Words String		Word Counts	
Report Generated on			Character Counts	
		Submission ID	Total Pages Scanned	
			File Size	

Checked by

Name & Signature **Librarian**

……

Please send your complete thesis/report in (PDF) with Title Page, Abstract and Chapters in (Word File) through the supervisor at plagcheck.juit@gmail.com

ACKNOWLEDGMENT

Firstly, I express our heartiest thanks and gratefulness to almighty God for his divine blessing makes it possible to complete the project work successfully.

I am really grateful and wish my profound indebtedness to Supervisors Dr. Vikas Baghel Assistant Professor(SG), Department of ECE and Dr. Monika Bharti Assistant Professor(SG), Department of CSE/IT, Jaypee University of Information Technology, Wakhnaghat. Deep Knowledge & keen interest of my supervisors in the field of "Image Processing" made possible to carry out this project. Their endless patience, scholarly guidance, continual encouragement, constant and energetic supervision, constructive criticism, valuable advice, reading many inferior drafts and correcting them at all stages have made it possible to complete this project.

I would like to express my heartiest gratitude to Dr. Vikas Baghel, Department of ECE and Dr. Monika Bharti, Department of CSE/IT, for their kind help to finish my project.

I would also generously welcome each one of those individuals who have helped us straightforwardly or in a roundabout way in making this project a win. In this unique situation, I might want to thank the various staff individuals, both educating and non-instructing, which have developed their convenient help and facilitated my undertaking.

Finally, I must acknowledge with due respect the constant support and patience of my parents.

Project Group Number: 25

Pranjal Bansal

191503

Table of Contents

List of Abbreviations

Abbreviation	Full Form
IoT	Internet of Things
ML	Machine Learning
MCU	Micro Controller Unit
SVM	Support Vector Machine

List of Figures

Abstract

The robotics industry has witnessed the emergence of various trends in recent years, aimed at enhancing the efficiency, accessibility, and precision of robotic systems. These advancements have enabled robots to take on tasks that are dangerous, tedious, and unpleasant for humans. However, even with their abilities, robots still require human control, which can be achieved through wired or wireless controlling devices. While physical instruments are commonly used to control robots, the use of gesture control has gained popularity due to its natural and intuitive way of interacting with robotic systems.

The focus of this project is on utilizing gesture recognition to control robots with a higher degree of accuracy. Traditionally, controlling complex systems using switches and remote controllers can be challenging, particularly when multiple interfaces are working concurrently. However, with the help of OpenCV, a computer vision library focused on real-time computer vision, the task of hand gesture recognition has become more manageable. The proposed system involves using OpenCV to perform operations on the images captured by the webcam in Python, establishing a socket connection between a laptop and an ESP8266, where the ESP8266 acts as the client and the Python program acts as the server. The information obtained is then sent to an Arduino through an FTDI programmer serially. The microcontroller then commands the robot based on the gestures detected, instructing the motors to move in the desired direction.

The robotic car designed in this project has various applications, including in challenging situations such as fires or wars. The ability to control the robot with gestures also makes it useful for physically challenged individuals who can move objects with less physical effort. Hand gesture automation is a growing field with many potential benefits, and advancements in this technology could bring benefits to a wide range of industries.

The automated robotics industry has experienced substantial growth and progress in recent years due to technological advancements, an increased need for efficiency, and a desire to improve safety across multiple industries. Automated robotics systems are machines designed to carry out tasks typically performed by humans, such as assembly line production, warehouse management, and transportation.

The demand for enhanced efficiency across various sectors has been one of the primary drivers of the growth of the automated robotics industry. Automated robotics systems can complete tasks faster and with greater precision than humans, which leads to increased

productivity and reduced costs. Furthermore, the use of automated systems enables the optimization of processes, further enhancing efficiency.

Safety concerns have also contributed significantly to the growth of the automated robotics industry. Many industries have hazardous or dangerous jobs, such as those that involve heavy machinery or exposure to chemicals, which pose risks to human workers. By using automated systems to perform these tasks, the risk to human workers can be reduced, making workplaces safer and decreasing the likelihood of workplace accidents.

01: INTRODUCTION

1.1 Introduction

The robotics industry has developed benefit of a number of new trends in recent times to increase efficacy, usability, and delicacy. Works that’s damaging to people, dull or unwelcome occupations, and so forth are examples of such jobs. Indeed though they can perform mortal functions, robot still needs mortal control. Wireless signature bias can be used to control robots. Both are profitable and recently able to complete all kinds of jobs. Lately, gesture control of robots becomes increasingly veritably popular in addition to the use of palpable tools. The main advantage of gestures is that they offer a more natural way of engaging and speaking with robotic equipment. Image processing and machine literacy are generally used in the development of apps and systems. Machine literacy and image processing are generally used in the development of systems or apps. The utilization of base mounted selectors with low mass and low indolence, as well as parallelograms, is the abecedarian principle behind the delta robot design. It enables robot end-effecter to accelerate greatly. It's generally known that in artificial operations, this kind of robot can accelerate up to 15 times. Numerous nations that were formerly among the husbandries have a high rate of success. The way robots approach life in every area is simply an expression of this new global station. The International Federation of Robotics (IFR) has published data showing that the number of cooperative robots encyclopedically increases by 23 annually and by 5 annually for artificial robots. This dynamic development has its roots of businesses to increase the trust ability and products while also speeding up manufacturing and perfecting product quality, as well as in demographic factors like the ageing of society and the anticipated decline in the number of people who'll be professionally active in the coming times. Automated industry frequently and constantly employed in these artificial sectors where it's necessary to repeat regular task. Automotive factors are industry assiduity with the current position of robotization. The continuing study's idea is to maximize the light of the continuance of the design. The resistance of the material employed is explosively related to the lifetime of the vehicle being handed over being handed. Actually, during vehicle operation the static land task nearly ever happens. Cycled loads are placed on the faceable machines. They're about causing bitsy material damage. This strain builds up at a vulnerable area and ultimately causes a crack to start and spread. A fatigue fracture is the end outgrowth. In factual use, bending and torsion put together most generally put stress on the frames of the means of transportation. Hand gesture controlled robots use mortal- robot commerce technology to allow the control of robotic systems using hand gestures. This technology has the implicit to give a more natural and intuitive system of controlling robotic systems compared to traditional methods such as buttons, joysticks, or voice commands. The use of hand gestures for robot control has gained significant attention in recent times due to advances in computer vision and mach e literacy, which have made it possible to develop robust and accurate gesture recognition algorithm. To operate, hand gesture controlled robotic systems use a detector or camera that captures images of stoner's hand, a gesture recognition algorithm that analyzes these images recognize the hand gestures, and a regulator that translates recognized gestures into commands that are transferred to the robot. The development of hand gesture controlled robotic systems has been driven by the need moreover natural and intuitive ways of interacting with robots, as traditional styles can be clumsy and a lot of technical training is required . The implicit operations of hand gesture controlled robotic systems are vast, ranging from artificial robotics to consumer electronics. In artificial settings, hand gesture control can be used to operate machinery or robots without the need for physical contact, which reduces the threat of accidents and injuries. In healthcare, hand gesture controlled robots and help in patient care, furnishing backing to those with limited mobility or communication capacities. In consumer electronics, hand gesture control can be used in gaming or virtual reality operations, furnishing a more immersive and interactive experience. As the development of hand-gear-controlled robotic systems continues, related areas such as computer vision and machine literacy are also advancing. Gesture recognition algorithms generally use deep learning methods that require large quantities of training data to achieve high delicacy. This has led to the development of large-scale gesture datasets and the creation of benchmarking systems that enable experimenters to compare the performance of different algorithms. Despite the implicit benefits of hand-gear-controlled robotic systems, several challenges still need to be addressed. One of the main challenges is the robustness and delicacy of the gesture recognition algorithm. The recognition algorithm must directly detect and classify a wide range of hand gestures in complex and dynamic surroundings. Also, the algorithm must be suitable to acclimatize to variations in lighting, background, and hand size and shape. Another challenge is the quiescence or detention between the stoner's gesture and the robot's response. This detention can be caused by colorful factors, such as the time needed for image capture and processing, network quiescence, or the time needed for the robot to execute the command. Quiescence can significantly affect the user experience and the usability of the system, particularly in operations where timing is critical. Overall, hand gesture-controlled robotic systems are an instigative area of exploration and development that has the implicit potential to revise human-robot commerce. As the technology continues to advance, the implicit operations of hand gesture-controlled robotic systems are anticipated to expand, making them an essential tool in a wide range of disciplines.

1.2 Problem Statement

Filling a dashboard with buttons is a poorly accepted aesthetic approach. The current fashion is to use large, numerous displays in place of conventional instruments. Also, the new futuristic dashboards are constructed to be lighter. Also, studies suggest that an auto's multimedia capabilities are veritably distracting for the motorist, making interfaces that rely heavily on button operation parlous. In fact, using audio controls on a phone has been shown to be a significant and regular cause of distraction. The main causes of this distraction were set up to be the manipulation of multimedia, navigation, and phone systems. The use of hand gestures to control the movement of a machine in real time is proposed as a better option for the robotization sector in the problem statement for this design. For a real-world demonstration of a machine that can be operated using hand gestures, we used a lattice. Each wheel's gyration is solely controlled by one of the four motors on the lattice.

The bus is rotated precisely to achieve the desired direction movement. We will be utilizing Google's MediaPipe frame, which offers configurable machine learning results. It's a feather light, open-source, and cross-platform framework. Pre-trained ML results for face discovery, position estimation, hand recognition, object discovery, and other tasks are included with MediaPipe. The most recent conception of motor cars is gradually testing a fairly fresh idea called the hand gesture system. The technology operates with the aid of infrared detectors mounted within the dashboard of the vehicle, which can honor and interpret a variety of hand gestures for nautical reasons. The debit is that the motorist must flash back a variety of distinct hand signals in order to pierce the colorful functions of the vehicle. A poor gesture can't be effective, which might lead to vexation on the road. The usual remote access device is basically a touch-screen interface inspired by smart phones that does away with the need to press colorful buttons or acclimatize colorful clothes inside the cabin. The motorist has access to a nearly limitless number of navigation possibilities thanks to this technology. Both systems share the same failings. In this case, the two systems have both benefited from the Smartphone trend of touch screens, but using a commodity that's on our stage is veritably different from using a screen that's two bases in front of us. Also, there's the pause factor, which occurs more frequently on outfits placed on vehicles. The absence of automated robotic machines can produce colorful issues for multiple diligences, such as dropped productivity and implicit hazards to workers. This will explore some of the significant problems that can arise due to the lack of automated robotic machines. Productivity Reduction Without automated robotics machines, numerous tasks have to depend on homemade labor, which can be time-consuming and hamstrung. Homemade labor is more prone to crimes than automated systems, leading to increased time-out, rework, and lower output. This can result in reduced product situations that can negatively impact colorful diligence's profitability. High labor charges homemade labor can be expensive and requires ongoing training and supervision. In discrepancy, automated robotics machines can work for extended periods of time without the need for rest, a break, or compensation. Also, the conservation and form costs of automated robotics machines are generally lower than those of homemade labor, leading to significant cost savings for companies. Manual labor can be dangerous, particularly when taking care of heavy machinery or dangerous accoutrements. Without automated robotics machines, mortal workers are frequently exposed to safety pitfalls, which can result in severe injuries, illnesses, or even losses. In discrepancy, automated robotics machines can operate in dangerous surroundings and perform tasks that pose pitfalls to mortal workers, therefore enhancing worker safety. Inconsistency and quality control challenges Manual labour can be inconsistent and prone to crime, leading to quality control challenges that can harm a company's character. Automated robotics machines can perform tasks with high precision and thickness, reducing quality control problems. Limited Manufacturing Flexibility Manual labor can be inflexible, limiting a company's capability to adapt to changing requests and demands. Again, automated robotics machines can be fluently reprogrammed to perform new tasks or acclimatize to new manufacturing processes, enhancing a company's inflexibility and capability to respond snappily to changing requests and demands. High energy consumption Manual labor requires significant energy consumption, similar to lighting, heating, and cooling, which can be precious. Automated robotic machines can be designed to operate efficiently, reducing energy consumption and costs. inability to operate in challenging surroundings Some disciplines, such as mining, construction, or aerospace, require performing tasks in grueling surroundings that can be delicate or insolvable for mortal workers to pierce. In similar cases, automated robotic machines can perform these tasks, improving effectiveness and worker safety. Limited Data Collection and Analysis Without automated robotics machines, diligence may not have access to critical data on their processes or systems, limiting their capability to make informed opinions or optimise their processes for better effectiveness or quality. Automated robotics machines can collect precious data on the performance of the system or processes, enabling informed opinions and process optimisation. In conclusion, the lack of automated robotics machines can beget multiple issues across different disciplines, such as dropped productivity and safety pitfalls for workers. Automated robotics machines can enhance effectiveness, reduce labour costs, and provide precious data on processes and systems. Also, automated robotics machines can operate in dangerous surroundings and perform tasks that pose pitfalls to mortal workers, enhancing worker safety. Companies that invest in automated robotics machines can gain a significant competitive advantage over those that rely solely on homemade labor.

1.3 Objectives

The major thing is to offer a reliable and more natural system for the stoner to control a wireless robot in its surroundings through gestures. We will be utilising Google's MediaPipe frame, which offers configurable machine learning results. It's a featherlight, open-source, and cross-platform framework. Pre-trained ML results for face discovery, position estimation, hand recognition, object discovery, and other tasks are included with MediaPipe. This module would describe the hand stir and shoot instructions to regulate the direction of the machine in agreement. The smart vehicle and laptop camera both benefit from wireless communication thanks to the ESP8266 WiFi chip. Once the link is made, the machine may be moved using real-time hand gestures. The main ideal of a hand gesture-controlled auto is to provide a more natural and intuitive way for motorists to interact with their vehicle. This technology aims to enhance the driving experience and ameliorate safety by allowing motorists to control the colourful functions of their vehicles through simple hand gestures rather than counting on physical buttons or voice commands. One of the significant advantages of hand gesture-controlled buses is that they can reduce motorist distraction, which is a leading cause of accidents on the road. Traditional controls require motorists to take their eyes off the road and hands off the wheel to adjust the auto's climate control, radio, or other functions. Hand gesture controls exclude this need, allowing motorists to make adaptations while keeping their hands on the wheel and eyes on the road. Piecemeal, in addition to enhancing safety, hand gesture controls can also ameliorate the driving experience. The natural and intuitive nature of gesture controls means that motorists can fluently and snappily acclimatise to colourful settings without the need to search for buttons or navigate through menus. This can make driving more pleasurable and less stressful, particularly in heavy traffic or long passages. Another benefit of hand gesture controls is that they can be tailored to the preferences of individual motorists. For example, motorists can programme a specific gesture to spark their favourite radio station or acclimatise the volume to their requested position. This position of customization can make driving more personalised and pleasurable. Likewise, hand gesture controls can add an ultramodern and innovative sense to a vehicle, making it more seductive to tech-savvy consumers. As the automotive industry continues to evolve and embrace new technologies, hand gesture controls are becoming less popular as a way to separate vehicles from their challengers. Still, there are some challenges associated with hand gesture-controlled buses that need to be addressed. One of the significant challenges is ensuring that the technology is reliable and responsive. However, it can frustrate motorists and detract from the overall driving experience if the system is slow to respond or doesn't acknowledge gestures directly. Another challenge is ensuring that the hand gesture controls are intuitive and easy to use. Different motorists may interpret specific gestures differently, so it's pivotal to ensure that the gestures used are simple and easy to understand. In conclusion, the primary goal of hand gesture-controlled buses is to provide a more natural and intuitive way for motorists to interact with their vehicle, perfecting the driving experience and enhancing safety. Although there are challenges associated with this technology, its benefits are significant and can make driving more pleasurable, substantiated, and ultramodern. As the automotive industry continues to embrace new technologies, hand gesture controls are likely to become more common and play a more significant role in shaping the future of driving.

1.4 Methodology

On a laptop, the hand detection module is first launched. The webcam continually records hand gestures in real time, which is then processed to determine which gesture is being made using landmarks from the MediaPipe library. When a gesture is recognised, the relevant output is shown on the screen as a visual representation of the gesture image. The wirelessly operated automobile would be responding to the gesture as a command. Using the urllib.request library to interface with the MCU board, the appropriate command is delivered to the NodeMCU board over the TCP protocol. Once the directive has been received by the board, it is compared against the circumstances to determine which set of guidelines should be followed. A condition matching the command is passed to an if else block, which then executes the corresponding function to cause the robot car to move in the desired direction.

1.5 Organisation

I Introduction

The introduction, the issue description, the inspiration, and the reasons why this project was chosen are just a few of the project-related themes covered.Automation has the potential to sustain your process domestically, improve process control, and significantly reduce lead times in comparison to outsourcing or relocating your process overseas. Automation solutions are focused on your specific needs and goals and quickly pay for themselves because of things like decreased operating expenses, shortened lead times, increased productivity, and other things. Increased vehicle safety is cited as one of automation's key benefits. Higher levels of automation in automated driving systems remove human drivers from the sequence of events that might lead to collisions. Although these devices are not currently available for purchase, this new technology may have several advantages. These devices will work together to protect drivers, passengers, cyclists, and pedestrians. Although these devices are not currently available for purchase, this new technology may have several advantages. These devices will work together to protect drivers, passengers, cyclists, and pedestrians. Although it might be difficult to foresee all of autonomous driving systems' societal benefits, its disruptive potential is understood. When completely developed, automated driving systems may increase the options for transportation in underserved areas while enhancing mobility for the elderly and those with disabilities. Equity should be considered and addressed in the design of the ADS infrastructure and vehicles.

II Literature Survey

An academic writing assignment known as a literature review places the academic literature on a particular topic and shows that the author is knowledgeable about it. Because it also includes a discussion of the sources, it's regarded as a literature review rather than a literature report. It's a strategy for reading and stimulating literature. There are several systems available for using gestures to control robots. Gesture conduct is later linked by template matching and skeletonizing. Other gesture discovery approaches include adaptive colour segmentation(4), hand finding and labelling with blocking, morphological filtering, and morphological analysis. Recently, a variety of ways have been suggested to control in-auto entertainment systems. All of these ways aim to lessen the need for secondary driving duties that require mortal visual coffers. The most ultramodern systems rely on four main technologies: hand gesture discovery, speech recognition, touch displays, and sophisticated buttons. Utilising the audible-sensitive channel is a fairly natural way to ameliorate motorist-auto connection. Hand gesture-controlled automated systems have been an area of exploration numerous times, with a focus on developing more intuitive and responsive systems that can directly interpret and respond to mortal gestures. One of the crucial areas of exploration has been developing more advanced detectors and algorithms to detect and interpret complex hand movements in real-time. These detectors generally use camera or infrared technology to capture subtle hand movements, such as cutlet gestures or hand reels, to control the colourful functions of a system. Research has also concentrated on developing more sophisticated algorithms for gesture recognition and interpretation. These algorithms use machine literacy and deep literacy methods and are trained on large datasets of hand gestures to ameliorate their delicacy and trustability. By analysing patterns in hand movements, these algorithms can fete and interpret a wide range of gestures, allowing for further natural and intuitive control of automated systems. Hand gesture control has been applied in colourful disciplines disciplines, similar as healthcare, manufacturing, and robotics. In healthcare, it has been used to control medical biases like surgical robots, allowing for more precise and intuitive control of these biases during complex procedures. In manufacturing, hand gesture control has been used to control robots on assembly lines, allowing for more effective and flexible product processes. Still, one of the main challenges in this exploration is ensuring that the technology is dependable and responsive, especially in complex and dynamic surroundings. To address this, advanced algorithms and detectors are being developed to directly detect and interpret hand gestures in real-time, and user interfaces that are intuitive and easy to use are also being developed. Overall, exploration of hand gesture-controlled automated systems has been ongoing, with a focus on developing more advanced detectors, algorithms, and user interfaces that can directly detect and interpret hand gestures in real-time. Recent advances in machine literacy, deep literacy, and detector technology are helping to make hand gesture control a more practical and dependable system for interacting with automated systems in colorful disciplines.

III System Development

The fundamental concept behind the project's development flow is covered in this part. Both functional and non-functional requirements are categories for the requirements. Here, complexity analysis is used to describe the extraction procedure as well. By passing the accuracy parameter into the mediapipe hand gesture module itself, the accuracy of our model's hand detection may be determined. The module gives customers the option of deciding how high they want the threshold to be. Only when the threshold is reached does the model recognise a specific gesture and send the command to the ESP8266 module, where it is analysed and the motion of the automobile is controlled accordingly. Mediapipe is the hand gesture library that we are utilising. MediaPipe Hands uses an ML pipeline made up of many interconnected models: a model for detecting palms that uses the entire image and produces an orientated hand bounding box.

IV Performance Analysis

Discusses the technology and tools that are employed. It also explains System Design, using several design diagrams. The project's implementation and project snapshots are also covered. An effective analysis is produced as a consequence of comparing the performance with that of other models that are already in use. In this section, the classification strategies for the proposed model as well as the types of characteristics that are extracted are detailed in depth. Next, a comparison of the test results for various algorithms with pertinent attributes is shown.

V Conclusions

Here is a summary of the project. Although the obtained results in terms of the recognition rates are good, the system's efficacy may be increased by utilising additional cutting-edge learning approaches, such as machine learning. We also have access to a huge dataset. The knowledge base may be constructed using any datasets by using this deep learning innovation. For this, though, extra training time is necessary. As a result, the system can support some parallel processing strategies. There is also discussion on the Future score.

02: LITERATURE SURVEY

There has been a lot of exploration done on videotape- grounded hand-gesture recognition algorithms for numerous operations(1),(2). Depth-grounded styles have also been used lately(3). The maturity of dynamic hand- gesture recognition styles bear temporal localisation of the gesture, for case, using a double classifier for" stir" and" no stir"(5). In gesture frames, the hand region is constantly segmented using colour and/ or depth information by thick or meager hand- drafted descriptors(6) and fitted with cadaverous models(4). Sequences of features for dynamic gestures are used to train classifiers as Hidden Markov Models(HMM)(7), tentative Random Fields(8), Support Vector Machines(SVM)(9), or Decision timbers in order to determine the type of gesture. Convolutional DNNs have also been used in the history to identify six stationary hand movements using depth images(14) and to descry and honor 20 gestures from the Italian sign language using RGB- D images of hand regions and upper- body cadaverous features(5). These earlier DNN- grounded systems for gesture identification differ from our work in terms of data emulsion ways, features used, and operation scripts. The bulk of gesture recognition styles in use moment were developed under controlled lighting conditions, where affordable depth and colour detectors work well(3). Gesture discovery becomes grueling in unbridled illumination situations, similar as those encountered in an machine, and is a content that has entered much lower attention. A many videotape-grounded ways for automatic gesture identification(10),(11),(12) make use of near- IR cameras and specialised IR illuminators. These ways combine HMM classifiers with manually created features similar Hu moments(10), decision rules(11), or figure shape features(12). A system that makes use of RGBD data, overeater features, and an SVM classifier was suggested in(13). specially, no earlier systems for in- auto gesture interfaces have combined vision- grounded, radar, and DNN classifier detectors. Systems for recognising mortal stir using audio signals'micro-Doppler fingerprints have also been created singly of vision- grounded styles(15),(16), and(17). Due to the high medium aural noise, auricular detectors for gesture recognition aren't directly usable inside motorcars; nevertheless, the abecedarian idea behind these detectors — using the distinct Doppler autographs for gesture identification has also served as the alleviation for our work. The field of hand gesture recognition(HGR) has generated a wealth of exploration(18),(19),(20),(21),(22),(23),(24),(25),(26),(27),(28). The crucial obstacles in the field of advanced motorist backing systems still include lighting interferences, real- time capabilities, scaling, gyration, and restatement, as well as HMI- related problems(similar as commerce area, gesture set,etc.). multitudinous Computer Vision issues, particularly those related to 3D Vision and HGR, have been successfully addressed by Deep Learning. There's still a dearth of work in this area. Glatt(29) has shown how Deep literacy can be successfully used to produce HGR using Kinect data with the help of Deep Belief Networks. The stylish recognition results range between 75 and 85 and are largely original scores acquired in this donation, indeed if identical delicacy rates as high as> 98 are noway realised. Barros etal.(30) show how CNNs may be used to interpret Italian sign movements from Kinect data with error scores of8.3 for the stylish model while running their system in real-time. Tang et al(31).'s demonstration of the operation of Deep Neural Networks to distinguish between 20 different hand postures with good delicacy scores makes use of a Kinect detector. While the authors assert that illumination invariance is achieved while using both depth and colour data, it's still unclear how this ideal was actually fulfilled because both the RGB and depth measures forming from a Kinect detector are incorrect when exposed to direct sun. Because ultramodern ToF cameras can collect data at over to 90 frames per second, the approach described in this composition assumes depending on a single depth detector to achieve illumination invariance and real- time capability. The new aspect of our system is the quick data metamorphosis phase, which not only makes CNNs usable but also keeps real-time performance. To the stylish of our knowledge, this approach combines affordable tackle with quick algorithmic processing to give good recognition results and is a unique donation to the field of HGR for infotainment control using CNNs. There are a variety of technologies available for controlling robots with gestures. Some of the gesture recognition ways employed include adaptive colour segmentation(32), hand finding and labelling with blocking, morphological filtering, and also gesture conduct defined by template matching and skeletonizing. The gesture inputs aren't dynamic because of template matching. Another option uses a machine interface device to give the robot with real- time gestures(33). To cover cutlet bending, analogue flex detectors are employed on the hand glove(34). Ultrasonic detectors are also used to assess hand position and exposure to honor gestures(35). Another system uses the Microsoft Xbox 360 Kinect(C) to identify movements(36). Kinect uses an RGB and an infrared camera to collect data on colour and depth, independently. still, this approach isn't particularly provident. lately, a variety of ways have been suggested to control in- auto entertainment systems. All of these ways aim to lessen the need for secondary driving duties to need mortal visual coffers. The most ultramodern systems calculate on four main technologies hand gesture discovery, speech recognition, touch displays, and sophisticated buttons. Utilising the audile sensitive channel is a fairly natural way to ameliorate motorist- auto connection. Once the motorist's voice orders are recognised, the control may be fulfilled(38). Hua et al(37).'s study on usability enterprises with in- auto voice instructions is good, and they offer some recommendations for this kind of commerce. Some lately released motors included the use of spoken commands(KIA, Ford). still, there are significant downsides to this manner of interacting generally. In actuality, the semantic meaning of the directives may be unclear. still, it might be grueling to do a dependable speech recognition job, especially in loud settings like an machine(e.g on a trace on in a business jam). This system should be avoided due to these factors. In order to manage the complexity of the multimedia systems, one of the generally used common ways in recent motorcars focuses on employing a menu- grounded interface that's accessible through a touch screen(39). Point- grounded touch defenses were the first kind to be developed. Since there's no way to offer tactile feedback, the stoner must use his fingertip to navigate to the icons or menu particulars on the screen. This kind of touch screen is worrisome since it creates a visual distraction. The recent preface of touch gesture commands in place of point-grounded commands has bettered this commerce approach(40); therefore, using touch gestures analogous to those on the Apple iPhone helped to reduce the need for visual attention. On the other hand, this strategy increased the control system's capacity for literacy, memory, and effectiveness. The music and navigation systems are controlled by cutlet touch gestures on amulti-touch screen that's integrated into the steering wheel by Doring etal.(41). They assert that doing so lowers the motorist's visual demand by 60. Hyundai lately unveiled another development of the touch screen in a auto(42). A remote touch pad that can shoot 3D signals manages this innovative touch screen. These approaches still need the motorist to use his visual senses and aren't designed for a threat-free engagement, despite the advancements they make to conventional touch panels. Buttons can also be used to spark the supplementary features arranged in menus. Traditional buttons can be used and placed above the steering wheel so that the motorist can readily pierce them while driving. To move freely among the menus, Sandnes etal.(43) advise utilising three chording keys and chording sequence patterns. This strategy calls for a significant memory burden and a steep literacy wind,nevertheless.Recently, a new style of rotary regulator called a" clump" appeared and spread to other machine types(BMW, Audi, Mercedes Benzetc.). In this case, the stoner receives visual feedback. Vibrotactile signals transmitted through the clump can be used to offer feedback to reduce this aspect(44). Applying adaptive content and stoner modelling can help dock the time spent browsing the menu(45). Given the advancements in technology moment and the fact that people constantly use hand gestures to express their intentions during communication, hand gestures can be a significant part of information exchange between people and computers. Perceptual computing gives computers the capability to be apprehensive of their surroundings. In other words, the computer is suitable to identify the colorful druggies and colorful environmental aspects that are present and occuring around it. Having stated that, hand gesture recognition is a kind of perceptual computing stoner interface used in HCI to enable computers to record and interpret hand gestures and to issue instructions grounded on an understanding of a particular gesture. The authors of Oinam etal.(2017) cooked two distinct styles for recognising hand gestures using vision and one system using data from a glove. stationary hand and live hand gesture recognition are the approaches grounded on sight. The glove used in the data glove- grounded approach featured five flex detectors. Results indicated that as compared to the data glove- grounded approach, the vision- grounded fashion was more steady and reliable. According to Rosalina etal., hand movements may be linked by analysing the figure that was collected during picture segmentation while the speaker was wearing a glove(2017). likewise, YoBu, a new data glove, was employed by Danling, Yuanlong, and Huaping(

2016) to gather information for gesture discovery. The exploration by Gunawardane and Nimali(2017) examined the use of a data glove with a Leap Movements Controller for tracking the stir of the mortal hand utilising flex detectors, gyroscopes, and visual data. The Leap Motion Controller displayed a good repetition and strong pledge for soft cutlet type operations, according to the results. likewise, the movements are also recorded using a Leap Motion Controller in Eko, Surya & Rafiidha(2017), Shaun etal.(2017), and Deepali & Milind(2016). In Siji Rani, Dhrisya, and Ahalyadas(2017), the authors used a new Hand Gesture Control in Augmented Reality System(HGCARS), in which gesture recognition is carried out using a secondary camera and reality is captured using an IP camera. The virtual object is also added to the videotape feed attained from an IP camera and controlled by using the position and depth of hand, measured using a webcam. also, the experimenters from Salunke & Bharkad(2017), Rokhsana etal.(2017), Jessie etal.(2016), and Anshal, Heidy & Emmanuel(2017) used webcams to collect data. The authors bandy colorful ways used in gesture recognition, similar as point birth, bracket, and shadowing, and estimate their advantages and limitations. They also present a comprehensive taxonomy of different gesture recognition styles, including rule- grounded, template- grounded, and machine literacy-grounded approaches. The paper highlights the operations of gesture recognition in colorful disciplines, including mortal- computer commerce, robotics, healthcare, and entertainment. The authors also identify the challenges and unborn exploration directions in the field, similar as developing more accurate and robust algorithms, perfecting the recognition of dynamic and complex gestures, and exploring new operations of gesture recognition. The composition by Pavlovic, Sharma, and Huang offers a comprehensive review of the exploration on the visual interpretation of hand gestures for mortal- computer commerce(HCI). The authors start by emphasizing the significance of gesture- grounded interfaces in enhancing the lightheartedness and ease of use of mortal- computer commerce. They also give a literal overview of the development of gesture recognition technology, from early systems grounded on simple hand position shadowing to more sophisticated systems that can interpret complex hand movements and gestures. The authors also review the colorful ways and algorithms used in hand gesture recognition, similar as hand shape modeling, hand stir analysis, and spatiotemporal segmentation. They assess the benefits and limitations of these ways and identify some of the main challenges in gesture recognition, similar as handling variations in hand appearance and stir, dealing with occlusions and clutter in the image, and feting dynamic and nonstop gestures. The composition also discusses some of the pivotal operation areas of gesture recognition technology, including HCI, subscribe language recognition, and robotics. The authors punctuate the eventuality of gesture recognition for creating further intuitive and natural interfaces for computer systems, as well as its eventuality for perfecting availability for people with disabilities. Incipiently, the authors identify some of the open exploration questions and unborn directions in the field, similar as developing further robust and dependable gesture recognition algorithms, exploring new modalities of gesture- grounded commerce, and probing the social and artistic factors that impact gesture use and interpretation. Overall, the paper provides an perceptive and instructional review of exploration on the visual interpretation of hand gestures for HCI. It demonstrates the progress made in the field over the times and identifies some of the significant challenges and openings for unborn exploration. The paper by Suarez and Murphy offers an overview of hand gesture recognition with depth images. The authors bandy the benefits of using depth cameras, similar as landing depth information and perfecting recognition in grueling lighting conditions. They review colorful ways for hand gesture recognition, including template- grounded, point- grounded, and machine literacy- grounded styles, assessing their advantages and limitations. The paper also presents the implicit operations of this technology in colorful fields, including robotics, gaming, and mortal- robot commerce, pressing the eventuality for creating further natural and intuitive interfaces for these operations and perfecting availability for people with disabilities. The authors identify open exploration questions and unborn directions in the field, similar as developing more accurate and robust algorithms for hand gesture recognition, exploring new modalities of gesture- grounded commerce, and studying the social and artistic factors that affect gesture interpretation and use. Overall, the paper provides a comprehensive and instructional review of exploration on hand gesture recognition with depth images, pressing the advancements made in the field and relating the openings and challenges for unborn exploration LaViola's paper" An preface to 3D gestural interfaces" explores the conception of 3D gestural interfaces as an volition to traditional 2D graphical stoner interfaces. The author argues that 3D gestural interfaces offer a more natural and intuitive way of interacting with computers, particularly for tasks that involve spatial manipulation and disquisition. The paper provides a literal overview of the development of 3D gestural interfaces, from early systems that used simple hand shadowing to more recent systems that can interpret complex hand and body movements. The author discusses different detectors and tracking technologies used in 3D gestural interfaces, including camera- grounded systems, depth detectors, and inertial dimension units. The paper also covers colorful ways and algorithms used in 3D gesture recognition, including hand disguise estimation, gesture segmentation, and machine literacy- grounded styles. The author evaluates the advantages and limitations of these ways, including their delicacy, robustness, and ease of use. The paper discusses some of the crucial operation areas of 3D gestural interfaces, similar as gaming, virtual and stoked reality, and scientific visualization. LaViola highlights the eventuality of 3D gestural interfaces for creating further immersive and engaging stoner gests , as well as their eventuality to ameliorate availability for people with disabilities. Eventually, the author identifies some of the open exploration questions and unborn directions in the field, similar as developing further natural and intuitive gestures for 3D commerce, exploring new modalities of 3D gestural interfaces, and probing the social and artistic factors that impact 3D gesture use and interpretation. Overall, the paper provides a thorough and instructional preface to 3D gestural interfaces, pressing the progress made in the field and relating some of the crucial challenges and openings for unborn exploration. Neverova etal. propose amulti-scale approach to gesture discovery and recognition in their paper. They argue that former approaches have limited effectiveness due to their focus on original features or holistic models, which may not completely capture the complexity of gestures. The authors' proposed approach combines original and global features by assaying gestures at different scales. They prizemulti-scale features from input data using a aggregate of Gaussian scale- space images and incorporate a hierarchical bracket scheme for refining recognition of gestures at different scales. The paper includes experimental results on three datasets, showing that themulti-scale approach outperforms several state- of- the- art styles in terms of recognition delicacy. The authors also demonstrate the robustness of their approach to variations in lighting conditions and standpoint. The paper discusses implicit operations for their proposed system, including mortal- robot commerce, subscribe language recognition, and gaming. The authors emphasize the significance of accurate and dependable gesture recognition for creating further natural and intuitive interfaces for these operations. Eventually, the authors identify several exploration questions and unborn directions, similar as exploring newmulti-scale point birth styles, probing the effectiveness of the approach for nonstop gesture recognition, and developing more effective and scalable algorithms for real- time operations. Overall, the paper presents a promising approach to gesture discovery and recognition that combines original and global features, with implicit operations in colorful areas of mortal- computer commerce. Trindade etal. propose a hand gesture recognition system that utilizes color and depth images, along with hand angular disguise data, to ameliorate recognition delicacy and robustness. The authors suggest that incorporating hand disguise data can further enhance the performance of the system. The system uses skin color segmentation and depth- grounded segmentation to prize the hand region from the input images. The authors cipher hand angular disguise data, which provides information about the exposure and shape of the hand. This data is used to prize features from the hand region for gesture recognition. Experimental results on a dataset of six hand gestures demonstrate that the proposed system outperforms several state- of- the- art styles in terms of recognition delicacy. The authors also demonstrate the system's robustness to variations in lighting conditions and hand disguise. The paper discusses implicit operations of the proposed system, including mortal- robot commerce, virtual and stoked reality, and subscribe language recognition. The authors punctuate the significance of accurate and dependable hand gesture recognition for creating further natural and intuitive interfaces. The authors identify unborn exploration directions, similar as probing the effectiveness of the system for nonstop gesture recognition, exploring new point birth styles grounded on hand disguise data, and developing more effective and scalable algorithms for real- time operations. Overall, the paper presents an effective approach to hand gesture recognition that combines color and depth information with hand disguise data. The proposed system has shown promising results in experimental evaluations and has implicit for colorful operations in mortal- computer commerce. The paper by Wang etal. introduces a retired tentative Random Field(HCRF) model for gesture recognition, which aims to capture the full complexity of gestures by incorporating both observed and hidden variables in the model. The authors argue that former approaches have been limited by handcrafted features or inadequate temporal modeling. The HCRF model is a probabilistic graphical model that allows for common modeling of the temporal elaboration of gestures and their corresponding point sequences. The authors demonstrate the effectiveness of their approach for feting nonstop gesture sequences and present experimental results on two datasets, showing that the proposed HCRF model outperforms several state- of- the- art styles in terms of recognition delicacy. The implicit operation areas of their proposed system, including mortal- robot commerce, subscribe language recognition, and gaming, are also bandied. The authors emphasize the significance of accurate and dependable gesture recognition for creating further natural and intuitive interfaces for these operations. The paper identifies some of the open exploration questions and unborn directions in the field, similar as exploring new ways to incorporate temporal information into the model, probing the effectiveness of the proposed system for complex gestures with multiple factors, and developing more effective and scalable algorithms for real- time operations. Overall, the paper presents a new and effective approach to gesture recognition that uses a probabilistic graphical model to capture the temporal elaboration of gestures and their corresponding point sequences. The proposed HCRF model has shown promising results in experimental evaluations and has implicit for colorful operations in mortal- computer commerce. The paper by Dardas and Georganas describes a real- time hand gesture discovery and recognition system using bag- of- features and support vector machine ways. The authors argue that former styles for hand gesture recognition weren't suitable for real- time operations and propose a system that can address this limitation. The system has three main stages hand discovery, point birth, and gesture bracket. Skin color segmentation and morphological operations are used in the hand discovery stage to prize the hand region. In the point birth stage, the bag- of- features approach is employed to describe the hand region with visual words. In the gesture bracket stage, a support vector machine classifier is used to fete the hand gesture grounded on the uprooted features. Experimental results on a dataset of six hand gestures demonstrate that the proposed system is accurate, presto, and robust to variations in lighting conditions and hand disguise. The paper highlights the implicit operations of the system in mortal- robot commerce, virtual and stoked reality, and subscribe language recognition, stressing the significance of real- time performance for these operations and the need for effective and accurate hand gesture recognition systems. The authors also identify some open exploration questions and unborn directions in the field, including probing the effectiveness of the proposed system for further complex hand gestures and exploring new point birth styles grounded on depth information. Overall, the paper presents an effective and effective approach to real- time hand gesture discovery and recognition using bag- of- features and support vector machine ways. The proposed system has promising results and has implicit for colorful operations in mortal- computer commerce.

03: SYSTEM DEVELOPMENT

3.1 Language Used:

PYTHON 3: Python 3.0 is a new version of the computer language that is incompatible with prior iterations from the 2.x family. It is often referred to as "Python 3000" or "Py3k." The Python computer language was used to create a module for reorganising hand gestures. In order to drive the gesture-controlled automobile, it recognises hand movement and direction and provides the necessary orders. The Python urllib.request module, which accepts strings containing URLs or Request objects, is used to send commands to the ESP8266 controller board. By doing this, a client-server connection is created between the hardware and the laptop.

C++: Special methods and functions are added to the C++ language while writing the Arduino code. Human-readable programming languages include C++. A is processed and converted to machine language when it is created. The hardware, i.e., the car's motor motions and direction, are controlled using the C++ programming language in accordance with the intended gesture.

Python 3 IDE was used for coding. It was an IDE called Visual Studio Code. Visual Studio Code, a desktop source code editor for Windows, macOS, and Linux, is speedy and efficient. Along with a strong ecosystem of extensions for additional languages and runtimes (including C++, C#, Java, Python, PHP, Go), it comes with built-in support for JavaScript, TypeScript, and Node.js (such as .NET and Unity). The Arduino IDE was used to programme the NodeMCU in C++. The free and open-source Arduino Software makes it easy to write code and upload it to the board (IDE). With this programme, any Arduino board may be utilised.

3.2 Technical Requirements (Hardware)

CPU: AMD Ryzen 5 3550H or better/ Intel i5 9th gen or better.

GPU: Nvidia Gtx 1050 or better.

RAM:8 GB(Recommended)

WEBCAM: Required

HARDWARE: NodeMCU and Motor Sheild L298N

INTERNET CONNECTION: Required.

STORAGE: SSD of size 256 GB to 512 GB or HDD of size 1TB to 2TB

3.3 Functional Requirements:

An operational requirement describes how a software system should work and react to specific inputs or situations. They could include calculations, data processing, and other specialised talents.

Libraries Used:

• OpenCV: We utilised the OpenCV library since it provides a real-time Computer Vision Library, tools, and hardware. OpenCV is a fantastic tool for image processing and computer vision tasks. It is an open-source library that may be used for a variety of tasks, including face recognition, object tracking, landmark detection, and many more..

• MediaPipe: We used Google's MediaPipe framework, which allows for customisable machine learning solutions. It is a lightweight, open-source, and cross-platform framework. Pre-trained ML solutions for face detection, position estimation, hand recognition, object detection, and other tasks are included with MediaPipe.

• ESO8255WIFI: Wi-Fi is the focus of the ESP8266. In order to start transmitting and receiving data, we connected our ESP8266 module to a Wi-Fi network using this library.

• OS: This module offers a portable method of utilising operating system-specific features. We have utilised this library to make it possible to retrieve data from the operating system's storage, i.e., to collect hand pictures that would show a visual output for the hand motion that is now being identified.

• Urllib.request is a flexible library that may be used to open URLs using a number of different protocols. The urlopen function, which accepts a string containing a URL or a Request object, is the easiest way to utilise this module (described below). The URL is opened, and the results are returned as a file-like object.

• http: The Hypertext Transfer Protocol is used by a number of modules, which are collected in the http package.

Hardware Used:

- NodeMCU – ESP8266 WIFI Development Board:
- Motor shield L298N
- Jumper Vires

- Breadboard
- 12-volt battery
- Chassis Kit with body and 4 motors

3.4 Non-Functional Requirements:

Nonfunctional requirements are those that have no direct bearing on how well a system can carry out a certain function. Instead than specifying particular operations, they establish the criteria that may be used to evaluate a system's performance. They might relate to emergent system characteristics such Considerations should be made about store occupancy, reaction time, and dependability. User-generated nonfunctional demands are created. External variables must be taken into account, including financial constraints, organisational rules, and the requirement for system compatibility. Examples include: - Hardware and software systems, or - outside factors like:

• Product Needs: We are able to use an IDE like Google Collaboratory, VScode, or Arduino.

• Windows 8 or later as the operating system

• Installation of Python libraries such as opencv is a basic operational requirement

3.5 E-R Diagram / Data-Flow Diagram (DFD):

We have shown a step-by-step approach to the entire project in the image below, from the very beginning to the very finish. The webcam would serve as the entry point, capturing all user motions. The hand detection module would then identify the hand gestures and translate them into signals or orders for the hardware. The software will handle any errors that arise throughout the procedure by terminating it and displaying the error output. Hardware-wise, the Node MCU board continually processes the commands, dictating the direction and speed of the DC motors.

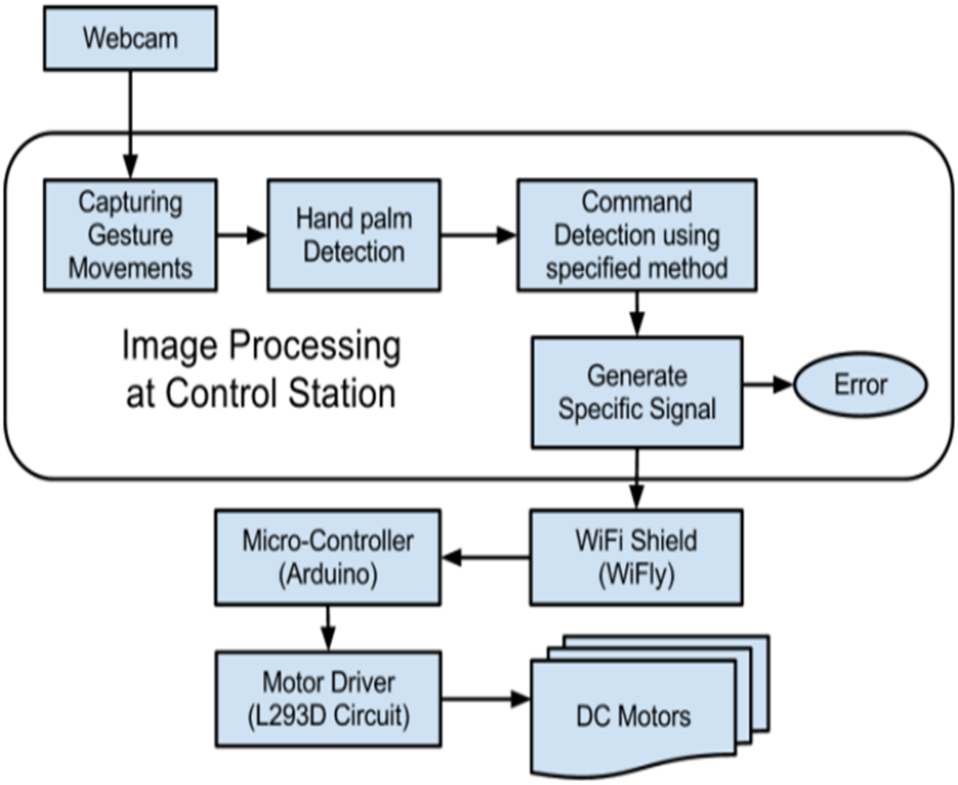


Fig 3.1(ER Model)

3.6 Data Set Features:

Giving the hand landmark model a properly cropped image of a hand greatly reduces the need for data augmentation (such as rotations, translations, and scaling) and instead allows the network to concentrate most of its efforts on accurate coordinate prediction. Palm detection is only utilised to relocalize the hand when the landmark model is unable to do so. The crops in our pipeline may also be made utilising the hand landmarks discovered in the previous frame.

The pipeline is implemented as a MediaPipe graph using a specialised hand renderer subgraph and a hand landmark tracking subgraph from the hand landmark module.

3.7 Data Pre-Set for Major Project:

The hand gesture library we are using is called Mediapipe. A model for identifying palms that makes use of the complete image and generates an oriented hand bounding box is part of the MediaPipe Hands ML pipeline. a hand landmark model that generates very precise 3D hand keypoints while operating on the portion of the image that was clipped by the palm detector. This approach is akin to the use of a face detector and a face landmark model in the MediaPipe Face Mesh solution.

04: PERFORMANCE ANALYSIS:

4.1 Model for Palm Detection:

The Mediapipe library gives us a single-shot detector optimised model to find the initial hand placements.

4.2 Hand Landmark Model:

After detecting palms over the whole image, the hand landmark model uses regression to accurately localise 21 3D hand-Knuckle coordinates inside the detector hand area, yielding immediately exact coordinates. Self-occlusions and partially visible hands have no effect on the model's ability to establish a trustworthy internal hand position representation. To get ground truth data, the developers manually highlighted 21 3D locations on 30K real-world pictures, as seen below. In order to better cover the range of potential hand positions and provide extra oversight on the nature of hand geometry, they additionally render a high-quality synthetic hand model over a variety of backdrops and map it to the associated 3D coordinates.

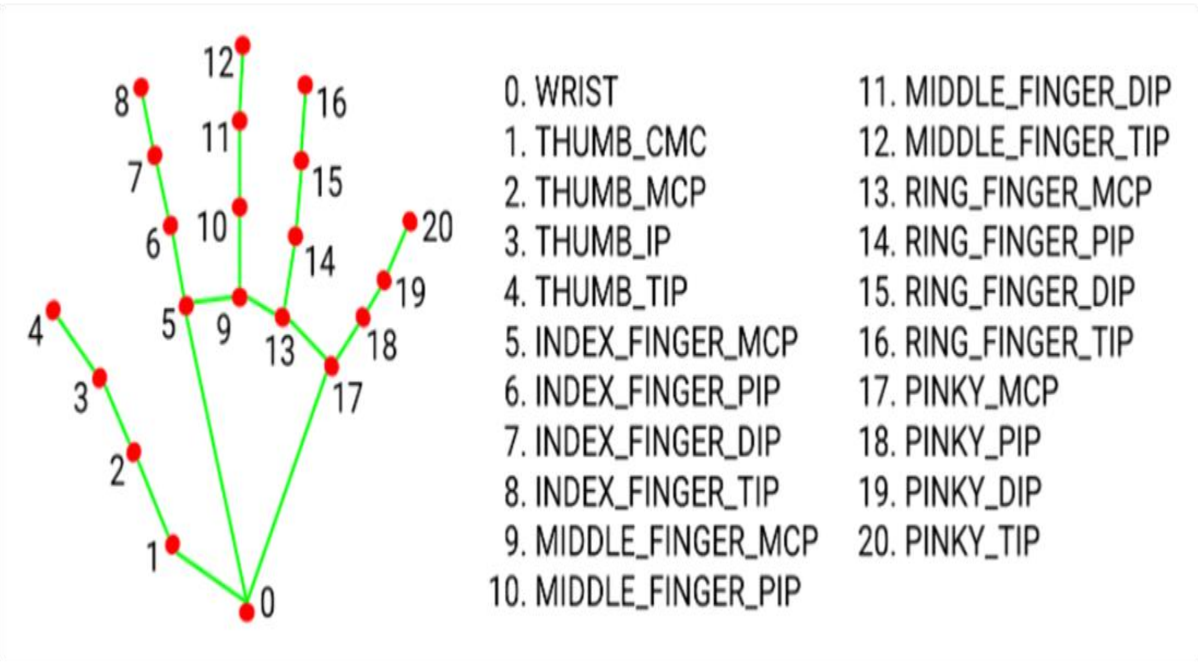


Fig 3.2 (Different Finer Indices Codes)

4.3 Number of Attributes, fields, description:

STATIC IMAGE MODE

If false is chosen, a video stream of the provided images is processed by the application. It will try to recognise hands in the initial input photos; if successful, it will then localise the hand landmarks more precisely. After locating the corresponding hand landmarks and detecting the maximum number of hands, it merely keeps an eye on those landmarks in subsequent pictures without doing another detection until it loses track of any of the hands. This lessens the delay when processing video frames. Setting the value of hand detection to true, which is executed on each incoming image, is the best course of action for managing a batch of static, potentially unrelated photos. By default, false.

MAX NUM HANDS

Maximum hands to be detected. By default, 2.

MODEL COMPLEXITY

Complexity of the hand landmark model is 0 or 1. Benchmark accuracy and inference delay frequently grow as models get more complex. 1. by default

MIN DETECTION CONFIDENCE

The hand detection model must produce a minimum confidence value of [0.0, 1.0] before the detection may be deemed successful. 0.5 is the default.

MIN TRACKING CONFIDENCE: The hand landmarks must be monitored with at least a landmark-tracking model confidence value of ([0.0, 1.0]); else, hand recognition will be turned on automatically for the next input image. The solution's resilience can be increased at the expense of a rise in latency. Hand detection is disregarded and applied to every image if static image mode is set to true. The default is 0.5.

4.4 Flow graph of the Major Project Problem:

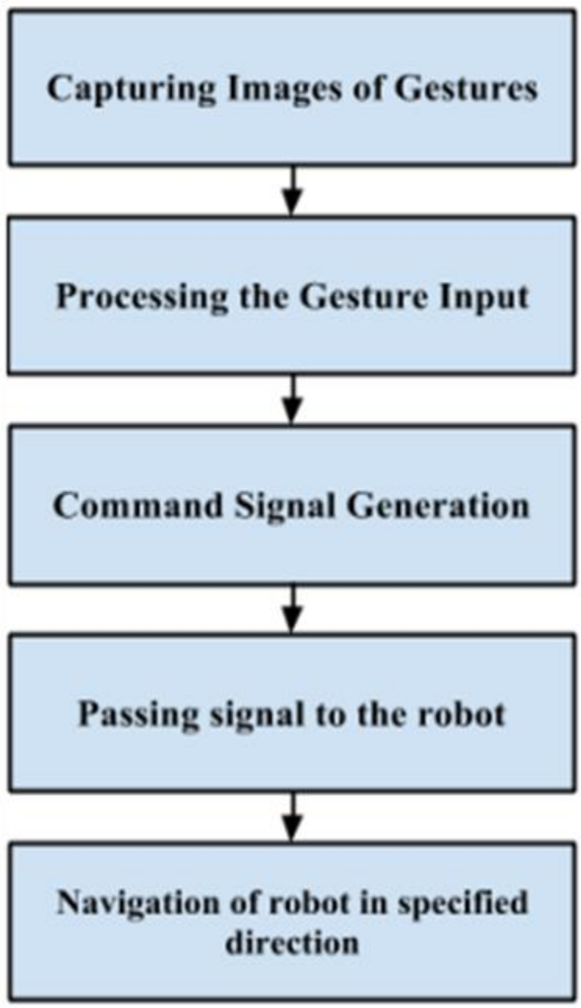


Fig 3.3(Flow Graph Of Project)

Step 1:

The motions are detected by the camera, which then reads the picture of the gesture and transmits it to the software, which analyses the type of gesture and the instruction that will be derived from it.

Step 2:

The programme receives the captured picture from the camera, analyses all of its dimensions, determines the kind of command that has to be made, and then sends this data to the command creation software.

Step 3:

The command signal generator uses all the data from the software to produce the command that will drive the automobile by sending it to the hardware.

Step 4:

The hardware modules receive all the processed data and use it to analyse signals and produce the movement of the automobile using hand gestures.

Step 5:

After taking in all the data and analysing all the motions, the automobile travels in the appropriate direction and waits for the next order.

4.5 Algorithm / Pseudo code of the Project Problem:

Pseudo Code for Hand Gesture recognition Module:

This program tracks the hand visible to the camera for processing it.

>>Function __init__() {

>>It a default function which is used to initialize the functional parameters of mediapipe hand module.

}

>>Function findHands(self,imgae,draw set to True){

>>This function processes the hands captured through the web cam and stores real-time RGB image in a variable so that we can draw over it.

>>If landmark is true

    >>Then run a loop to iterate over the landmarks

    >>If draw is set to true

>>Draw hand connections over the landmarks to give a display of all the hand landmarks for a good visual representation

>>And then return the image on to the screen itself

}

>>Function findPositions(self, image, hand no which represents R/L Hand, Draw set to true){

>>If landmark is true

    >>Save the hand result in a variable

>>Run a loop to iterate over the landmark id and landmark over the hand landmarks

>>Store the height and width of the image which would be displayed representing the hand gesture

    >>For better visualization draw a small circle representing the landmarks over the hand.

    >>Store these landmarks in a list

    >>Return the list

}

Now this module is called from a separate function to make the flow of finger detection much clearer.

Pseudo Code for Finger Counter Module:

>>We define the height and width of the webcam window that pops up when program executes

>>Store the webcam in a variable defining the webcam that would read the image

>>Storing the folder path in a variable. This folder contains sample Finger Images which would give us the pictorial representation of which finger is detected by the module.

>>Base variable storing the url base address of the nodeMCU web server

>>For image list in the directory folder

fetching the image in a list

appending the images in a list

>> Creating an object of the handDetector module setting the detection Confidence value to 75%

>> Storing landmark tip ids in a list

>>while set to true

>>fetching the image from webcam

>>creating an object of FindHands function and passing the image to it and storing in a variable

>>creating an object of findPostions and passing image to it and setting draw to false and storing the result in a variable.

>>If the length of findPostion list is not 0

>>If the tipid from the defined list over index 1 till last is greater than the tip id acquired over camera

Appending 1 to the list corresponding to the finger index which was detected

>>Else

Appending 0 to the list for each index position where finger is not detected

>>For id in the range 1-5

>>If the tipid from the defined list for the zeroth index is smaller than the tip id acquired over camera

Appending 1 to the list to show thumb was detected

>>Else

Appending 0 to the list to show thumb was not detected

>>Storing the total finger count to a variable

>>Implementing a condition check for sending command to the board corresponding to the >>count of the fingers. E.g., if the fingers = 2 sending command to Go left etc.

>>Getting height, width of the image png frame

>>Overlaying the respective gesture image onto the webcam display area

>>Display the image on to the screen

>>Waitkey set to 1

Pseudo Code for nodeMCU:

>>Defining all the pins with variable names for motor shield L298N

>>Importing the custom library

>>Defining the speed and speed_Coefficient and pwm parameters

>>Function setup{

Setting baud rate to 9600

Passing WIFI credintials for establishing connection

Setting pin modes to Output for all the pins defined above setup

}

>>Function goAhead{

Pin configuration to move the car in forward direction

}

>>Function goBack{

Pin configuration to move the car in backward direction

}

>>Function goRight{

Pin configuration to turn the car in right direction

}

>>Function goLeft{

Pin configuration to turn the car in left direction

}

>>Function stopRobot{

Pin configuration to make the car stop

}

>>Function loop{

>>If checkNewReq is 1{

If the path is = /forward

Return forward command as string

Else if path is =/backward{

Return backward command as string

Else if path is = /right

Return right command as string

Else if path is = /left

Return left command as string

Else if path is = /stop

Return stop command as string

Else {

>>Storing the path in a variable

>>Removing the backslash from the string to get the exact text command

>>Printing the command to serial monitor

If path is Forward

goAhead function is called

else if path is backward

goBack function is called

else if path is right

goRight function is called

else if path is left

goLeftfunction is called

```
                    else if path is stop
                          stopRobotfunction is called
                    else
                          printing to the serial monitor waiting
}
}
}
```

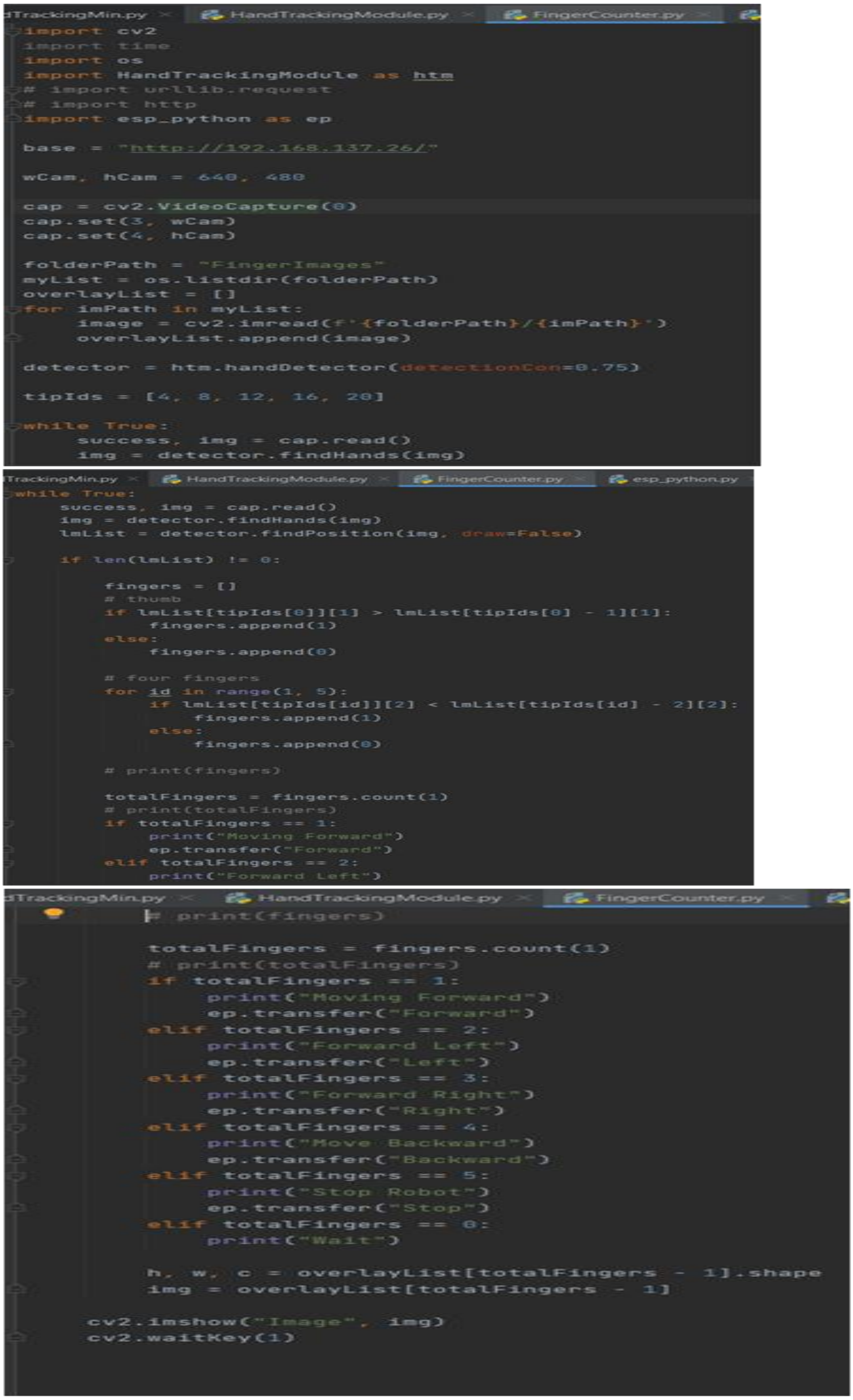
4.6 Screenshots of the various stages of the Project:

First, a generic class that implements the hand recognition module is created. In order to implement the various features in this module, it reads the real-time picture frames that were acquired by the camera. To maintain a clear and visible flow, we simply created a new file for the hand detection module. The following file, which is seen in Fig., imports this module.

```python
import cv2
import mediapipe as mp
import time


class handDetector():
    def __init__(self, mode=False, maxHands=1, modelComplex=1, detectionCon=0.5, trackCon=0.5):
        self.mode = mode
        self.maxHands = maxHands
        self.detectionCon = detectionCon
        self.trackCon = trackCon
        self.modelComplex = modelComplex
        self.mpHands = mp.solutions.hands
        self.hands = self.mpHands.Hands(self.mode, self.maxHands, self.modelComplex,
                                        self.detectionCon, self.trackCon)
        self.mpDraw = mp.solutions.drawing_utils

    def findHands(self, img, draw=True):
        imgRGB = cv2.cvtColor(img, cv2.COLOR_BGR2RGB)
        self.results = self.hands.process(imgRGB)
        # print(results.multi_hand_landmarks)

        if self.results.multi_hand_landmarks:
            for handLms in self.results.multi_hand_landmarks:
                if draw:
                    self.mpDraw.draw_landmarks(img, handLms,
                                               self.mpHands.HAND_CONNECTIONS)
        return img

    def findPosition(self, img, handNo=0, draw=True):
```

```python
def main():
    pTime = 0
    cTime = 0
    cap = cv2.VideoCapture(0)
    detector = handDetector()
    while True:
        success, img = cap.read()
        img = detector.findHands(img)
        lmList = detector.findPosition(img)
        if len(lmList) != 0:
            print(lmList[4])

        cTime = time.time()
        fps = 1 / (cTime - pTime)
        pTime = cTime

        cv2.putText(img, str(int(fps)), (10, 70), cv2.FONT_HERSHEY_PLAIN, 3,
                    (255, 0, 255), 3)

        cv2.imshow("Image", img)
        cv2.waitKey(1)


if __name__ == "__main__":
    main()
```

Fig4.1 Hand Tracking Module



```
dTrackingMin.py    HandTrackingModule.py    FingerCounter.py
import cv2
import time
import os
import HandTrackingModule as htm
# import urllib.request
# import http
import esp_python as ep

base = "http://192.168.137.26/"

wCam, hCam = 640, 480

cap = cv2.VideoCapture(0)
cap.set(3, wCam)
cap.set(4, hCam)

folderPath = "FingerImages"
myList = os.listdir(folderPath)
overlayList = []
for imPath in myList:
    image = cv2.imread(f'{folderPath}/{imPath}')
    overlayList.append(image)

detector = htm.handDetector(detectionCon=0.75)

tipIds = [4, 8, 12, 16, 20]

while True:
    success, img = cap.read()
    img = detector.findHands(img)
```

```
TrackingMin.py    HandTrackingModule.py    FingerCounter.py    esp_python.py
while True:
    success, img = cap.read()
    img = detector.findHands(img)
    lmList = detector.findPosition(img, draw=False)

    if len(lmList) != 0:

        fingers = []
        # thumb
        if lmList[tipIds[0]][1] > lmList[tipIds[0] - 1][1]:
            fingers.append(1)
        else:
            fingers.append(0)

        # four fingers
        for id in range(1, 5):
            if lmList[tipIds[id]][2] < lmList[tipIds[id] - 2][2]:
                fingers.append(1)
            else:
                fingers.append(0)

        # print(fingers)

        totalFingers = fingers.count(1)
        # print(totalFingers)
        if totalFingers == 1:
            print("Moving Forward")
            ep.transfer("Forward")
        elif totalFingers == 2:
            print("Forward Left")
```

```
dTrackingMin.py    HandTrackingModule.py    FingerCounter.py
        # print(fingers)

        totalFingers = fingers.count(1)
        # print(totalFingers)
        if totalFingers == 1:
            print("Moving Forward")
            ep.transfer("Forward")
        elif totalFingers == 2:
            print("Forward Left")
            ep.transfer("Left")
        elif totalFingers == 3:
            print("Forward Right")
            ep.transfer("Right")
        elif totalFingers == 4:
            print("Move Backward")
            ep.transfer("Backward")
        elif totalFingers == 5:
            print("Stop Robot")
            ep.transfer("Stop")
        elif totalFingers == 0:
            print("Wait")

        h, w, c = overlayList[totalFingers - 1].shape
        img = overlayList[totalFingers - 1]

    cv2.imshow("Image", img)
    cv2.waitKey(1)
```

Fig4.2 Finger Counter Module

```python
import urllib.request
import http

base = "http://192.168.137.26/"


def transfer(my_url):  # use to send and receive data
    try:
        n = urllib.request.urlopen(base + my_url).read()
        n = n.decode("utf-8")
        return n

    except http.client.HTTPException as e:
        return e
```

Fig4.3 NodeMCU and Python Communication Module

(This module is imported in the FingerCounterModule)

4.7 Prototype Images:

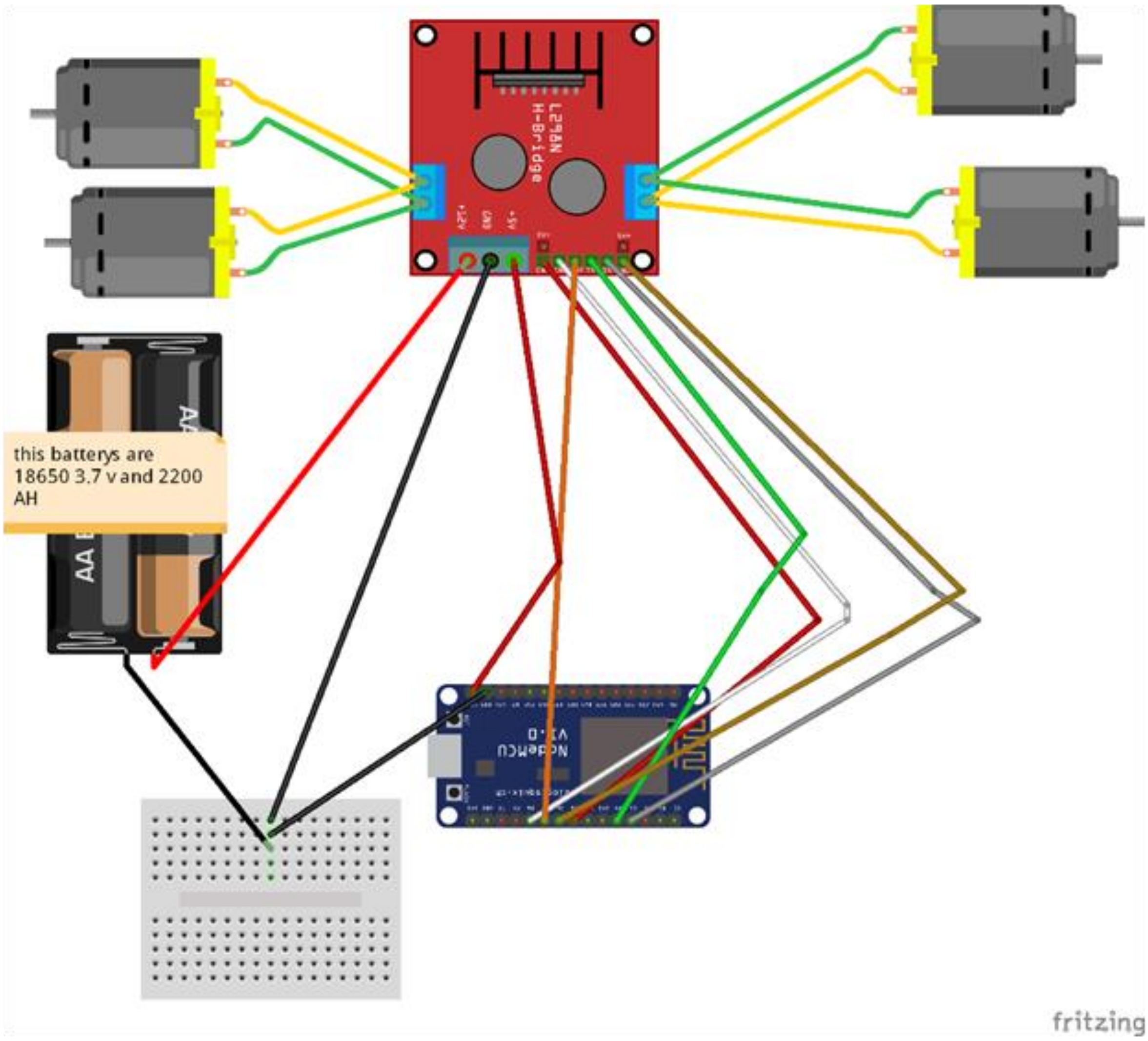


Fig4.4 Circuit Connection for the hardware

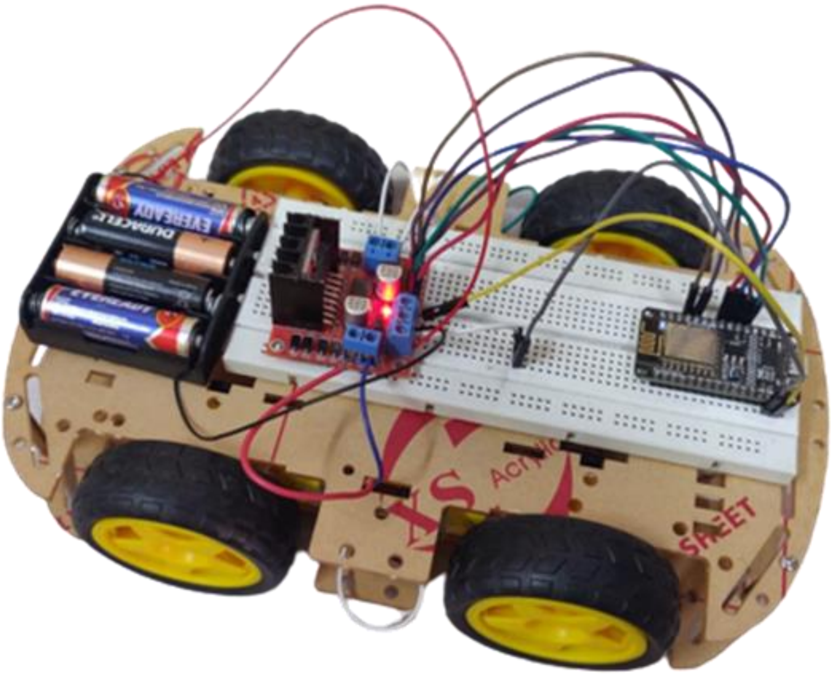


Fig4.5 Prototype of the working model

05: CONCLUSIONS

5.1 Conclusion

For the problem of hand gesture recognition, we suggested a quick and straightforward approach. The algorithm separates the hand region from seen pictures of the hand before drawing conclusions about the movement of the fingers used in the motion. On actual photographs we've obtained, we've shown how effective our computationally efficient technique is. We have just taken into account a small number of motions based on our motivating robot control application. To recognise a larger variety of movements, our system may be expanded in a number of different ways. If this method were to be applied in tough operating environments, the segmentation element of our algorithm would need to be enhanced. But it's important to keep in mind that the segmentation issue in general is still an unsolved research issue. Hand gesture recognition systems need to cope with occlusions, temporal tracking for identifying dynamic motions, and 3D modelling of the hand, which are still far beyond the present state of the art, in order to perform consistently in a broad scenario. We looked into a number of methods that are now used to communicate with the deaf and the mute. We outlined several significant flaws in the methods now in use and offered a remedy in the form of a suggested system approach. Through widely accepted standard gesture recognition, our specially built gadget effectively communicated with deaf and mute persons. When it is used with hardware, the reaction time is quite short. Compared to other classifiers, our suggested system's support vector machine technique significantly increased accuracy. This project's goal of employing gestures to drive a robotic automobile was accomplished with only a few minor issues. When the gadget is tilted in any way, the robot reacts as it should. The vehicle drives forward when the device is inclined downward, backward when it is tilted upward, left and right when it is slanted left and right, respectively, and stops when it is parallel to the earth's surface.The robotic automobile may be operated from a distance thanks to the quick communication between the app and the node MCU.

We overcame the issues we had with faulty connecting wires and soldering some of the pieces to the vero board. This study has demonstrated that a robot may be remotely controlled using an Android cellphone.

Life is made simpler by the development of IoT and by its integration with physical objects. The risky and dangerous duties are relatively simple to complete. Additionally, the introduction of IoT speeds up the completion of tasks. Additionally, there is a significant reduction in human error and very accurate results are produced.

By using powerful batteries and sensors with low power consumption, the restrictions, such as high power consumptions, may be solved. The human hand may move in many different directions, but the vehicle only recognises five of them. Other hand motions will thus be added to the project, and the output from the automobile will change correspondingly.

5.2 Future Scope

We looked into a number of methods that are now used to communicate with mute and deaf persons. Future two-way communication will be aided by the use of machine learning algorithms and the Google Assistant platform. This gadget will have the effect of encouraging those who are affected by this impairment to express their ideas and viewpoints towards societal welfare.

By making a few adjustments, Optimised Hand Gesture Based Home Automation For Feebles can also be used. Patients who are bedridden are given priority, followed by elderly individuals, those who are physically disabled, and those who struggle to utilise household items due to their ailments and impairments. Many household appliances may be operated with a straightforward hand motion. Since it is available 24/7, the access and reaction times are quicker. Users may control several household appliances, including lights, fans, buzzers, and many more, by using simple hand gestures and without the aid of a third party. You may get more information and security thanks to the mobile app and emergency alert feature. In this approach, there will be no risk to the patient. The wireless wifi module accelerates and simplifies the procedure. In order to modify the framework based on the user's profile, we will need to enhance the hand gesture library in the future. The frame may need to be used differently depending on the level of comfort of each consumer. We must broaden the application to include mechanical control, where the motion interface has to be more precise. The current home automation system reportedly has few functions and is inaccurate. High accuracy may be integrated by using sophisticated tensorflow data models to make further advancements. The automation of several devices is possible. It is possible to use advanced cameras that facilitate object detection at a greater distance.

We can use it for smart parking systems by providing guidance on the present state of parkland slots, a smart parking system will be a rapid cure to the ongoing traffic bottleneck and reduce the driver's annoyance in the search for open parking spaces. In the near future, there will be a huge need for smart auto parking systems. Even if the clever parkland layout that was previously in place still exists, we think that making it more easy and affordable will assist to increase its acceptability within the neighbourhood. The fuel consumption of vehicles is decreased by the Smart Parking System since it takes less time to find them in parking lots. Additionally, it prevents vehicles from idling through occupied parking spaces in a city.

By offering a central management system that ensures that the client addressing the security concerns only receives legitimate instructions.Additionally, enquiries are frequently made using past parking information so that users may receive guidance or suggestions on parking spaces and their chances in the days to come. This research suggests that it may be used to determine the cost of a parking space when a user rents or books a space. We can develop a smartphone application that would help vehicles find parking spaces at certain retail centres or multiplexes.

5.3 Application Contribution

Robots that can be controlled wirelessly are particularly helpful for a variety of tasks, such as military remote surveillance and robots that disperse bombs.

Physically disabled people in wheelchairs can employ robots that are controlled by hand gestures.

It is possible to create industrial-grade robotic arms controlled by hand gestures.

These robots can be utilised in civil engineering and construction fields.

A hand gesture-based Human Computer Interface (HCI) approach based on the Node MCU platform and a smart glove can be offered. An accelerometer and a flex sensor were features of the smart glove. While the control actions were translated from the hand movement in three axes to control up to three devices, the flex sensor was employed to enable the control system. An environmental control unit is created by the activities, which are wirelessly sent across a local network (ECU). The proposed method's simplicity, low cost, and low power were confirmed through comparisons with related work. The suggested hand gesture-based approach will be extremely helpful for people with limited mobility as well as patients with physical impairment.

REFERENCES:

[1] S. Mitra and T. Acharya, "Gesture recognition: A survey," IEEE Systems, Man, and Cybernetics, vol. 37, no. 3, pp. 311–324, 2007.

[2] V. I. Pavlovic, R. Sharma, and T. S. Huang, "Visual interpretation of hand gestures for human-computer interaction: A review," PAMI, vol. 19, pp. 677–695, 1997.

[3] J. Suarez and R. R. Murphy, "Hand gesture recognition with depth images: A review," in RO-MAN. IEEE, 2012, pp. 411–417.

[4] J. J. LaViola Jr., "An introduction to 3D gestural interfaces," in SIGGRAPH 2014 Courses, 2014.

[5] N. Neverova, C. Wolf, G. Paci, G. Sommavilla, G. W. Taylor, and F. Nebout, "A multi-scale approach to gesture detection and recognition," in Computer Vision Workshops (ICCVW), 2013, pp. 484–491.

[6] P. Trindade, J. Lobo, and J. Barreto, "Hand gesture recognition using color and depth images enhanced with hand angular pose data," in Multisensor Fusion and Integration for Intelligent Systems (MFI), 2012 IEEE Conference on, 2012, pp. 71–76.

[7] T. Starner, A. Pentland, and J. Weaver, "Real-time american sign language recognition using desk and wearable computer based video," PAMI, vol. 20, no. 12, pp. 1371–1375, 1998.

[8] S. B. Wang, A. Quattoni, L. Morency, D. Demirdjian, and T. Darrell, "Hidden conditional random fields for gesture recognition," in CVPR, vol. 2, 2006, pp. 1521–1527.

[9] N. Dardas and N. D. Georganas, "Real-time hand gesture detection and recognition using bag-of-features and support vector machine techniques," IEEE Transactions on Instrumentation and Measurement, vol. 60, no. 11, pp. 3592–3607, 2011.

[10] M. Zobl, R. Nieschulz, M. Geiger, M. Lang, and G. Rigoll, "Gesture components for natural interaction with in-car devices," in GestureBased Communication in Human-Computer Interaction. Springer, 2004, pp. 448–459.

[11] F. Althoff, R. Lindl, L. Walchshausl, and S. Hoch, "Robust multimodal hand-and head gesture recognition for controlling automotive infotainment systems," VDI BERICHTE, vol. 1919, p. 187, 2005.
[12] F. Parada-Loira, E. Gonzalez-Agulla, and J. Alba-Castro, "Hand gestures to control infotainment equipment in cars," in IEEE Intelligent Vehicles Symposium, 2014, pp. 1–6.
[13] E. Ohn-Bar and M. Trivedi, "Hand gesture recognition in real time for automotive interfaces: A multimodal vision-based approach and evaluations," Intelligent Transportation Systems, IEEE Transactions on, vol. PP, no. 99, pp. 1–10, 2014.
[14] K. R. Konda, A. Konigs, H. Schulz, and D. Schulz, "Real time ¨ interaction with mobile robots using hand gestures," in ACM/IEEE HRI, 2012, pp. 177–178.
[15] S. Gupta, D. Morris, S. Patel, and D. Tan, "Soundwave: using the Doppler effect to sense gestures," in CHI, 2012, pp. 1911–1914.
[16] K. Kalgaonkar and B. Raj, "One-handed gesture recognition using ultrasonic Doppler sonar," in ICASSP, 2009, pp. 1889–1892.
[17] S. Dura-Bernal, G. Garreau, C. Andreou, A. Andreou, J. Georgiou, T. Wennekers, and S. Denham, "Human action categorization using ultrasound micro-doppler signatures," in Human Behavior Understanding. Springer, 2011, pp. 18–28.

[18] T. Kopinski, S. Magand, A. Gepperth, and U. Handmann, "A pragmatic approach to multi-class classification," in The International Joint Conference on Neural Networks (IJCNN 2015), Killarney, Ireland, 2015, pp. 1–8. [Online]. Available: http://ieeexplore.ieee.org/document/7280768/
[19] T. Kopinski, A. Gepperth, and U. Handmann, "A time-of-flightbased hand posture database for human-machine interaction," in 14th International Conference on Control, Automation, Robotics and Vision, ICARCV 2016, Phuket, Thailand, 2016. [Online]. Available: http://ieeexplore.ieee.org/document/7838613/
[20] A. Ramamoorthy, N. Vaswani, S. Chaudhury, and S. Banerjee, "Recognition of dynamic hand gestures," Pattern Recognition, vol. 36, no. 9, pp. 2069–2081, 2003.

[21] T. Kopinski, A. Gepperth, and U. Handmann, "A real-time applicable dynamic hand gesture recognition framework," in IEEE 18th International Conference on Intelligent Transportation Systems (ITSC 2015). Las Palmas de Gran Canaria, Canary Islands (Spain): IEEE, 2015, pp. 2358 – 2363. [Online]. Available:http://ieeexplore.ieee.org/document/7313473/

[22] A. Kurakin, Z. Zhang, and Z. Liu, "A real time system for dynamic hand gesture recognition with a depth sensor," in Signal Processing Conference (EUSIPCO), 2012 Proceedings of the 20th European. IEEE, 2012, pp. 1975–1979.

[23] M. Van den Bergh and L. Van Gool, "Combining rgb and tof cameras for real-time 3d hand gesture interaction," in Applications of Computer Vision (WACV), 2011 IEEE Workshop on. IEEE, 2011, pp. 66–72.

[24] T. Kopinski, A. Gepperth, and U. Handmann, "A simple technique for improving multi-class classification with neural networks," European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning, 2015.

[25] E. Kollorz, J. Penne, J. Hornegger, and A. Barke, "Gesture recognition with a time-of-flight camera," International Journal of Intelligent Systems Technologies and Applications, vol. 5, no. 3, pp. 334–343, 2008. [26] M. Tang, "Recognizing hand gestures with Microsoft's kinect," Web Site: http://www.stanford.edu/ class/ee368/Project 11/ Reports/Tang Hand Gesture Recognition. pdf, 2011.

[27] T. Kopinski, A. Gepperth, S. Geisler, and U. Handmann, "Neural network based data fusion for hand pose recognition with multiple ToF sensors," in Lecture Notes in Computer Science: Artificial Neural Networks and Machine Learning ICANN 2014, vol. 8681. Springer Verlag, Berlin, Heidelberg, Germany, 2014, pp. 233–240.

[28] T. Kopinski, A. Gepperth, and U. Handmann, "A simple technique for improving multi-class classification with neural networks," in 23th European Symposium on Artificial Neural Networks, Computational Intelligence and Machine Learning (ESANN 2015), Bruges, Belgium, 2015, pp. 469–474. [Online]. Available:: https://www.elen.ucl.ac.be/Proceedings/esann/esannpdf/es2015-136.pdf

[29] R. Glatt, "Deep learning architecture for gesture recognition," 2014.

[30] P. Barros, G. I. Parisi, D. Jirak, and S. Wermter, "Real-time gesture recognition using a humanoid robot with a deep neural architecture," in Humanoid Robots (Humanoids), 2014 14th IEEE-RAS International Conference on. IEEE, 2014, pp. 646–651.

[31] A. Tang, K. Lu, Y. Wang, J. Huang, and H. Li, "A real-time hand posture recognition system using deep neural networks," ACM Transactions on Intelligent Systems and Technology (TIST), vol. 6, no. 2, p. 21, 2015.

[32] Chao Hy Xiang Wang, Mrinal K. Mandal, Max Meng, and Donglin Li, "Efficient Face and Gesture Recognition Techniques for Robot Control", CCECE, 1757-1762, 2003.

[33] Asanterabi Malima, Erol Ozgur, and Mujdat Cetin, "A Fast Algorithm for Vision-Based Hand Gesture Recognition for Robot Control", IEEE International Conference on Computer Vision, 2006.

[34] Thomas G. Zimmerman, Jaron Lanier, Chuck Blanchard, Steve Bryson and Young Harvill, "A Hand Gesture Interface Device", 189-192, 1987.

[35] Jagdish Lal Raheja, Radhey Shyam, Umesh Kumar and P Bhanu Prasad, "Real-Time Robotic Hand Control using Hand Gestures", Second International Conference on Machine Learning and Computing, 2010.

[36]Gesture Controlled Robot using Kinect http://www.eyantra.org/home/projects-wiki/item/180-gesture-controlled-robot-usingfirebirdv-and-kinect

[37] Hua, Z., Ng, W.L.: Speech recognition interface design for in-vehicle system. In: Proceedings of the 2nd International Conference on Automotive User Interfaces and Interactive Vehicular Applications, AutomotiveUI '10, pp. 29–33. ACM, New York, NY, USA (2010)

[38] Singh, S., Singh, S., Kour, M., Manhas, S.: Article:voice recognition in automobiles. International Journal of Computer Applications 6(6), 7–11 (2010). Published By Foundation of Computer Science.

[39] Srovnal, V., Machacek, Z., Hercik, R., Slaby, R., Srovnal, V.: Intelligent car control and recognition embedded system. In: IMCSIT, pp. 831–836 (2010)

[40] Ecker, R., Broy, V., Hertzschuch, K., Butz, A.: Visual cues supporting direct touch gesture interaction with in-vehicle information systems. In: Proceedings of the 2nd International Conference on Automotive User

Interfaces and Interactive Vehicular Applications, AutomotiveUI ’10, pp. 80–87. ACM, New York, NY, USA (2010).

[41] Doring, T., Kern, D., Marshall, P., Pfeiffer, M., Schoning, J., Gruhn, V., Schmidt, A.: Gestural interaction on the steering wheel: reducing the visual demand. In: Proceedings of the 2011 annual conference on Human factors in computing systems, CHI ’11, pp. 483–492. ACM, New York, NY, USA (2011)

[42] Kang, S.H., Lee, S.H.: User interface device for controlling car multimedia system (2011)

[43] Sandnes, F., Huang, Y.P., Huang, Y.M.: Near eyes-free chauffeur computer interaction with chording and visual text mnemonics. Journal of Universal Computer Science 16(10), 1311–1326 (2010).

[44] Ryu, J., Chun, J., Park, G., Choi, S., Han, S.: Vibrotactile feedback for information delivery in the vehicle. Haptics, IEEE Transactions on 3(2), 138 – 149 (2010)

[45] Fischer, P., Nurnberger, A.: my command automotive user interface: Personalised interaction with multimedia content based on fuzzy preference modelling. In: User Modelling, pp. 315–326 (2010)

APPENDICES:

```
/* This example is written for Nodemcu Modules */
  #define ENA   14          // Enable/speed motors Right        GPIO14(D5)
  #define ENB   12          // Enable/speed motors Left         GPIO12(D6)
  #define IN_1  15          // L298N in1 motors Rightx          GPIO15(D8)
  #define IN_2  13          // L298N in2 motors Right           GPIO13(D7)
  #define IN_3  2           // L298N in3 motors Left            GPIO2(D4)
  #define IN_4  0           // L298N in4 motors Left            GPIO0(D3)

  #include "ESP_Wahaj.h" // importing our library
  String command;             //String to store app command state.
  int speedCar = 800;         // 400 - 1023.
  int speed_Coeff = 3;
  int pwm = 255;
  String path = "nothing";

void setup(){
  Serial.begin(9600);
  start("LEGION9784","12341234");  // Wifi details connect to

   pinMode(ENA, OUTPUT);
   pinMode(ENB, OUTPUT);
   pinMode(IN_1, OUTPUT);
   pinMode(IN_2, OUTPUT);
   pinMode(IN_3, OUTPUT);
   pinMode(IN_4, OUTPUT);

}

void goAhead(){

      digitalWrite(IN_1, LOW);
      digitalWrite(IN_2, HIGH);
      analogWrite(ENA, speedCar);
```

```
void goBack(){


      digitalWrite(IN_1, HIGH);
      digitalWrite(IN_2, LOW);
      analogWrite(ENA, speedCar);

      digitalWrite(IN_3, HIGH);
      digitalWrite(IN_4, LOW);
      analogWrite(ENB, speedCar);
  }

void goRight(){

      digitalWrite(IN_1, HIGH);
      digitalWrite(IN_2, LOW);
      analogWrite(ENA, speedCar);

      digitalWrite(IN_3, LOW);
      digitalWrite(IN_4, HIGH);
      analogWrite(ENB, speedCar);
  }

void goLeft(){

      digitalWrite(IN_1, LOW);
      digitalWrite(IN_2, HIGH);
      analogWrite(ENA, speedCar);

      digitalWrite(IN_3, HIGH);
      digitalWrite(IN_4, LOW);
      analogWrite(ENB, speedCar);
  }
```

```
void stopRobot(){

      digitalWrite(IN_1, LOW);
      digitalWrite(IN_2, LOW);
      analogWrite(ENA, speedCar);

      digitalWrite(IN_3, LOW);
      digitalWrite(IN_4, LOW);
      analogWrite(ENB, speedCar);
 }

void loop(){
  //waitUntilNewReq();  //Waits until a new request from python come

  if(CheckNewReq() == 1)
  {
    //Serial.println("new request");
    if (getPath()=="/forward"){
    returnThisStr("forward command");
    }
    else if (getPath()=="/backward"){
    returnThisStr("backward command");
    }
    else if(getPath()=="/right"){   //this happens for browsers only.
      returnThisStr("right command");
    }
    else if (getPath()=="/left"){
    returnThisStr("left command");
    }
    else if(getPath()=="/stop"){   //this happens for browsers only.
      returnThisStr("Stop Robot");
    }

    else        //here we receive data. You can receive pwm255 and the decode it
    {
      path = getPath();
      //returnThisStr("nothing");
      path.remove(0,1);    //Remove slash /
      delay(500);
      Serial.println(path);
      if(path=="Forward"){
        goAhead();
      }
      else if(path=="Backward"){
        goBack();
      }
      else if(path ==  "Right"){
        goRight();
      }
      else if(path == "Left"){
        goLeft();
      }
      else if(path == "Stop"){
        stopRobot();
      }
      else
      {
        Serial.println("Waiting");
      }
//      pwm = path.toInt();    //convert to int you can use toFloat()
//      Serial.println(pwm);
    }

  }

}
```

HAND GESTURE CONTROLLED SMART CAR USING IMAGE PROCESSING

ORIGINALITY REPORT

10%	8%	5%	%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.coursehero.com Internet Source	1 %
2	ir.juit.ac.in:8080 Internet Source	1 %
3	github.com Internet Source	1 %
4	peerj.com Internet Source	1 %
5	www.irjet.net Internet Source	1 %
6	dspace.daffodilvarsity.edu.bd:8080 Internet Source	1 %
7	Mohammad J M Zedan, Mamoon A Al-Jbaar, Mohammed A M Abdullah. "Real-time Environmental Control System for Disability Access under Node-MCU Platform", IOP Conference Series: Materials Science and Engineering, 2019 Publication	<1 %