SCHOOL OF COMPUTING SCIENCE AND ENGINEERING

GALGOTIAS UNIVERSITY, GREATER NOIDA

CANDIDATE'S DECLARATION

I/We hereby certify that the work which is being presented in the thesis/project/dissertation, entitled **"Wireless Remote Connection For IOT Vehicles"** in partial fulfilment of the requirements for the award of the Bachelors of Technology submitted in the School of Computing Science and Engineering of Galgotias University, Greater Noida, is an original work carried out during the period of month, December 2021, under the supervision of **"Dr. J. N. Singh"** Professor, Department of Computer Science and Engineering, Galgotias University, Greater Noida.

The matter presented in the thesis/project/dissertation has not been submitted by us for the award of any other degree of this or any other places.

Ashwani Tripathi (18SCSE1140015)

This is to certify that the above statement made by the candidates is correct to the best of my knowledge.

Supervisor Name

Designation

CERTIFICATE

The Final Thesis/Project/ DissertationViva-Voce examination of **“ASHWANI TRIPATHI (18SCSE1140015)”** has been held on ________________ and their work is recommended for the award of Btech(CSE) with specialization in Computer Networks and Cyber Security.

Signature of Examiner(s) **Signature of Supervisor(s)**

Signature of Project Coordinator **Signature of Dean**

Date: December, 2021

Place: Greater Noida

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ABSTRACT

In today's world autonomous automation excites the researchers and increase in human needs have encouraged the students as well as scientists to build new automated devices. This paper can help one understand the changing trends in autonomous vehicle technology. Due to advancement in technology and upgrades have increased their performance and use. Most needed requirement for the automated devices or vehicles is the communication between them. In addition, the Government of India is emphasizing a huge number of resources on military progress. In this regard this paper is focused on a flawless connection system between a remote-controlled bot to an extent where connection does not act as a hurdle. To achieve this goal the relay devices (powered by raspberry pi) would be configured as repeaters for the connection network connecting remote control to vehicle(bot). In this project, Wi-fi adapters will be acting as a signal emitter or extender to amplify the connectivity and range of the remote vehicle. With this connectivity bot can easily take live feed and transmit the data for doing facial recognition at receiver's end. This project uses advanced research on network configurations and inter-communication schemes in IOT devices. The remote connection range is extended using the relay-chain method, which further enhances the connection with the bot using subsequent relay bots and ensures that data transfer is not traced and encrypted. With the use of existing algorithms, obstacles and any suspicious activity can be easily detected and transmitted to the military base. The hardware platform which includes raspberry pi board, all the

hardware like pi camera and the ultrasonic sensor for improved efficiency & the camera used along with an ultrasonic sensor to provide necessary data from the world for real time processing and application. The project covers machine learning principles for IOT technology and input feed processing.

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CHAPTER 1. INTRODUCTION

Introduction:

The quick development and growth of industry and advancement of technology have diminished the human efforts, the fundamental reason for which being machines!! Machines play an important role in our life. A machine might be anything, be it a mobile phone or a bike, or even a robot. Robots have found an increasing demand in a wide range of applications in our life. Their use in defence has expanded. Robots ensemble human beings in various ways be it looks or functioning, but previously robots were not controlled by computer programs or electronic circuits. Back then they were constructed using the principle of mechanics enhanced over time with the coming of the electronic age. In today’s world, robots find use in various places is it to detect buried bombs or in industrial applications. A robot is a mechanical or virtual artificial agent, usually an electro-mechanical machine that is guided by a PC program or electronic circuit, and thus a type of an embedded system. The branch of technology that deals with the design, construction, operation, and application of robots as well as PC systems for their control, sensory feedback, and data processing is robotics. These technologies deal with automated machines that can take the place of humans in dangerous ambiance or manufacturing processes, or resemble humans in appearance, conduct. The complexity of computer software is based on how difficult the robot’s tasks are. In this project, we make use of a local network to establish communication between the user and a robotic vehicle. This is a reliable connection and live video feedback is available to control the robotic vehicle. Due to the use of the local network and the relay chain based network system, there is no limitation on the range of separation distance between the user and the robotic vehicle, as long as there are relay bots in range ready to operate. Internet of Things has opened up a completely new range of real-world applications namely telesurgery, tele-manufacturing, tele-training, traffic control, surveillance, health care-space exploration, calamity rescue, etc. and the list is supposed to increase further in the upcoming years. Surveillance is the way toward observing a circumstance, a range, or a man. This generally occurs in a military scenario where surveillance on borders and territory of the enemy is essential for national well-being. Human surveillance is achieved by deploying personnel near sensitive areas in order to continuously monitor for changes. But humans do have their limitations, and deployment in inaccessible places is not always feasible. There are also added risks of losing them in the event of getting caught by the enemy. With advances in technology over the years, however, it is possible to remotely monitor areas of importance by using robots in place of humans. Apart from the advantage of not having to risk any human, terrestrial and aerial robots can also pick up details that are not obvious to humans. By furnishing them with high determination cameras and different sensors, it is conceivable to acquire data about the particular zone remotely. Satellite communication makes it possible to communicate seamlessly with the robots and obtains real-time audiovisual feedback. Thus, in recent times, surveillance has become an area of great research interest. Thus, it is our aim to build a full-featured smart surveillance robot using a Raspberry pi that can be remotely controlled. Most people spend their time on the network than the average time they sleep. So by making the robotic vehicle be controlled by the local network, it becomes easy for anybody to use it from a remote end.

In this project, control of the robotic vehicle is from the remote end with the use of the local network and also we are able to get the videos from the robot end for the purpose of surveillance. At the client-side, we will be able to see the live video and control the movement of the robot and control the camera directions as well. DC motors are being used for the movement of robotic wheels and camera movement i.e. 360° rotation. Raspberry Pi 3 Model B is used for video streaming and sending the streaming video to the user PC with the help relay bots. The use of the relay chain system does not bring the limitation of range into consideration as if we have access to the target bot via relay bots extending the network.. In this implementation of the robot, the web camera connected to the Raspberry pi keeps on recording what is going on there at the host place and saves it into the pi. This project provides or controls the surveillance robot using wireless technology. It also provides the live video obtained from the robot. The robot is based on Raspberry pi.

The project utilizes Raspberry pi 4 model B to command all the actions of the robot. A webcam is mounted on the robot, which will give live video-streaming. An obstacle avoidance module and a metal buzzer are used to detect an obstacle and avoid it. LDR is used to give glow LEDs to give light in the darkness. The robot can climb up and climb downstairs. The raspberry pi hosts the cloud server. It broadcasts the information to the user and the user then controls the motion of the robot through a web page hosted on the server.

A vast amount of natural and man-made events cause crises and disasters, affecting millions of lives. In such events where human lives are at stake, major rescue operations are dealt with with high sensitivity. Therefore, developing robot technologies for surveillance, rescue, and forefront missions are encouraged. A wireless military bot is basically a remote control car that has an internet wireless transmission connection that arrives at a point of the case without putting people's lives in danger. The activities happening around are scanned by the sensors integrated into it, is reflected by the remote laptops/computer systems. Wireless Sensor Network (WSN) is generally used after emergency response or disaster-causing scenarios to ensure a secure connection between the computer and the surrounding environment of the affected site [1].

Based on the thesis proposed by Benkhelifa et al. [3] it is efficient for emergency responder's locators to use mobile wireless sensor networks. Reddy and Krishna, [4] gave an idea to bring robots along with the rescue teams to help enter explosion-prone regions, for example, in coal mines. There has been extensive research about the development of motion detection using Raspberry Pi, in [2, 5]. In [2], an embedded web server is used to provide a static web and CPU, while making a remote bot.

Remote Surveillance:

Today each and every one is concerned about their security since the growth rate of crime has increased. This caused people to have started to consider the significance of surveillance systems. The majority of the people are doing IP-based installations rather than analog because of them being accessible from anywhere. In order to make the IP-based systems affordable for people with having low budget, we need to develop a system that is cost-effective and portable. This project uses raspberry pi model ‘B’ for making this real-time surveillance possible. The Pi has the capability of installing and processing high resource software's which makes it possible to accomplish the objectives of live streaming & controlling the robot

Machine learning for environmental analysis:

Computer vision is a field of computer science that enables machines not only to see but also to process and analyse digital images and videos. One big application area of computer vision is object detection [6], the capability of a computer to locate and identify objects in an image. With the recent advances in deep learning and convolutional neural networks (CNN) [7], computers can from large image datasets learn to recognize and track objects seen in images and videos with great accuracy. This thesis studies the possibility of implementing an object detector on a single board computer, the Raspberry Pi B+, capable of maintaining a real-time frame rate while keeping high precision. The problem we face is the lack of computing power that is required in an object detecting system. Two popular object detecting methods have been selected and are evaluated by measuring detection accuracy, inference time, and throughput (FPS)

Object detection is the process of detecting and defining objects of a certain known class in an image. Only a few years back, this was seen as a hard problem to solve. Before Krizhevsky presented the CNN AlexNet [8] at the ImageNet Large Scale Visual Recognition Competition in 2012, researchers were struggling to find a solution to image classification with a very low error rate. Since then, many objects detecting methods applying CNN has been presented showing great performance and efficiency. However, much computing power is still needed to run visual tasks effectively and on a device with limited hardware resources, running an object detecting system can be challenging. The Raspberry Pi [9] is a small single-board computer, no larger than a credit card. Single-board computers lack the computing power of traditional desktop systems but due to their low cost and size, they can many times be preferable to use for certain tasks.

Formulation of Problem

This research project deals with the design and implementation of a Local Network controlled robot using Raspberry Pi. It uses wireless technology to provide essential security using a surveillance system. The proposed project will capture information and transmit it via Wi-Fi to a local configured network, which is monitored from the network source. Raspberry Pi controls a video camera for surveillance. It streams live video and records it. This robotic vehicle will be controlled via a local network and extended via relay chain method. The Raspberry Pi will hence retain the network stability. In order to extend the network range, we will send other bots carrying the repeaters. The whole essence of the project is to establish communication between these two parties (source ad surveillance bot). High powered network card and local network ensures a real time surveillance transmitted live from the bot to the source. Local network also ensures the security of the network that is very hard to crack, especially when it is not open/visible to any enemy frequency. Due to the ability of computational capacity, it can also work as automatic response triggers in some specific cases.

Motivation

There are at least three ways that robots can be useful in war zones.

1. Bomb disposal

Bomb disposal robots reduce risk to humans. Mostly remotely operated, they have little autonomy and are used to investigate and defuse or detonate improvised explosive devices. As robots become more dexterous and agile there will come a time when there is no need for a human to be next to a bomb to defuse it. The robot in The Hurt Locker – a movie based around a bomb disposal unit in Baghdad – was portrayed as pretty useless. But future robots will be able to do everything the humans do in that film, better and quicker.

No one objects to robot bomb disposal.

2. Room-by-room clearing

Room by room clearing is one of the riskier infantry tasks.

In World War II, booby traps were sometimes triggered by pressure sensors under whisky bottles and packets of cigarettes. Human troops entering houses often succumbed to the allure of smokes and booze and were killed as a result.

Today ISIS fighters disguise booby traps as bricks and stones. These are specifically prohibited by international humanitarian law.

In theory, with smaller versions of sensors of the kind used to inspect luggage at airports, robots could perceive the wiring and pressure sensors associated with such booby traps.

Robots like the Pointman Tactical Robot and the iRobot Negotiator are already capable of entering buildings, climbing stairs and moving over obstacles to search buildings. Future versions are more likely to be armed, have more advanced sensors, hold greater autonomy, and be classified.

More agile humanoid (or animal-like) versions of these robots could be used to clear buildings of booby traps and enemy fighters seeking to ambush troops.

3. Maintaining safety zones

It's plausible that robots could contribute to maintaining perimeter security in the near future.

Military robot technology could be used to enforce safe havens that protect unarmed civilian refugees from genocides similar to those that happened in Srebrenica and Rwanda, and unlawful bombing as is ongoing in Syria.

Peacekeeping military robots could stop war criminals killing innocent civilians at little or no risk to supervising human peacekeepers.

Much of the technology you could use is already available "off the shelf" from equipment vendors. Surface-to-air missile defence systems that can target missiles, aircraft and artillery shells such as Raytheon's Patriot and Phalanx have been in production for decades.

Sentry robots such as the Hanwha Techwin (formerly Samsung Techwin) SGR-A1 and the DoDamm SuperAegis II are also currently available and widely fielded.

Objective

We will build and modify the remote control infrastructure as per mission needs. The bot will be capable of taking live feed and processing the input for face detection/ QR Scanner/ other information that can be brought into use and research. The remote connection range is extended by using a relay-chain method, using which, the connection with the bot will highly extended using subsequent relay bots and the data transfer from the bot will be untraceable and encrypted. This project includes the IoT technology and machine learning principles for input feed processing.

The project contains following main domains of functionality:

1. Raspberry Pi Bot

   The project is expected to include building of a Raspberry Pi bot, controlled by a local network extended by relay chain method. The bot can reach to minute places where, either it's hard for humans to reach or it is highly danger for human life to involve.

2. Stable connection in remote areas

   Due to a chain of bots, carrying and repeating the signals from the source to the target bot, the stability of the project is flawless In terms of range and security.

3. Live surveillance

   The project gives us the ability to possibly use machine learning in future to inculcate image detection, recognition and alert based on the military records for some sensitive individuals/weaponry/situations.

Mine Clearance

Mine clearance is another application where army robots can be deployed for mine reconnaissance and area clearance operations to detect and remove landmines and sea mines. A robot minimizes the risk of unexploded ordnance and other dangerous objects. Land robots and ROVs are used for mine clearance operations. For instance, in 2016, Russian military used a hi-tech “robot solider” known as Uran-6 robots to clear the historic World Heritage site of Palmyra of explosives after the area was liberated from Islamic State rule. Uran-6 robots defused almost 3,000 explosive devices including mines.

CHAPTER 2. LITERATURE SURVEY

Similar Work

In the past century, we've been able to achieve remarkable milestones in the automobile industry, especially in manufacturing reliable, safe, and affordable devices.

Because of the fact that there has been a huge advancement in network technologies, hardware equipment, computation, communication technologies and remote bots are becoming a reality. It's a foreseen fact that there has been a large amount of testing of remote bots in industrial means. Technology giants have been putting an enormous amount of resources and funds into the autonomous industry and robotics, as they prepare the world for the upcoming era of full commercialization of autonomous cars. Although, the challenges that come with it are known to everyone, including the computational complexity, real-world ad real-time data analytics. Validation of trained models and testing are major technical issues to deal with. Some non-technical challenges are consumer stimulation, moral concerns, and insurance management. In the final phases, to ensure efficient robots and autonomous cars with effective cost and safety, we learn about several limitations that need to be rectified by manufacturers, designers, organizing regulators, and policy builders and managers.

Self-driving cars have been emerging as a key component of future intelligent transportation systems. And in order to actuate this long-term vision, bots and autonomous cars need to be autonomously driving along collision-free paths and follow traffic laws altogether. There are then, two cases two follow the lead.

The first one is the approach that uses a predefined set of roads and traffic laws and signals.

The second and the more preferred approach is to follow algorithms and systems and use a centralized map built with different types of environment sensing sensors to identify other vehicles, traffic signs, obstacles, and pedestrians.

The proposed map has various things, including the information of real-time obstacles, and also pedestrians and traffic signs in the form of virtual obstacles. Using these kinds of maps, certain software like the automated path planner can identify and generate paths that avoid collisions and follow the traffic laws altogether.

There have been some events where these algorithms have been validated and tested in different environments. One example to consider is the 2012 Hyundai autonomous ground vehicle competition.

Altogether using edge computing, looks like a reliable solution for environment-friendly transportation for developed cities and urban areas.

In this paper, we see a discussion over a short life retaining traffic predictions, an elemental enabler for the welfare of applications of ACC, with the guidance of

European telecommunications Standards Institute Multi-access EC(MEC) architecture that manifests boundation differing from those followed with traditional cloud computing.

Firstly, an experimental platform centralized on data is designed and brought into use to inculcate the development of traffic prediction algorithms. In addition, this paper also discusses the short vision model of traffic prediction that includes with it, some features like a vehicle velocity model, a traffic light model, even with limiting computational resources of MEC servers.

The working and effects of traffic lights and all the way are not easy and rather uncommon to testing and trained protocols, hence not examined in most areas of research, certainly not with the related work. This would mean working with the driver during the queuing time when he arrives at a road's intersection and encounters a stopping signal (red sign).

Moreover, to forecast the vehicle velocity, we propose a novel low-complexity semiparametric prediction model considering periodic features and spatial/temporal correlations of dynamic road events. The experiment results demonstrate that our vehicle-velocity prediction model achieves almost equivalent accuracy to the well-known Long Short-Term Memory Neural Network model, requiring much lower computational complexity.

Autonomous car navigation based on updating dead reckoning (DR) by road profile recognition (RPR). The navigation system requires sensors to detect changes in altitude and driving direction which are installed in modern cars for different purposes (e.g. ABS sensors). The layout of the navigation system is discussed and simulations are carried out over driving distances of approximately 150 km on the basis of realistic road data and ordinary sensor accuracies. Positioning errors of lower than 10 m (standard deviation) are observed. To achieve this accuracy the synchronization error between measured and mapped data must be continually estimated. The introduced navigation method is ideal to complete present commercial car navigation systems using Navstar GPS. The Radio Frequency Identification (RFID) system is looked upon as one of the top ten important technologies in the 20 th century. Industrial automation application is one of the key issues in developing RFID. Therefore, this paper designs and implements a RFID-based autonomous mobile car for more extensive application of RFID systems. The microcontroller of Microchip PIC18F4550 is used to control the autonomous mobile car and to communicate with RFID reader.[10] By storing the moving control commands such as turn right, turn left, speed up and speed down etc. into the RFID tags beforehand and sticking the tags on the tracks, the autonomous mobile car can then read the moving control commands from the tags and accomplish the proper actions. Due to the convenience and non-contact characteristic of RFID systems, the proposed mobile car has great potential to be used for industrial automation, goods transportation, data transmission, and unmanned medical nursing etc. in the future.

Autonomous parallel parking of a car-like mobile robot by a neuro-fuzzy behavior based controller- M. Khoshnejad; K. Demirli [11] The concept of sensor-based behavior is used to design a neuro-fuzzy control system for a car-like-mobile-robot. The problem addressed is the parallel parking in a rectangular constrained space with just one backward maneuver. To accomplish the autonomous fuzzy behavior control, the car-like-mobile-robot has trained to park in just 2 parking dimensions based on the training data obtained from sensor information generated offline by adopting a fifth-order polynomial as the reference trajectory. The proposed controller is an ANFIS architecture that generates turning angle as output. As long as the states (positions and orientations) of the robot are measurable at each discrete-time step during the control process, this controller can make the robot follow feasible trajectories by just knowing the initial configuration of the robot and park successfully at the prescribed goal position.[11]The simulation results which are based on real dimensions of a typical car demonstrate the feasibility and effectiveness of the proposed controller in practical car maneuvers. 2.7 Design of multifunctional autonomous cars using ultrasonic and infrared sensors - Ayesha Iqbal; Syed Shaheryar Ahmed [12] The daily routine problems that common man face on roads while commuting are becoming a serious problem with each passing day.

People get late and meet accidents. The model of autonomous cars presented in this research paper aims to solve these issues by taking humans off the wheels, so that they do not have to drive anymore and the risk of accidents, getting late and traffic congestions can be reduced to a minimum. This car is able to follow the track, overtake other cars, detect obstacles, take sharp bends and turns, follow traffic signals and turn on its lights under low light conditions. [12]Circuit diagrams for performing all these functions have been presented and the mechanical model of the car has also been shown in the paper, which is practically implemented and successfully run by the authors.

Comparative Study

According to statistics on robots used in the military, robots have been a core part of military strategies worldwide, even in times when the sales of robotic units experienced a decline in civilian society.

The following statistics will throw light on how robots have empowered the military industry.

1. **Ultra-Tiny Drones – Norway, Black Hornet**

While drones at higher altitudes can provide a macro level of information, some companies are also producing ultra-small drones the size of hummingbirds to provide individual soldiers with information about what is literally just around the corner.

Norwegian Prox Dynamics, which was later acquired by FLIR for $134 million, created the Black Hornet. It was the world's first operational Personal Reconnaissance System to be deployed by a military when UK forces used it in Afghanistan in 2012. Since then, an updated version has been purchased for use by Norway, Australia, Germany and the United States.

The ultra-small drone can be carried and quickly deployed by a soldier in the field to scan the local area with vision or infrared cameras from a place of relative safety. The feed is beamed back to the soldier on a small iPad like display.

2. **Experts expect the global spending on military robotics to reach $16.5 billion in 2025.**

In 2017, worldwide spending on military robotics was just $7.5 billion. According to statistics on future military robots, the US alone is predicted to spend up to $1 billion in the coming years on military robotics. This follows as several contracts are already being awarded to tech giants and robot building companies.

3. **The military robot market size will hit $30.8 billion by 2022.**

Back in 2017, the market was worth $16.7 billion. It rose to $17.34 billion in 2018 and is expected to grow with a CAGR of 12.92% between 2020 and 2022.

4. **The robotics industry already employees about 150,000 people worldwide in engineering and assembly jobs.**

To some, having robots in the workplace stands as a threat to their jobs. However, research has shown that this is not the case. As it turns out, military robots of the future are being designed to augment and collaborate effectively with human workers, not to replace them. The presence of robots in a production line increases productivity and accuracy, all at a reduced cost of operation.

Existing System

Different methods and technologies used in remote controlled unmanned camouflaged bot are: -

A. Self-Control Mode : The purpose of this mode is to enable the autonomous performance of unmanned ground vehicles without human supervision. To complete this operation navigation technology such as GPS and magnetic compass are used to deliver on-board the system has enough data to function as a self-navigating system. Other technologies such as infra-red sensors are used by us in our model to provide a functional limit for escape capabilities, it improves autonomous functionality.

The main functions of the self-control mode are: UGV can travel from point A to point B without Human Navigation Directions. Adjust strategies based on neighbourhoods using route planning and obstacle detection algorithms to perform these tasks.

Algorithm design for the self-control mode

The algorithm design for self-control mode is quite easy and straightforward. We mainly considered two important algorithms: path planning and obstacle detection algorithms for the UGV to navigate automatically. First, the user obtains the current GPS coordinates and the heading reading from the compass for the UGV. Then the destination coordinates are acquired from the user. Angles are calculated by which the UGV orients with the desired direction using simple trigonometric functions. Calculated angle provides the UGV movement control signals. The UGV navigates itself to the desired location based on the IR sensors values which are obtained with respect to the obstacles. Path planning algorithms are used to decide the path taken. Obstacle avoiding algorithm is also incorporated, which makes sure the unmanned ground vehicle avoids obstacles while doing the task at hand in the most efficient manner based on the IR sensors values which are obtained with respect to the obstacles. At the base station side, the user obtains the GPS coordinates continuously from the UGV. Destination coordinates are given by the user itself. Based on the path planning and obstacle detection algorithm, UGV navigates automatically.

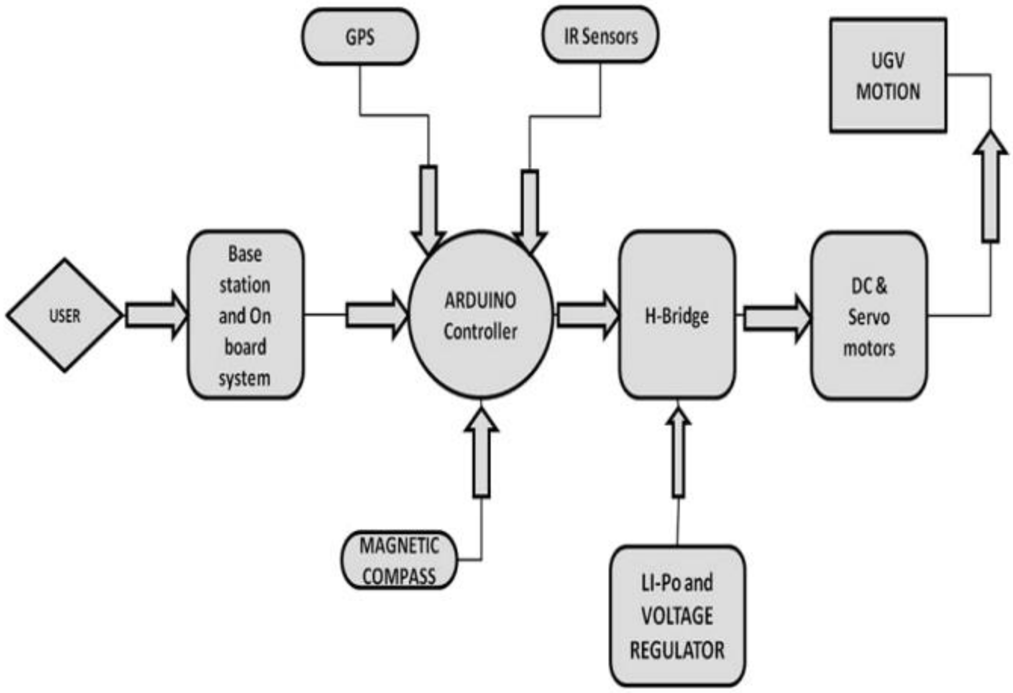

Figure 1. Block Diagram of Self Control Mode

B. Gesture Control Mode: The aim of this mode is to enable gesture functioning of the unmanned ground vehicle without base station assistance. To accomplish this operation, hand gesture commands need to be acquired using an inertial measurement unit and then be transferred wirelessly using zigbee technology. The main tasks of the gesture control mode are: Gesture control mode is implemented when situations do not permit the UGV to be operated with base station assistance (manual and auto control). UGV is capable of traveling from one point to another using hand gestures commands from humans. Hand gesture commands are acquired using an inertial mea-surement unit and transferred wirelessly using zigbee technology. For these tasks to be performed, hand gesture commands need to be acquired completely using an inertial measurement unit and transferred wirelessly using zigbee technology.

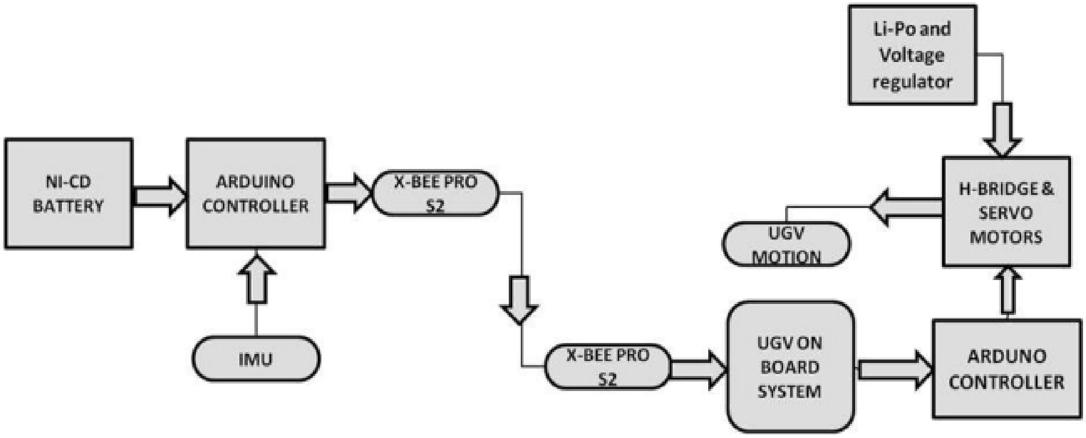

Figure 2. Block Diagram of Gesture Control Mode

C. Command Controlled Mode: The aim of this mode is to enable operation of unmanned ground vehicles using inputs which could vary from a simple computer keyboard to other self-designed input devices. The commands are sent over to the UGV remotely using wireless communication technologies such as ZigBee or internet, while it transfers live video feedback to the user. ZigBee is a wireless technology designed to connect simple high-tech devices for useful purposes. The main tasks of the command control mode are:

• Maneuver the UGV wirelessly by transmitting navigation commands from the base station based on the video received from the on-board camera.

• Control the turret wirelessly in order to locate and eliminate targets in the field of vision. For these tasks to be performed, we considered "Arduino". It is an open-source software and easy-to-use hardware. Writing code and uploading it to the i/o board is very easy and simple. Algorithm design for command control mode The algorithm design for command control mode is quite easy and straightforward. We considered two sides for building a prototype UGV: Base station/user side and UGV side. Base station/user side: Navigation commands such as up, down, left and right arrow keys in the computer keyboard have been assigned for rover (UGV) movement. The keys pressed have been mapped into specific characters which are sent as control signals to the arduino controller. The characters sent have their unique function assigned to them which is shown. UGV side: UGV transmits video signals from the on-board camera to obtain navigation commands. Once the navigation commands are obtained, UGV monitors serial input for the received characters and makes the subsequent decisions. The following functions are executed in response to the character sent [up (), down (), left (), right (), halt ()]. We have provided clockwise and anticlockwise pin assignment for forward and reverse movement of the UGV. Dedicated PWM signal pin for 80 - 120 degrees range of servo turn is maintained and H - Bridge Enable control is being utilized for braking. Also, in this mode, the turret is wirelessly controlled in order to locate targets in the field of vision. At the base station side, commands controls from the computer keyboard will be given as shown in figure 3. Based on the commands from the computer keyboard such as up, down, left and right arrow keys have been assigned for rover (UGV) movement. The specific keys press the Arduino controller. Once the control signals are obtained, the following functions will be executed by the UGV.

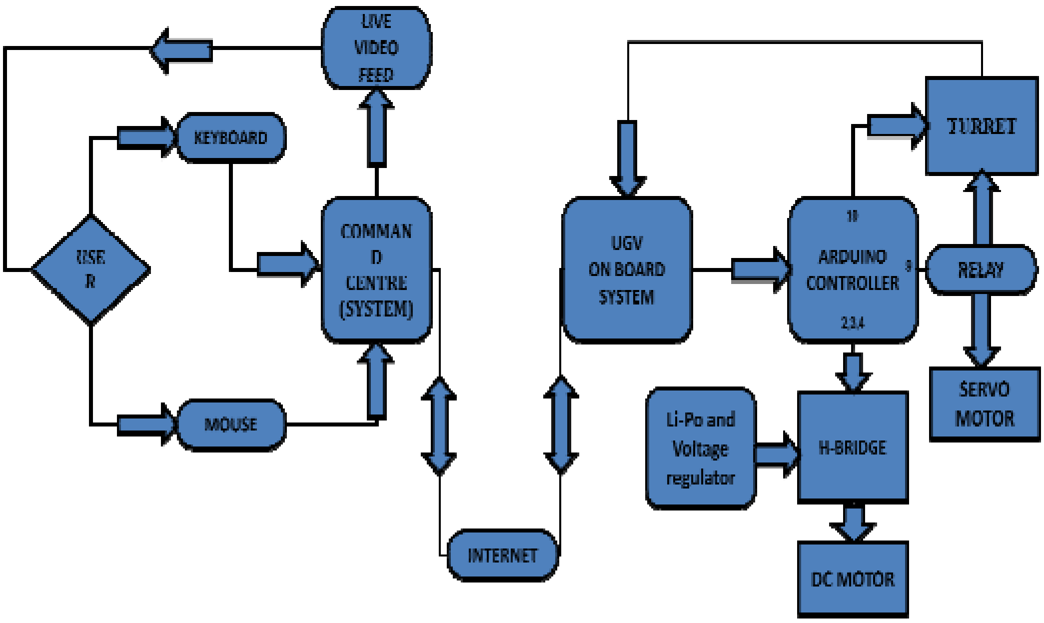

Figure 3. Block Diagram of Command Controlled Mode

Proposed System

To overcome the drawbacks, we are facing from the existing available tools, we will be using a Raspberry Pi board. The Raspberry Pi is a minicomputer also known as SBC (Single Boarded Computer) and the Arduino is a programmable microcontroller whose functionality depends on the way it is programmed. Comparing Arduino and raspberry pi will be like comparing a mere calculator to a full-fledged laptop. The Arduino is a quite low power microcontroller which provides control over hardware. With the help of the Arduino Integrated Development Environment, programs (<32Kb) are interfaced with hardware like switches, sensors, LCDs, the internet, other microcontrollers, etc. On the other hand, Raspberry Pi is intended to function smoothly even while using high resource software. Ethernet, video and audio processing, large quantities of RAM and quite a large amount of storage space, makes it a minicomputer. It runs a complete operating system (OS) like Linux and various other flavors of Linux as well as Android. It can also develop programs within those operating systems that can control the systems functions and the IO that are made available.

Size issue is also minimized in the proposed solution as it is very compact and can pass through 1 square feet hole. Smaller size helps it in not getting detected in enemy territory.

Boards like Arduino do not have processing power, but in this proposed solution we are using a board with good computation power and enough storage capacity to store the live feed and other data received from the location.

With the use of the latest Wifi-6 technology live surveillance is easily monitored without any kind of interference. Wi-Fi operation in the 6 GHz frequency band enables Wi-Fi to continue delivering positive experiences for the most bandwidth-intensive applications. Wi-Fi 6E certification as part of Wi-Fi CERTIFIED 6 offers the features and capabilities of Wi-Fi 6, extended to the 6 GHz band. Several nations around the globe are making the 6 GHz band available for unlicensed use, and Wi-Fi CERTIFIED 6 provides worldwide interoperability certification for devices in these markets. Live feed not only sends the video of that location but also provides the data received from the sensors present inside the bot.

Wi-Fi i.e., Wireless fidelity technology ensures the connection stability by going into hidden network mode which helps in sending the data ensuring the security.

To overcome the limitation of long range, we would be using a Wi-fi module in multiple IOT vehicles which will receive the text input from the microcontroller and will show the output by transmitting the signals to other components of the vehicle. Here for increasing the wireless communication range we will be using multiple Wi-fi modules in multiple devices and will move them one by one for better connectivity and minimal data loss.

CHAPTER 3. METHODOLOGY

Why to use Raspberry Pi?

The Raspberry Pi is a mini-computer also known as SBC (Single Boarded Computer) [13] and the Arduino is a programmable microcontroller whose functionality depends on the way it is programmed. Comparing Arduino and raspberry pi will be like comparing a mere calculator to a full-fledged laptop [14]. The Arduino is a quite low power microcontroller which provides control over hardware [15] [16]. With the help of the Arduino Integrated Development Environment, programs (<32Kb) are interfaced with a hardware like switches, sensors, LCDs, the internet, other microcontrollers, etc. [8]. On the other hand Raspberry Pi is intended to function smoothly even while using high resource software. Ethernet, video and audio processing, large quantities of RAM and quite a large amount of storage space, makes it a mini-computer. It runs a complete operating system (OS) like Linux and various other flavors of Linux as well as Android. It can also develop programs within those operating systems that can control the systems functions and the IO that are made available [14].

Figure 4. Raspberry Pi Top View

Arduino and Raspberry PI might appear alike because they both are tiny little circuit boards with some electronic chips and pins on them to make it function but they are very different devices altogether [14]. In fact Arduino is a low power micro-controller; not a mini-computer like the raspberry pi [17]. A micro-controller is just a minor part of a computer, and only provides a part of the functionality of the Raspberry Pi [17].The Arduino is programmable with C language, but it cannot run a complete operating system (OS), whereas raspberry pi can run complete operating system like Linux and android [14]. The Raspberry Pi has Python as the main programming language, but can also run C, C++, Java, Ruby, Perl[18].The projects made in it are more of software based rather being hardware based. It can yet do hardware control based project with the GPIO pins it has onboard. Arduino is an open-source hardware/development board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. It has included USB interface, 6 analog input pins, as well as 14 digital I/O pins [19]. Official Arduinos have used the megaAVR series of chips, specifically the ATmega8, ATmega168, ATmega328, ATmega1280, and ATmega2560 [20]. The Arduino has an integrated development environment (IDE) which is a cross platform application written in Java so that it can be used on any machine. Raspberry pi includes a complete operating system loaded on an SD card, audio out, HDMI and RCA video output and an Ethernet port. An Arduino is picture perfect for electronics projects. It contains various input and output that can be directly connected to components, sensors and is extremely easy to use [21].

Figure 5. Arduino Board

Arduino runs the firmware which allows it to communicate with a computer via USB and gives access to work on it. [21]. Once a program has been dumped on it, it is good to go anywhere we plug it. We do not need to reboot, plug in a keyboard, or choose an application to run. It does what it is been programmed to do directly. Beside the Raspberry Pi is an extremely powerful device which comes in a very small size which is perfectly suitable for embedded systems, or projects demanding more memory and processing power. The Raspberry is considerably more complex for simple electronics projects like just flashing an LED While on the other hand using the Arduino, it just comprises of connecting an LED and resistor to two pins and simply uploading about 8- 10 lines of code [21]. Beside on Raspberry Pi if the operating system is already installed then there is only a need to install some libraries to control the GPIO pins. Raspberry pi can do everything an Arduino can, but in complex way. Nevertheless the Arduino is not as powerful as the Pi. The Arduino sends data to PC or Pi via serial.

Pros and Cons

It is important for users that want to get the Pibot to consider whether it fits with their utilities and are willing to get this robot and tailoring the product to their own needs. Generally every project does have some advantages or disadvantages. Surely this project also has some pros and cons:

PROS:

- The biggest advantage of this robot is that it is fully dependant on the Raspberry Pi which is a microcomputer. This robot is useful for the organization where they can't afford the costly surveillance systems.
- This robot can occupy the whole auditorium or big hall for surveillance.
- If the user think that it is based on Raspberry Pi technology and user should have the extensive command on programming then NO. The robot comes with the all utilities and software's required for live streaming and

surveillance so that the user can use it without any hesitation or fear that they might not be able to control it.

CONS:

- This robot can occupy only one location for surveillance at a time.
- For configuring the robot user has to go to system every time. This should be little hectic for user. Also considering that fact that this robot is not compatible with Windows operating system and cannot install it which most of the users are familiar to use

Innovation

WiFi has been defined by a set of standards known as IEEE802.11. WiFi owes its creation to several inventors and patents, but the establishment of the IEEE committee that created the core standards made the original Wireless Fidelity networking technology possible. Offering basic specification for the still-new technology, 802.11 served as guidance for the development of early routers, data transfer on a 2.4 GHz frequency. Subsequent amendments continue to expand theoretical rates, ranges and techniques, incrementally improving performance and potential. The latest – 801.11ax, shows just how far WiFi has come.

Achieving up to 11 Gbit/s in a 5 GHz band, the potential is exponentially greater, offering extensive improvements in connection speeds and better connection strength. Through beamforming – an innovative targeting technology that allows for constructive and destructive interference and strong signals – the wireless connection can even be directed at a specific device. All these improvements in such a short period are closing the gap between physical and wireless connections, and the result sometimes means WiFi is an all-around better choice for modern business.

The motive of using Wifi in our project helped in making the connection stronger with zero data loss. In this project we are using a repeating method to improve the communication range between the final device and the end user. In repeating mode, the wifi device amplifies as well as repeats the signal of the existing very low wifi signal to a stronger one. For simplicity we can take the example of Indian Railways electric wiring. In Indian Railways electric wiring after a certain distance railway uses a transformer to regulate proper voltage across the electric wiring to run the train. Similarly, relay bots in this project will act as signal regulators to communicate and send the live feed collected from the enemy territory. These relay bots are similar to each other, to reduce the cost of the project will be using sensors in only the first bot which will be entering the enemy territory first and other bots will only contain the Raspberry Pi board and wifi module along with the power supply to establish the long range connection.

Hardware Requirements

A pre-built four wheel drive (4WD) chassis is used as a base on which following hardware components are fit:

Figure 6. Raspberry Pi 4B

- Raspberry Pi (rev B) for GPU and CPU computations

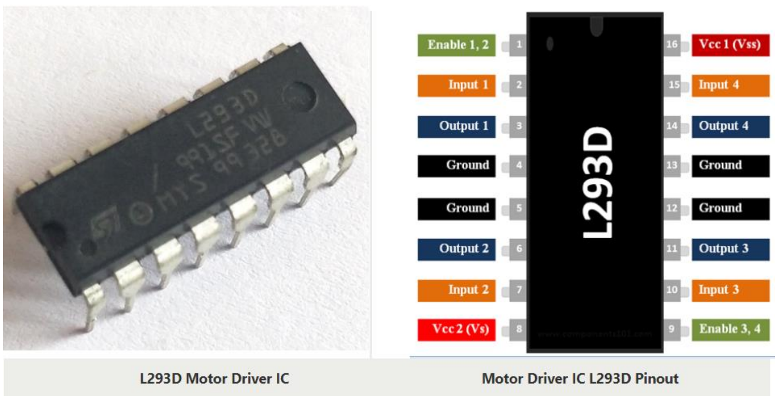

Figure 7. Motor Driver IC L293D

- Motor driver IC L293D which can control two motors

Figure 8. AAA Batteries

- 8 AAA batteries to provide power

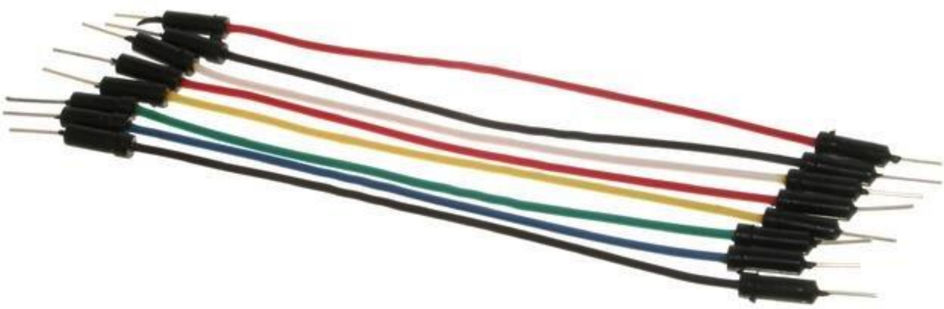

Figure 9. Jumper Wires

- Jumper wires to connect individual components

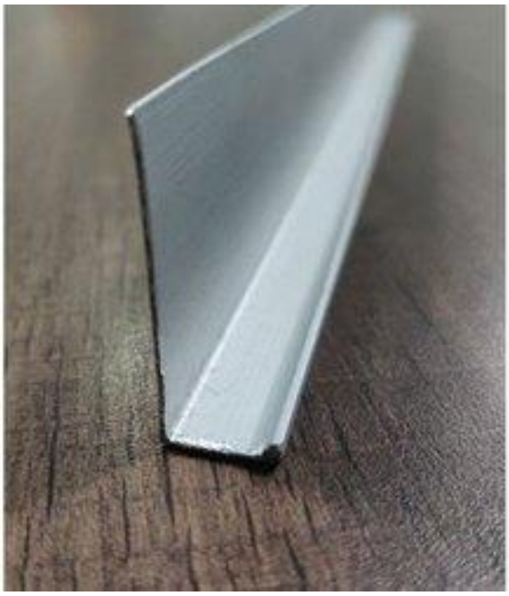

Figure 10. Aluminium Strip (L Shape Cut)

- L shaped aluminium strip to support camera

Figure 11. Raspberry Pi Camera Module

- Pi camera

Figure 12. Ultrasonic Sensor

- Ultrasonic sensor to detect obstacles

Figure 13. Servo Motor

- Servo motor to make the head (camera) flexible to rotation

Hardware and Software Description

Raspberry Pi

The Raspberry Pi is a credit card-sized single-board computer. There are currently five Raspberry Pi models in market i.e. the Model B+, the Model A+, the Model B, the Model A, and the Compute Module (currently only available as part of the Compute Module development kit). All models use the same SoC (System on Chip - combined CPU & GPU), the BCM2835, but other hardware features differ. The A and B use the same PCB, whilst the B+ and A+ are a new design but of very similar form factor.The Compute Module is an entirely different form factor and cannot be used standalone. In this project, we have used the model B Rev 2. It comprises of a 512 MB RAM model with two USB ports and a 10/100 Ethernet controller.

Pi Camera

It is the camera shipped along with Raspberry Pi. Pi camera module is also available to which can be used to take high-definition videos as well as still photographs.

Ultrasonic Sensors

Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) evaluate attributes of a target by interpreting the echoes from radio or sound waves respectively. In this project, they are used to detect the distance of obstacles from the car.

Raspbian OS

Of all the operating systems Arch, Risc OS, Plan 9 or Raspbian available for Raspberry Pi, Raspbian comes out on top as being the most user-friendly, best-looking, has the best range of default softwares and optimized for the Raspberry Pi hardware [19]. Raspbian is a free operating system based on International Journal of Computer Applications (0975 – 8887) Volume 113 – No. 9, March 2015 23 Debian (LINUX), which is available for free from the Raspberry Pi website.

Python

Python is a widely used general-purpose, high-level programming language. Its syntax allows the programmers to express concepts in fewer lines of code when compared with other languages like C, C++or java.

RPi.GPIO Python Library

The RPi.GPIO Python library allows you to easily configure and read-write the input/output pins on the Pi's GPIO header within a Python script. This package is not shipped along with Raspbian.

OpenCV

It (Open Source Computer Vision) is a library of programming functions mainly aimed at real-time computer vision. It has over 2500optimized algorithms, including both a set of classical algorithms and the state of the art algorithms in Computer Vision, which can be used for image processing, detection and face recognition, object identification, classification actions, traces, and other functions. This library allows these features be implemented on computers with relative ease, provide a simple computer vision infrastructure to prototype quickly sophisticated applications. The library is used extensively by companies like Google, Yahoo, Microsoft, Intel, IBM, Sony, Honda, Toyota, and startupsarea as Applied Minds, Video Surf and Zeitera. It is also used by many research groups and government. It is based on C++ but wrappers are available in python as well. In our project is used to detect the roads and guide the car on unknown roads.

Hardware Components Connection

The 4 wheels of the chassis are connected to 4 separate motors. The motor driver IC L293D is capable of driving 2 motors simultaneously [22]. The rotation of the wheels is synchronized on the basis of the sides i.e. the left front and left back wheels rotate in sync and right front and right backwheels rotate in sync. Thus the pair of motors on each side is given the same digital input from L293D at any moment. This helps the car in forward, backward movements when both side wheels rotate in same direction with same speed. The car turns when the left side wheels rotate in opposite direction to those in right [22]. The chassis has two shelves over the wheels separated by 2 inch approx. The IC is fixed on the lower shelf with the help of two 0.5 inch screws. It is permanently connected to the motor wires and necessary jumper wires are drawn from L293D to connect to Raspberry Pi [22]. The rest of the space on the lower shelf is taken by 8 AA batteries which provide the power to run the motors. To control the motor connected to pin 3 (O1), pin 6 (O2), the pins used are pin 1, pin 2 and pin 7 which are connected to the GPIOs of Raspberry pi via jumper wires[22]

Table 1. High +5V, Low 0V, X=either high or low (don't care)

Pin 1	**Pin 2**	**Pin 7**	**Function**
High	High	Low	Anti-clockwise
High	High	High	Stop
High	Low	Low	Stop
High	Low	Low	Stop
Low	X	X	Stop

The raspberry pi case is glued on the top shelf along with the L shaped aluminium strip. The pi is fit in the case and the aluminium strip gives the support to the camera fit on servo motor and the ultrasonic sensor. The Wi-Fi dongle is attached to the USB port in Raspberry Pi in order to connect to it wirelessly. The complete connection of the raspberry pi with motor controller L293D can be found in fig 2[22]. Since raspberry pi needed its own IP, it needs to be connected to a Wi-Fi router or Hotspot. For the same we need to make some changes in the field specified so as to make raspberry pi recognize the router every time it boots up. Navigate to the file “/etc/network/interfaces” and add following lines to make the PI connect with your router after reboot.

CHAPTER 4. IMPLEMENTATION

Figure 14 below shows the overall concept design of this project. Raspberry Pi 4 is utilized as a microprocessor that is used to control the robot car movement through a computer or smartphone. The surveillance can be seen from the wireless IP camera that is attached to the robot car. The interface of the robot controller is installed the laptop or smartphone and the user will press the button movement or using keyboard to instruct the robot car to move. The instruction and video feed received from the robot car is enabled through wireless connection between Raspberry Pi and the laptop/smartphone.

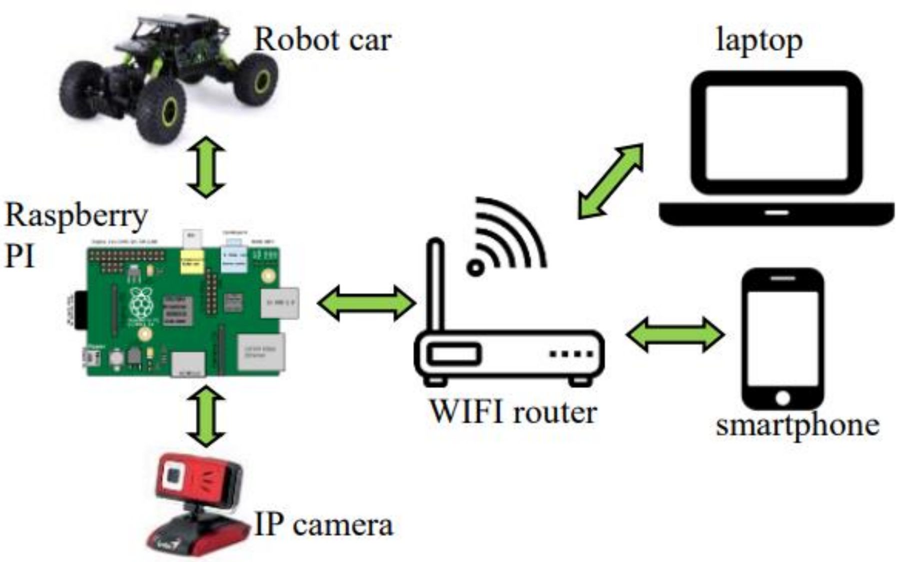

Figure 14. Prototype Concept Diagram

Figure 14. shows the physical design of the Raspberry PI Robot Board controller. This microprocessor will be connected to other equipment such as wireless IP

camera, SD card, USB wireless dongle, i298n Dual Controller and Crawler is selected to be used in this project as the robot car. The body of crawler is suitable for the movement, and it can be custom made to the frequency and also able to operate using Wi-Fi through laptop or smartphone. To control crawler's movement, i298n Dual Controller is used to control the speed of crawler. The function of this DC motor controller is to control speed of WRC car's front tyre and rear tyre. To visualize image on site, a wireless IP camera have to be installed on the robot car. Analogue to Digital converter is used to check robot car's battery percentage. From this monitoring function, we can check balance of battery percentage and planned for recharging. The SD card is for storage data for the Raspberry Pi code and surveillance capture files. Battery Lipo is used for this project to supply this prototype which has need below 7.2V/2 cells. It is easily recharge, easy to carry anywhere and it is more suitable to use for surveillance project.

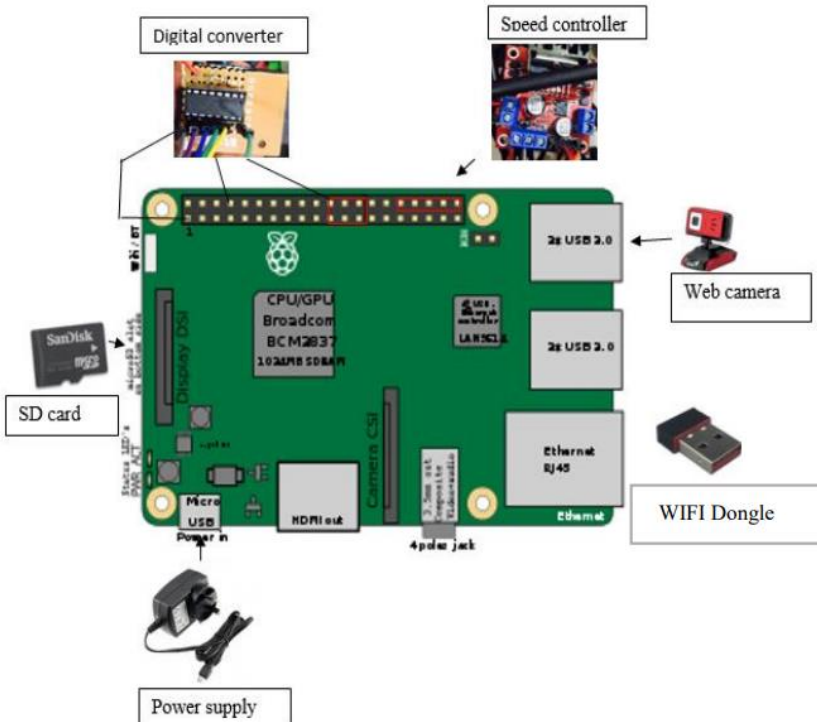

Figure 15. Physical Design of Raspberry Pi Robot Car board controller with pin configurations

To set up the hardware, all components will be attached based on the pin configuration shown in Figure 15. To set up the software, go to VNC viewer. Enter IP address and click sign in. Desktop of Raspberry Pi will appeared prior to login. After login to Raspberry pi, the connection should be same the network with computers/smartphone. Click on connection and connect to the same connection. If the connection is not in same network, the Raspberry Pi could not communicate to the robot car. For this project we use Python and named as MAINGUI.py. The code mainly consist of the surveillance monitor, and the button movements to control the robot car front and rear tyre for each left and right side. There are also reverse and stop function buttons. Button capture is created to capture the image for record purposes. To monitor the battery, we set LED-like an indicator which display the battery percentage.

Wi-Fi module with the required drivers is used in each relay bot to create a communication channel for sending and receiving data. Relay bots are connected to each other using repeating mode settings.

CHAPTER 5. RESULTS

For this chapter, we run functionality test by running the MAINGUI.py file on the Raspberry Pi through the VNC Viewer. All the component is powered up before the Raspberry Pi is boot up. From the test, we were able to monitor the robot car movement, capture the image and also monitor the battery percentage. Figure 16 shows the surveillance monitor of the robot car. The burning Raspberry Pi board which happens in is avoided as we have been using LiPo battery which supply power below 7.2V.

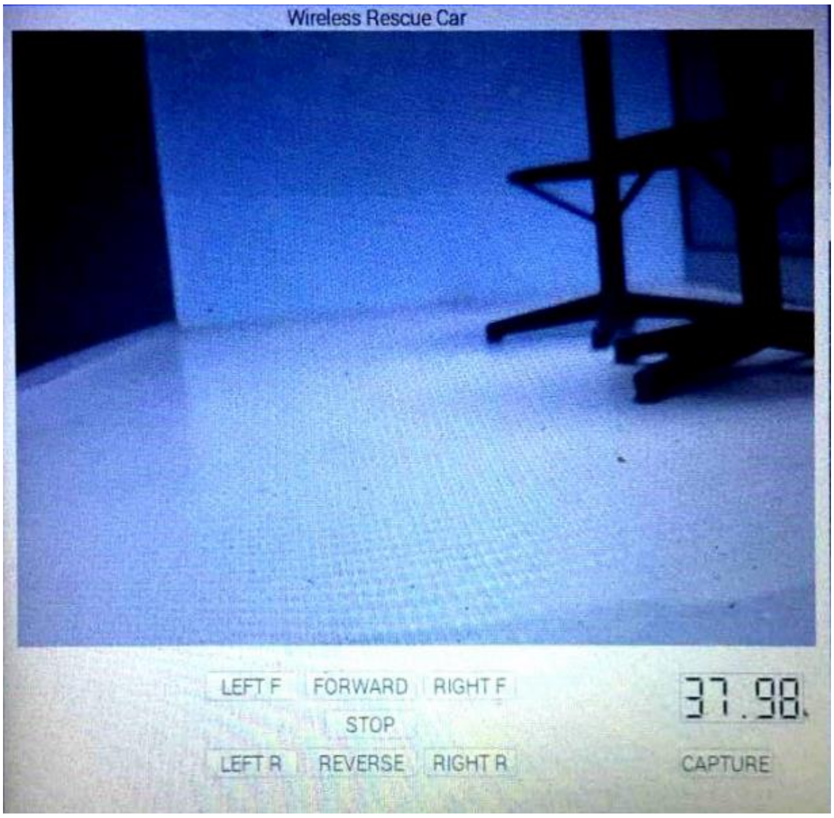

Figure 16. Surveillance Screen

CHAPTER 6. FUTURE SCOPES

1. We can integrate more advanced Machine Learning Algorithms for live analysis of environment.
2. For non-remote areas, device can be modified to be controlled over the internet, eliminating the cost of relay bots to extend the network connection.
3. With the emergence of 5G and network slicing, the effective internet facilities can fasten the real time responses and increase the efficiency.

A future scenario may include the use of directional antennas (*Directional antennas* send and receive signals in one direction only, usually in a tightly focused, very narrow beam. The signal pattern from a directional antenna has a cigar shape, and looks the same from the top as from the sides. This shape is referred to as a *lobe.* Directional antennas usually have small side lobes, which are typically ignored because they don't do much for a signal. However, you should be aware that they exist in case you find a small signal off to the side of a directional antenna) instead of omni-directional antennas (Omnidirectional antennas receive signals equally from all directions.) along with the use of machine learning algorithms to calibrate the rotation of the motor. Here rotation will help in fixing the directional antenna in one direction with respect to the other relay bots.

CHAPTER 7. CONCLUSION

The main contribution of the proposed system is the indicator of battery percentage which will help to plan the recharging process. This prototype also improved by using LiPo battery to avoid the microprocessor burning and also gives mobility to the robot car. By using wireless IP camera, information collected by the robot car can be analysed in real time. For future enhancement, we would like to deploy IR sensor for night vision. We believe that the enhancement of this project is ideal for advance surveillance system in cyber physical system.

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