PATROBOT

A Project Report Submitted
In Partial Fulfilment of the Requirements
for the Degree of

BACHELOR OF TECHNOLOGY

In

Electronics and Communication Engineering

by

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DECLARATION

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person or material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher education, except where due acknowledgement has been made in the text.

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Certified that **Abhishek Yadav**(200013125005), **Alok Kumar** (200013125010), **Samriddhi Srivastava** (200013125039) and **Vinayak Kumar Pandey** (200013125053) has carried out the project work presented in this project report entitled “Patrobot” for the award of Bachelor of Technology (Electronics and Communication Engineering) from Faculty of Engineering and Technology, University of Lucknow, Lucknow under my guidance. The project report embodies results of original work, and studies are carried out by the student themselves and the contents of the project report do not form the basis for the award of any other degree to the candidate or to anybody else from this or any other University/Institution.

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ABSTRACT

The Smart Patrobot, stands for “Patrolling Robot”, is an innovative solution designed to enhance community safety and promote sustainable gardening. This project integrates two critical aspects - patrolling in society for security and monitoring the moisture levels of plants for efficient agricultural management. It leverages advanced technology to create a multifunctional system that benefits both urban and rural environments. The primary goal is to design a versatile robot capable of patrolling public spaces for enhanced security and surveillance, while also assisting in gardening tasks to contribute positively to the community's aesthetics and green spaces. Electronics and control systems are fundamental, employing advanced microcontrollers or processors to manage sensor inputs and control actuators for various tasks. Sensor integration is critical, leveraging obstacle detection sensors (e.g., ultrasonic, infrared) for navigation and safety during patrolling, alongside gardening-specific sensors (e.g., electrode) for monitoring soil moisture levels and plant health. Software development is integral, encompassing navigation algorithms for efficient path planning and obstacle avoidance, as well as user-friendly interfaces for remote monitoring and control. Data processing capabilities enable real-time analysis of sensor data to inform decision-making during patrols and gardening activities. Ultimately, this project aims to deliver a deployable patrolling robot capable of enhancing community safety through surveillance while contributing to greening efforts through efficient gardening support, promoting a sustainable and aesthetically pleasing environment for society.

The integration of these functionalities into a single autonomous system presents a cost-effective solution for communities, addressing both security and environmental sustainability. Field tests conducted in a residential community demonstrate the robot's effectiveness in maintaining high standards of security and plant care, highlighting its potential as a valuable asset for modern urban living.

ACKNOWLEDGEMENT

We would like to express our sincere thanks to Er. Sushil Kumar Gupta for his valuable guidance and support in completing our project. We would also like to express our gratitude towards our head of department Dr. Siddharth Singh for giving us this great opportunity to do a project on Patrobot. Without their support and suggestions this project would not have been completed. We are ensuring that this project is done by team members and not copied from anywhere.

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CHAPTER 1

INTRODUCTION

In an era marked by advancing technology and evolving security needs, the utilization of autonomous patrolling robots emerges as a promising solution to enhance surveillance and monitoring capabilities. These robots represent a fusion of robotics, artificial intelligence, and security systems, offering a proactive approach to safeguarding various environments. A Robot is an electromechanical machine that is controlled by computer program to perform various operations. Industrial robots have designed to reduce human effort and time to improve productivity and to reduce manufacturing cost. Today human-machine interaction is moving away from mouse and pen and becoming much more pervasive and much more compatible with the physical world.

The Smart Patrobot, stands for "*Patrolling Robot*", is an innovative solution designed to enhance community safety and promote sustainable gardening. Patrolling robots are autonomous or semi-autonomous machines designed to monitor and secure an area, often used in settings like warehouses, industrial facilities, or even outdoor spaces like parks and campuses. This project integrates two critical aspects - patrolling in society for security and monitoring the moisture levels of plants for efficient agricultural management. It leverages advanced technology to create a multifunctional system that benefits both urban and rural environments. These robots typically feature sensors, cameras, and sometimes even arms for interacting with objects. They can navigate predefined routes or map out areas themselves, detecting anomalies, intruders, or hazards. Some patrolling robots are equipped with AI algorithms for decision-making, enabling them to respond to different situations effectively.

1.1Need for Enhanced Security Measures

In today's dynamic world, traditional security methods often fall short in addressing the complexities of modern threats. Conventional surveillance systems heavily rely on human operators, making them susceptible to errors, fatigue, and limited coverage. With the rise of sophisticated intrusions and security breaches, there is a pressing need for more robust and proactive security measures. Patrolling robots offer a compelling solution by augmenting human efforts with advanced technology, thereby fortifying security protocols and minimizing vulnerabilities.

Here are additional points elaborating on the need for enhanced security measures:

1.1.1 Dynamic Security Threat Landscape:

In today's interconnected world, security threats are becoming increasingly sophisticated and dynamic. From cyber attacks to physical intrusions, adversaries continuously evolve their tactics to bypass traditional security measures. As a result, there is a growing demand for proactive security solutions that can adapt to emerging threats in real-time.

1.1.2. Vulnerabilities of Traditional Surveillance Systems:

Traditional surveillance systems, relying heavily on human operators, are prone to limitations such as human error, fatigue, and blind spots. Human surveillance can be compromised by factors like distraction, reduced visibility in adverse weather conditions, or physical limitations in monitoring vast or remote areas. These vulnerabilities underscore the need for automated, reliable surveillance alternatives.

1.1.3. Rapid Urbanization and Population Growth:

With rapid urbanization and population growth, urban areas face increasing challenges in maintaining public safety and security. Conventional security methods may struggle to keep pace with the expanding urban landscape, leading to gaps in surveillance coverage and increased vulnerability to criminal activities, vandalism, or terrorism. Autonomous patrolling robots offer a scalable solution to augment security infrastructure and address the evolving needs of urban environments.

1.1.4. Critical Infrastructure Protection:

Critical infrastructure such as power plants, transportation networks, and communication systems are prime targets for malicious actors seeking to disrupt essential services or cause widespread disruption. Securing these assets against physical and cyber threats requires proactive surveillance and rapid response capabilities. Patrolling robots equipped with advanced sensors and surveillance technology can provide continuous monitoring of critical infrastructure, identifying potential vulnerabilities and mitigating risks before they escalate into security breaches.

1.1.5. Compliance with Regulatory Requirements:

In many industries, compliance with regulatory requirements and industry standards is paramount to ensuring security and safety standards are met. Patrolling robots can help organizations achieve compliance by providing verifiable, auditable surveillance data, demonstrating adherence to regulatory guidelines and best practices. By implementing autonomous patrolling robots, organizations can streamline compliance efforts and mitigate the risk of regulatory non-compliance penalties.

1.1.6 Public Safety and Crisis Response:

Ensuring public safety and effective crisis response are fundamental responsibilities of security agencies and emergency services. Patrolling robots play a crucial role in enhancing public safety by conducting proactive surveillance, detecting potential threats, and providing real-time data to support rapid response and decision-making during emergencies. Their ability to navigate hazardous environments and access hard-to-reach areas makes them valuable assets in disaster management scenarios, facilitating search and rescue operations and reducing response times.

1.1.7. Rising Concerns about Privacy and Civil Liberties:

With the proliferation of surveillance technologies, there is a growing public concern about the implications for privacy and civil liberties. Patrolling robots equipped with robust privacy safeguards and transparent operational protocols can help alleviate these concerns by ensuring responsible and ethical use of surveillance data. Implementing clear guidelines for data collection, storage, and access can foster trust and acceptance of patrolling robots as valuable tools for enhancing security while respecting individual rights and freedoms.

1.2 Advantages of Implementing Patrolling Robots

The implementation of patrolling robots offers several advantages over traditional security methods:

- **Enhanced Efficiency**: Patrolling robots operate continuously, tirelessly patrolling designated areas and maintaining vigilance around the clock, thus reducing reliance on human resources and mitigating the risk of oversight or fatigue-related errors.
- **Cost-effectiveness**: While the initial investment in deploying patrolling robots may be significant, the long-term cost savings are substantial, as they eliminate the need for round-the-clock human surveillance and minimize losses due to security breaches or theft.
- **Improved Safety**: By assuming the responsibility of patrolling hazardous or high-risk areas, patrolling robots mitigate potential risks to human security personnel, enhancing overall safety and reducing exposure to dangerous environments.
- **Scalability and Adaptability**: Patrolling robots are highly scalable and adaptable, capable of patrolling diverse environments ranging from industrial facilities and warehouses to outdoor spaces such as parks and campuses, thereby catering to a wide range of security needs.
- **Customizable Patrol Routes:** Patrolling robots offer the flexibility to define and customize patrol routes according to specific security requirements and environmental conditions. Operators can program these robots to patrol designated areas at scheduled intervals, optimizing coverage and ensuring thorough surveillance of critical zones.

- **Interactive Communication:** Some advanced patrolling robots are equipped with interactive communication capabilities, allowing them to interact with individuals within their patrol areas. These robots can provide verbal instructions, answer queries, or relay pre-recorded messages, enhancing their role as security ambassadors and facilitating communication between security personnel and the public.
- **Environmental Monitoring:** In addition to security surveillance, patrolling robots can perform environmental monitoring tasks such as detecting changes in temperature, humidity, or air quality. Integrated environmental sensors enable these robots to identify potential hazards such as fires, chemical leaks, or gas emissions, triggering appropriate response protocols and mitigating risks to personnel and property.
- **Integration with Security Systems:** Patrolling robots seamlessly integrate with existing security systems and infrastructure, enhancing their effectiveness and interoperability. They can interface with CCTV cameras, access control systems, and alarm systems, providing real-time data and alerts to security personnel and central monitoring stations. This integration streamlines security operations, enabling faster response times and coordinated incident management.
- **Autonomous Charging and Maintenance:** To ensure continuous operation and minimal downtime, patrolling robots feature autonomous charging and maintenance capabilities. These robots can autonomously navigate to charging stations when their battery levels are low, ensuring uninterrupted patrol coverage. Self-diagnostic systems enable robots to perform routine maintenance tasks and identify potential issues, preemptively addressing mechanical or technical issues before they impact performance.
- **Multi-Modal Sensory Perception:** Patrolling robots leverage multi-modal sensory perception to gather comprehensive data about their surroundings. In addition to visual surveillance through cameras, these robots may incorporate other sensors such as LiDAR (Light Detection and Ranging), radar, or ultrasonic sensors to detect obstacles, analyze terrain, and navigate complex environments with precision. This multi-modal sensory fusion enhances situational awareness and enables robots to adapt to diverse operating conditions.
- **Non-Intrusive Surveillance:** Patrolling robots are designed to conduct non-intrusive surveillance, minimizing disruption to daily operations and civilian activities. Their unobtrusive presence reduces the likelihood of provoking privacy concerns or causing unnecessary alarm among occupants of patrolled areas. With their discreet yet vigilant monitoring capabilities, patrolling robots strike a balance between security enforcement and maintaining a welcoming and non-threatening environment.
- **Secure Data Transmission and Storage:** Security of data transmission and storage is paramount in patrolling robot operations. These robots utilize encrypted communication protocols and secure data storage mechanisms to safeguard

sensitive information collected during patrols. By adhering to industry-standard encryption protocols and cybersecurity best practices, patrolling robots ensure the integrity and confidentiality of surveillance data, mitigating the risk of unauthorized access or data breaches.

1.3 The Motivation behind undertaking this project:

- **Addressing Security Challenges:** The primary motivation behind embarking on this project is to address the increasingly complex security challenges faced by organizations and communities. Traditional security measures often prove inadequate in mitigating modern-day threats such as vandalism, theft, terrorism, and unauthorized access. By developing and implementing patrolling robots, we aim to enhance security protocols and bolster defense mechanisms against evolving risks.
- **Improving Efficiency and Effectiveness:** Human surveillance efforts are inherently limited by factors such as fatigue, human error, and subjective interpretation. Patrolling robots offer a compelling alternative by augmenting human capabilities with advanced technology, thereby improving the efficiency and effectiveness of security operations. These robots can tirelessly patrol designated areas, conduct real-time monitoring, and detect anomalies with precision, reducing the reliance on human resources and minimizing response times to security incidents.
- **Enhancing Safety and Peace of Mind:** The safety and well-being of individuals within patrolled environments are paramount considerations driving this project. By deploying patrolling robots equipped with state-of-the-art sensors and surveillance technology, we aim to create safer and more secure environments for occupants and visitors. The presence of these robots instills a sense of peace of mind, reassuring stakeholders that proactive measures are in place to safeguard their interests and assets.
- **Embracing Technological Innovation:** Innovation lies at the heart of this project, as we strive to leverage cutting-edge technologies to address pressing security needs. The development of autonomous patrolling robots represents a convergence of robotics, artificial intelligence, and sensor technologies, pushing the boundaries of what is possible in the realm of security solutions. By embracing technological innovation, we seek to stay ahead of emerging threats and ensure that our security infrastructure remains resilient and adaptive.
- **Cost-Effectiveness and Long-Term Sustainability:** Investing in patrolling robots offers compelling cost-effectiveness and long-term sustainability benefits. While the initial implementation costs may be significant, the operational savings and risk mitigation benefits outweigh the upfront expenditures in the long run. By reducing reliance on costly human surveillance resources and minimizing losses

due to security breaches or incidents, patrolling robots contribute to the financial sustainability and resilience of organizations and communities.

- **Contributing to Public Good:** Ultimately, the motivation behind this project extends beyond individual interests to encompass the broader goal of contributing to the public good. By enhancing security measures and creating safer environments, we aim to foster trust, resilience, and social cohesion within communities. The deployment of patrolling robots aligns with our commitment to serving the common good and upholding the values of safety, security, and peace for all stakeholders.

1.4 Problem Statement:

- In the face of escalating security threats and the limitations of traditional surveillance methods, there exists a critical need for innovative solutions to enhance security measures and safeguard various environments. Current security systems, reliant on human surveillance, are susceptible to human error, fatigue, and limited coverage, leaving organizations and communities vulnerable to emerging risks such as vandalism, theft, terrorism, and unauthorized access. Moreover, the complexity of modern security challenges, compounded by factors such as rapid urbanization, population growth, and evolving threat landscapes, underscores the inadequacy of conventional security approaches in effectively addressing multifaceted security concerns.
- The problem statement for this project revolves around the development and implementation of autonomous patrolling robots as a proactive and technologically advanced solution to address the shortcomings of traditional security methods. These robots must be capable of autonomously patrolling designated areas, conducting real-time monitoring, detecting anomalies, and alerting security personnel to potential threats or security breaches. Additionally, the deployment of patrolling robots should not only enhance security effectiveness and efficiency but also ensure cost-effectiveness, scalability, and compatibility with existing security infrastructure. The challenge lies in designing, building, and deploying patrolling robots that are robust, reliable, and adaptable to diverse environments, while also addressing concerns related to privacy, ethics, and regulatory compliance.

Therefore, the problem statement for this project can be summarized as follows:

Developing and implementing autonomous patrolling robots to overcome the limitations of traditional security methods, enhance surveillance capabilities, and mitigate emerging security threats in diverse environments, while ensuring cost-effectiveness, scalability, and compliance with privacy and ethical considerations.

CHAPTER 2

LITERATURE REVIEW

The paper focuses on the use of far-infrared (FIR) stereo vision technology for pedestrian tracking. "Far-infrared" refers to electromagnetic radiation with longer wavelengths than those of visible light, typically in the range of 15,000 to 1,000 micrometers. Stereo vision involves using two cameras to perceive depth and distance by comparing the visual information from each camera. The objective of the paper is likely to explore the effectiveness of far-infrared stereo vision for tracking pedestrians. By utilizing FIR stereo vision, the authors aim to overcome challenges such as low visibility conditions (e.g., darkness, fog) that may hinder traditional visible light-based tracking methods. [1]

The objective of the paper is to propose and evaluate drive assistance systems that can detect and monitor pedestrians in real-time, with a particular emphasis on nighttime scenarios. The aim may include improving pedestrian safety and reducing the risk of accidents involving pedestrians during nighttime driving. The results section likely presents the findings of the study, including the performance of the drive assistance systems in real-world scenarios. Metrics such as detection accuracy, false positive rate, reaction time of the system, and its robustness under varying lighting and weather conditions may be discussed. [2]

The paper may begin by discussing the importance of autonomous navigation in various scenarios, including unmarked paths where traditional navigation methods may be insufficient. The results section likely presents the performance of the proposed navigation system in real-world or simulated scenarios. This may include metrics such as path accuracy, obstacle avoidance capability, and overall navigation efficiency. The paper likely concludes by summarizing the key findings and emphasizing the significance of the proposed navigation system for autonomous vehicles. It may also suggest future research directions or improvements to the system. [3]

The paper likely focuses on real-time obstacle detection using stereovision technology, specifically addressing scenarios with nonflat road geometry. The paper may introduce the importance of obstacle detection for autonomous vehicles, particularly in dynamic environments with varying road geometries. The results section likely presents the performance of the proposed obstacle detection system in real-world or simulated scenarios. This may include metrics such as detection accuracy, false positive rate, and computational efficiency. Overall, the paper contributes to the field of intelligent vehicles by addressing the challenge of real-time obstacle detection on nonflat road geometries, which is crucial for ensuring the safety and effectiveness of autonomous driving systems. [4]

The paper "A Computer Graphics Reflectance Pattern" by R.L. Cook and K.E. Torrance, published in the ACM Graphics Transactions (TOG) in 1982, likely introduces a novel technique for modeling reflectance patterns in computer graphics. Through mathematical formulations or empirical data, the authors likely propose a method aimed at accurately simulating how light interacts with surfaces, with a focus on generating realistic renderings. The paper likely includes discussions on the significance of such advancements for enhancing the visual quality of computer-generated imagery and may suggest future research directions or improvements to the proposed model. [5]

The paper focuses on likely explores advancements in computer-generated imagery (CGI) techniques, aiming to shed light on the process of generating realistic images in computer graphics. Phong's work may delve into various aspects of CGI, including rendering algorithms, lighting models, and shading techniques, with the objective of enhancing the quality and realism of generated images. The paper likely discusses the implications of these advancements for fields such as animation, visualization, and virtual reality, emphasizing their role in providing new insights and visual experiences. Additionally, Phong may suggest future directions for research and development in CGI, aiming to further improve its capabilities and expand its applications. [6]

The paper likely provides a comprehensive examination of different methodologies and technologies utilized for detecting humans in night vision settings. It may cover a variety of approaches, such as image processing algorithms, infrared sensing methods, and machine learning techniques, which are commonly employed to identify and track human subjects in environments with limited illumination. By surveying the existing literature and research findings, the paper likely aims to offer insights into the strengths, weaknesses, and comparative effectiveness of various human detection strategies in night vision scenarios. Additionally, it may discuss challenges encountered in this domain, such as issues related to noise, occlusions, and varying environmental conditions, while also highlighting potential avenues for future research and development to improve the accuracy and reliability of human detection systems in low-light environments. [7]

The paper likely presents a novel approach for detecting humans using far-infrared light cameras. The authors probably introduce a method that involves generating a background image to distinguish humans from their surroundings in low-light conditions. This technique may utilize the unique thermal signatures emitted by humans in the far-infrared spectrum to differentiate them from other objects or background elements. The paper likely details the experimental setup, data acquisition process, and algorithmic procedures involved in human detection using far-infrared cameras. Additionally, it may include a thorough evaluation of the proposed method's performance in terms of detection accuracy, false positive rate, and robustness under various environmental conditions. Overall, the paper likely contributes to the field of human detection by offering a promising solution that leverages far-infrared technology for improved performance in challenging lighting conditions. [8]

The paper likely presents a comprehensive exploration of an automatic intruder combat system designed for smart border surveillance. The authors likely discuss the various components and functionalities of the system, including sensor networks, image processing algorithms, and autonomous response capabilities. The paper may also address the challenges associated with border surveillance, such as detection accuracy, false alarms, and system reliability in harsh environmental conditions. Furthermore, it likely highlights the significance of such systems in bolstering national security and protecting borders against intrusions. Overall, the paper likely contributes valuable insights into the field of border surveillance and presents a promising approach towards ensuring effective monitoring and response along national borders. [9]

The content likely involves the testing and evaluation of a security service system incorporating autonomous guard robots. The report probably details the results and findings from the test operations, including the performance of the autonomous robots in various security scenarios, such as patrolling, surveillance, and response to intrusions. It may discuss aspects such as the effectiveness of the robots in detecting and deterring security threats, the reliability of their autonomous navigation and decision-making capabilities, and any challenges or limitations encountered during the testing phase. Overall, the report likely contributes insights into the feasibility and potential applications of using autonomous robots for enhancing security services. [10]

The paper likely focuses on the development and implementation of remote teleoperated and autonomous mobile security robots tailored for deployment in ship environments. It probably discusses the challenges and considerations unique to ship-based security operations and outlines the methodologies and technologies utilized in the development of these robots. The paper may cover topics such as sensor integration, navigation algorithms, communication systems, and the integration of remote teleoperation and autonomous functionalities. Furthermore, it may include case studies or experimental results demonstrating the effectiveness and feasibility of the developed security robot systems in enhancing security and surveillance capabilities in maritime settings. [11]

This manual likely serves as a comprehensive guide to the methods and techniques used for monitoring soil moisture levels in farmland. It may cover topics such as the principles of soil moisture measurement, types of sensors and instrumentation used, installation and calibration procedures, data collection and analysis techniques, and practical applications for optimizing irrigation and agricultural management practices. Given that the manual is in Chinese, it would likely be a valuable resource for researchers, agronomists, and agricultural practitioners in China seeking to improve water management and crop productivity through effective soil moisture monitoring strategies. [12]

Existing System

The existing systems for patrolling robots vary depending on the specific application and requirements, but here are some common features and components found in many patrolling robot systems:

1. Mobility Platform: Patrolling robots typically utilize wheeled or tracked platforms for mobility. These platforms are designed to navigate various terrains and obstacles encountered during patrolling tasks.
2. Sensors: Patrolling robots are equipped with a variety of sensors to perceive their environment. These sensors may include cameras (visible light, infrared, or thermal), lidar, radar, ultrasonic sensors, and motion detectors. These sensors enable the robot to detect and recognize objects, obstacles, and anomalies in its surroundings.
3. Navigation System: Patrolling robots often incorporate navigation systems to autonomously traverse predefined routes or patrol areas. These systems may use GPS for outdoor navigation and localization, while indoor navigation may rely on techniques such as SLAM (Simultaneous Localization and Mapping) or beacon-based localization.
4. Communication: Patrolling robots require communication capabilities to transmit data, receive commands, and provide status updates. This communication may be wireless, such as Wi-Fi, cellular, or radio communication, allowing the robot to stay connected to a central control station or operator.
5. Power Source: Patrolling robots are powered by batteries or other energy sources, providing the necessary power to operate their components and systems during patrols. Depending on the application, these power sources may need to support long-duration patrols without frequent recharging or refueling.
6. Control System: The control system of a patrolling robot includes the software and algorithms responsible for coordinating sensor inputs, navigation commands, and decision-making processes. This system enables the robot to autonomously execute patrol missions while adapting to changing environmental conditions.
7. Payload: Patrolling robots may carry additional equipment or payloads depending on their specific application. This could include lights, sirens, speakers for audio communication, manipulator arms for interacting with objects, or payload compartments for transporting items.

Overall, the design and implementation of patrolling robot systems require careful consideration of factors such as environment, mission requirements, and operational constraints to develop effective and reliable solutions for various security, surveillance, inspection applications. Also, the existing system is not suitable for heavy and large vehicles. In order to overcome this dilemma, we have prepared a new detection system of this project.

CHAPTER 3

HARDWARE IMPLEMENTATION

3.1 Introduction

In response to the growing need for efficient and sustainable urban green spaces management, the project "Patrobot" presents a pioneering solution designed to enhance the environmental monitoring and security of residential societies. Patrobot is an autonomous patrolling robot equipped with advanced sensors and intelligent control systems, specifically tailored to navigate residential areas and monitor the moisture levels of plants within the society premises.

In this project, the major components of the Patrobot involves ensuring seamless integration and interaction among the Arduino Uno microcontroller, ultrasonic sensor, IR sensor, servo motor, camera, soil moisture sensor, L298 motor shield and chassis (including motors and wheels).

The seamless coordination among the major components of the Patrobot, highlighting its autonomous navigation, plant moisture monitoring, visual surveillance, and data transmission capabilities. It illustrates how the Arduino Uno microcontroller serves as the central control unit, orchestrating the operation of sensors, servo motor, camera, and soil moisture sensor. The integration of ultrasonic and IR sensors enables obstacle detection and navigation, ensuring the Patrobot can navigate safely through its patrol route. Meanwhile, the soil moisture sensor periodically measures the moisture level of the soil surrounding plants, allowing the Patrobot to initiate watering cycles when necessary. The camera captures visual data for remote monitoring and surveillance, facilitating proactive management of plant health and environmental conditions. Additionally, the Arduino Uno utilizes communication modules to transmit real-time data to a central control station, enabling operators to make informed decisions and adjust Patrobot's activities as needed. This comprehensive coordination ensures that the Patrobot operates efficiently, enhances urban green spaces management, and promotes sustainability in residential societies.

3.2 Block Diagram

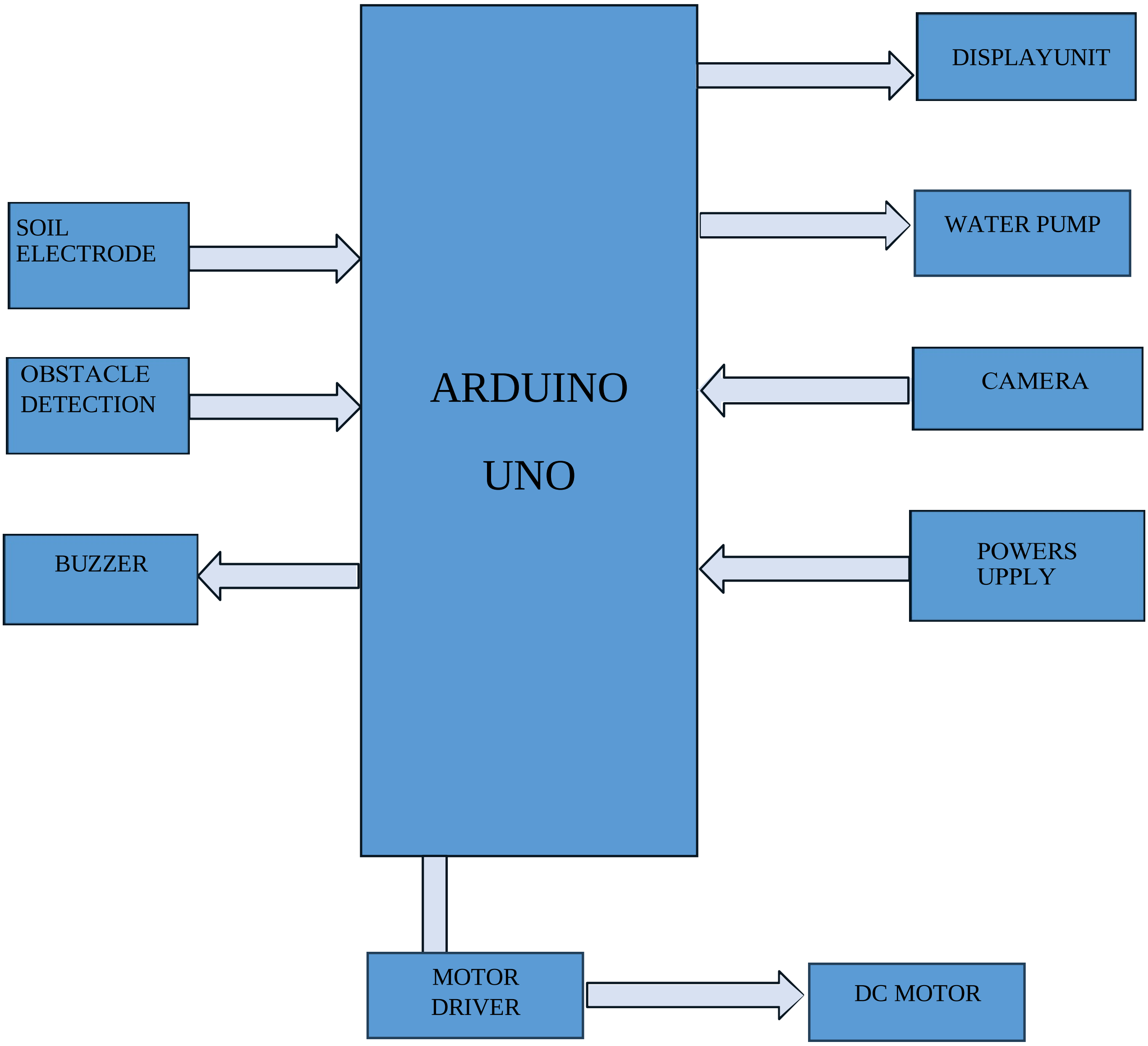

Fig3.1: Block diagram of Patrobot

3.3 List of Components

- Arduino Uno
- Wheel & TT Gear Motor
- L298N Motor Driver Shield
- LED
- Camera
- Soil Moisture Sensor
- Buzzer
- HC05 Bluetooth
- Relay
- Water Pump
- Wires
- Battery

3.3.1 Arduino Uno

ArduinoATMEGA-328microcontrollerhasbeenprogrammedforvariousapplications.By using the power jack cable, Arduino microcontroller has been programmed so that the execution of the program may takes place. Various kinds of Arduino board are present in the market. In this paper, Arduino UNO ATMEGA-328 microcontroller is described in a detailed manner.

Arduino software is installed in the computer and so that we can edit and upload the program according to the applications. Mainly these Arduino software supports C and C++ programming languages. Various inputs and outputs are present in the Arduino board and therefore simultaneously 8 input and output ports can be used for various applications. Some of the applications used by using Arduino boards are rotating general motor, stepper motor, control valve open, etc.

Nearly 7, 00,000 numbers of Arduinos are present in the market. Of these, Arduino ATMEGA-328microcontrollerconsistof14inputandoutputanaloganddigitalpins(from these 6 pins are considered to be a PWM pins), 6 analog input pins and remaining are digital inputs. Power jack cable is used to connect Arduino board with the computer. External battery is connected with the Arduino microcontroller for the power supply. Arduino is an Open-Source microcontroller from which there is no feedback present in the microcontroller.

This Arduino board consist of I2C bus, that can be able to transfer the data from Arduino board to the output devices. These Arduino boards are programmed over RS232 serial interface connections with Atmega Arduino microcontrollers. The operating volt ranges from 5v. The input voltage recommended for Arduino microcontroller is from 7v and the maximum of 12v. The DC input current given to the Arduino board is in the range of 40mA.

It consists of different types of memories such as flash memory, EEPROM, SRAM. The length of the Arduino board is nearly about 68.64mm and the width of the microcontroller is about 53.4mm. The weight of the Arduino microcontroller is about 20g. We can use various types of microcontrollers such as 8-bit AVL Atmel microcontroller and 32-bit Atmel arm microprocessor. From these different kinds of processors, we can use those processors for various engineering projects as well as industrial applications. Some of the examples of using the Arduino in the industrial applications are controlling the actuators and sensors. Some of the examples of Arduino microcontrollers are Arduino Duemilanove, Arduino UNO, Arduino Leonardo, Arduino Mega, Arduino MEGA 2560 R3, Arduino MEGA 2560 R3, Arduino Nano, Arduino Due, Lily Pad Arduino, micro-Arduino. We have already mentioned, Arduino has been programmed by using C and C++ programming language. These C and C++ are high level languages. Normally it has 18 number of input and output pins.

Amongthose6pins are considered to be an analog input. From these analog inputs, we can be able to work the Arduino microcontroller using analog inputs supply. Normally analog inputs can be in the range of 0-5V. Similar to that digital inputs are present in the microcontroller which can act the use of microcontroller using digital inputs. Digital inputs can be in the range of 5V.

ATMEGA 328 microcontroller, which acts as a processor for the Arduino board. Nearly it consists of 28 pins. From these 28 pins, the inputs can be controlled by transmitting and receiving the inputs to the external device. It also consists of pulse width modulation (PWM).

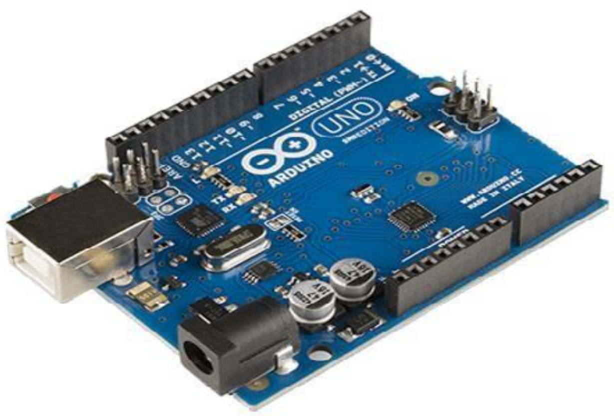

Fig3.2: Arduino Atmega-328

Arduino atmega-328 microcontroller board consist of 6 analog inputs pins. These analog inputs can be named from A0 to A5. From these 6 analog inputs pins, we can do the process by using analog inputs. Analog inputs can be used in the operating range of 0 to 5V.

Analog signal is considered as the continuous time signal, from which this analog signal can be used for certain applications. These are also called as non-discrete time signal.

Inputs such as voltage, current etc.., are considered to be either analog signal or digital signal only by analyzing then time signal properties. Various applications of Arduino microcontroller can use only an analog input instead of digital inputs. For these applications, analog input ports or pins can be used.

Digital Inputs:

Digital inputs can be defined as the non-continuous time signal with discrete input pulses. It can be represented as 0"s and 1"s. These digital inputs can be either on state or in off state. Arduino atmega328 microcontroller also consists of 12 digital input pins. It can be stated as D0 toD11. Nearly12 inputs can be used for digital input/output applications. The working of the digital input ports is where the discrete input pulses can be triggered and supplied to the ports. These ports receive the input and therefore the port can be used for both input and output process. These digital pins can access only the digital inputs.

ATMEGA-328IC:

This ATMEGA-328 integrated chip consists of 28 pins. It consists of 6 analog inputs that are shown in the pin diagram. Analog inputs can be represented as PC0 to PC5. These analog input pins possess the continuous time signal which acts as an analog input for the system. Further it also consists of 12 digital inputs. It can be represented as PD1 to PD11 which act as a digital input port based on pulse width modulation (PWM). These PWM, which transmits the signal in the form of discredited form. Both analog and digital input ports can be used for various applications for the input power supply, VCC and GND pins are used. Pins PB6 and PB7, which acts as a crystal to generate a clock signal. By using this crystal, we can generate the clock signals and by these clock signals, we can use this clock signals for input sources.PC6 pin are the one where it can be used for the reset option. Resetting the program can be done by using this PC6 pin.

Power Jack Cable /USB Port:

This Arduino atmega-328 microcontroller can be interfaced with the other electronic devices such as computer by using USB port or power jack cable from these power jack cable, we can upload the program of Arduino for their applications. At first, the program can be initialized or can be edited by using Arduino software tools. Then these programs can be transferred through Arduino microcontroller board by using USB cable or power jack cable.

Power Supply:

There is an additional power supply source present in Arduino microcontroller. Power supply port is present at the corner of the Arduino microcontroller. Either we can use this power supply port by connecting with external power supply (i.e, ac power supply), or by connecting a dc power supply through input pins. These Arduino microcontroller scan accept a range of power supply. When the power supply voltage range exceeds, the micro controller gets damaged. Hence, only the particular range of power supply should be given to the Arduino microcontroller.

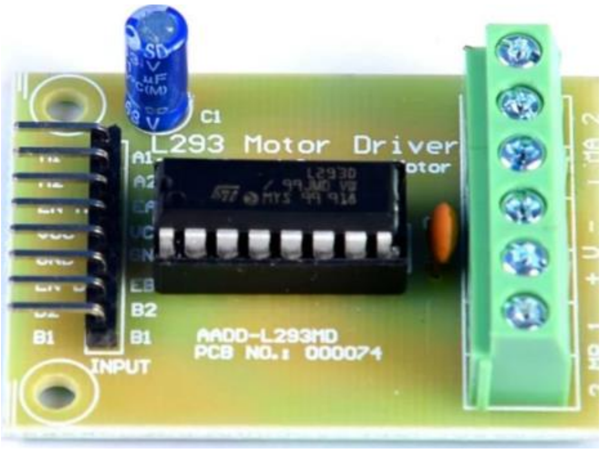

Fig3.3: L293 Motors Driver

3.3.2 Motor Driver Shield Components

The shield has several important components.
L293D is a basic motor driver integrated chip (IC) that enables us to drive a DC motor in either direction and also control the speed of the motor. The L293D is a 16 pin IC, with 8 pins on each side, allowing us to control the motor. It means that we can use a single L293D to run up to two DC motors. L293D consist of two H-bridge circuit. H-bridge is the simplest circuit for changing polarity across the load connected to it.

There are 2 OUTPUT pins, 2 INPUT pins, and 1 ENABLE pin for driving each motor. It is designed to drive inductive loads such as solenoids, relays, DC motors, and bipolar stepper motors, as well as other high-current/high-voltage loads.

Technical Specification:

- Wide Supply-Voltage Range: 4.5 V to 36 V

- Output Current: 600 mA Per Channel
- Peak Output Current: 1.2 A Per Channel
- Supply Voltage to the IC: 4.5V to 7V
- Transition time: 300ns (at 5Vand 24V)
- Size: 44mm* 40mm*20mm (L*W*H)

Features:

- LM393 based design
- Easy to use with Microcontrollers or even with normal Digital/Analog IC
- Small, cheap and easily available
- Fixed bolt hole for easy installation
- Comparator output, clean signal, great waveform, and strong driving ability

Applications:

- Robotics Application
- Mechatronics Application

3.3.3 TT Gear Motor & Wheels

A Gear motor is a mechanical device consisting of an electric motor and a gearbox, differing from a DC motor for lower RPM and higher torque. A gear motor is a motor designed with an integrated gearbox. Gear motors function as torque multipliers and speed reducers thus requiring less power to move a given load. The design of the gearbox structure, type of gears, lubrication and type of coupling affects its performance.

A gear motor is a mechanical system consisting of an electric motor and a gearbox containing a series of gears. The function of the gearbox coupled to the motor is to reduce its speed and increase its torque to do a given job at a given speed.

God created legs for locomotion and man created wheels for the same purpose, which is one of the greatest inventions in human era.Wheels are your best bet for robots as they are easy to design, implement and practical for robots that require speed. They also do not suffer from static or dynamic stability as the center of gravity of robot does not change when they are in motion or just standing still and do not require complex models, designs and algorithms. The disadvantage is that they are not stable on uneven or rough terrain and also on extremely smooth surfaces as they tend to slip and skid.

Fig3.4: Picture of TT Gear Motors & Wheels

3.3.4 LED

In the simplest terms, a light-emitting diode (LED) is a semiconductor device that emits light when an electric current is passed through it. Light is produced when the particles that carry the current (known as electrons and holes) combine together within the semiconductor material.

Since light is generated within the solid semiconductor material, LEDs are described as solid-state devices. The term solid-state lighting, which also encompasses organic LEDs (OLEDs), distinguishes this lighting technology from other sources that use heated filaments (incandescent and tungsten halogen lamps) or gas discharge (fluorescent lamps).

Fig3.5 :LED Light

Inside the semiconductor material of the LED, the electrons and holes are contained within energy bands. The separation of the bands (i.e. the bandgap) determines the energy of the photons (light particles) that are emitted by the LED.

The photon energy determines the wavelength of the emitted light, and hence its Color. Different semiconductor materials with different bandgaps produce different colors of light. The precise wavelength (color) can be tuned by altering the composition of the light-emitting, or active region.

LEDs are comprised of compound semiconductor materials, which are made up of elements from group III and group V of the periodic table (these are known as III-V materials). Examples of III-V materials commonly used to make LEDs are gallium arsenide (GaAs) and gallium phosphide (GaP).

Until the mid-90s LEDs had a limited range of colors, and in particular commercial blue and white LEDs did not exist. The development of LEDs based on the gallium nitride (GaN) material system completed the palette of colors and opened up many new applications.

3.3.5 Camera Module

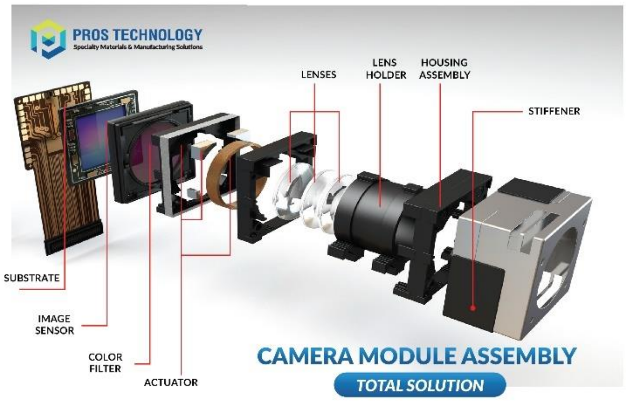

Fig3.6: Camera Module Assembly

An USB camera is a video camera that feeds or streams its image in real time to or through a computer to a computer network. When "captured" by the computer, the video stream may be saved, viewed or sent on to other networks travelling through systems such as the internet, and e-mailed as an attachment. When sent to a remote location, the video stream may be saved, viewed or on sent there. Unlike an IP camera (which connects using Ethernet or Wi-Fi), a webcam is generally connected by a USB cable, or similar cable, or built into computer hardware, such as laptops. The term “USB” camera (a clipped compound) may also be used in its original sense of a video camera connected to the USB continuously for an indefinite time, rather than for a particular session, generally supplying a view for anyone who visits its web page over the Internet. Some of them, for example, those used as online traffic cameras, are expensive, rugged professional video cameras.

3.3.6 Soil Moisture Sensor

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

The relation among the calculated property as well as moisture of soil should be adjusted & may change based on ecological factors like temperature, type of soil, otherwise electric conductivity. The microwave emission which is reflected can be influenced by the moisture of soil as well as mainly used in agriculture and remote sensing within hydrology. These sensors normally used to check volumetric water content, and another group of sensors calculates a new property of moisture within soils named water potential. Generally, these sensors are named as soil water potential sensors which include gypsum blocks and tensiometer.

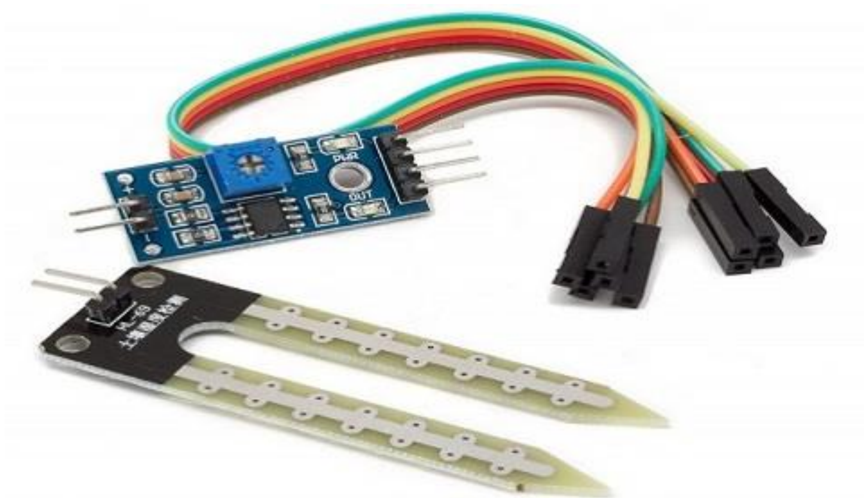

Fig3.7: Soil Moisture Sensor

Soil Moisture Sensor Pin Configuration:

The FC-28 soil moisture sensor includes 4-pins

- VCC pin is used for power
- A0 pin is an analog output
- D0 pin is a digital output
- GND pin is a Ground

This module also includes a potentiometer that will fix the threshold value, & the value can be evaluated by the comparator-LM393. The LED will turn on/off based on the threshold value.

3.3.7 Buzzer

An audio signaling device like a beeper or buzzer may be electromechanical or mechanical type. The main function of this is to convert the signal from audio to sound. Generally, it is powered through DC voltage and used in timers, alarm devices, printers, alarms, computers, etc. Based on the various designs, it can generate different sounds like alarm, music, bell.

Fig3.8: Buzzer

3.3.8 HC-05 Bluetooth

Introduction:

- It is used for many applications like wireless headset, game controllers, wireless mouse, wireless keyboard, and many more consumer applications.
- It has range up to <100m which depends upon transmitter and receiver, atmosphere, geographic & urban conditions.
- It is IEEE 802.15.1 standardized protocol, through which one can build wireless Personal Area Network (PAN). It uses frequency-hopping spread spectrum (FHSS) radio technology to send data over air.
- It uses serial communication to communicate with devices. It communicates with microcontroller using serial port (USART).

HC-05 Bluetooth Module:

- HC-05 is a Bluetooth module which is designed for wireless communication. This module can be used in a master or slave configuration.

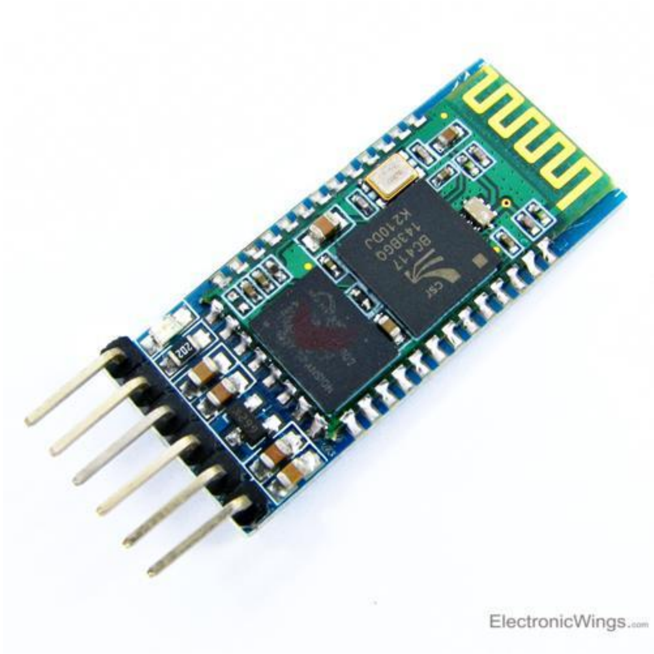

Fig3.9: HC-05 Bluetooth Module

HC-05 Bluetooth Module Pin Diagram:

Bluetooth serial modules allow all serial enabled devices to communicate with each other using Bluetooth.

It has 6 pins,

(i)Key/EN: It is used to bring Bluetooth module in AT commands mode. If Key/EN pin is set to high, then this module will work in command mode. Otherwise by default it is in data mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode.

HC-05 module has two modes,

(a) Data mode: Exchange of data between devices.

(b) Command mode: It uses AT commands which are used to change setting of HC-05. To send these commands to module serial (USART) port is used.

(ii)VCC: Connect 5 V or 3.3 V to this Pin.

(iii) GND: Ground Pin of module.

(iv)TXD: Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)

(v)RXD: Receive data serially (received data will be transmitted wirelessly by Bluetooth module).

(vi) State: It tells whether module is connected or not.

HC-05 module Information:

- HC-05 has red LED which indicates connection status, whether the Bluetooth is connected or not. Before connecting to HC-05 module this red LED blinks continuously in a periodic manner. When it gets connected to any other Bluetooth device, its blinking slows down to two seconds.
- This module works on 3.3V. We can connect 5V supply voltage as well since the module has on board 5 to 3.3 V regulator.
- As HC-05 Bluetooth module has 3.3V level for RX/TX and microcontroller can detect 3.3 V level, so, no need to shift transmit level of HC-05 module. But we need to shift the transmit voltage level from microcontroller to RX of HC-05 module.
- The data transfer rate of HC-05 module can vary up to 1Mbps is in the range of 10 meters

3.3.9 Relay

Relays consist of three pins normally open pin, normally closed pin, common pin and coil. When coil powered on magnetic field is generated the contacts connected to each other. Relay modules 1-channel features:

- Supply voltage – 3.75V to 6V
- Quiescent current: 2mA
- Current when the relay is active: ~70mA
- Relay maximum contact voltage – 250VAC or 30VDC
- Relay maximum current – 10A

How to connect relay module with Arduino?

As shown in relay working idea it depends on magnetic field generated from the coil so there is power isolation between the coil and the switching pins so coils can be easily powered from Arduino by connecting VCC and GND bins from Arduino kit to the relay module kit after that we choose Arduino output pins depending on the number of relays needed in project designed and set these pins to output and make it out high (5 V) to control the coil that allow controlling of switching process.

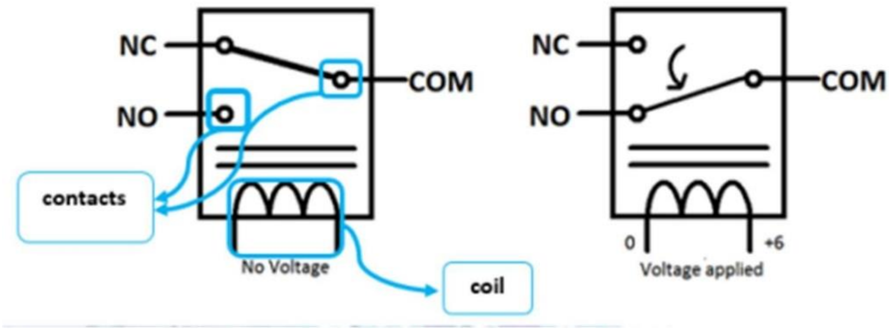

Fig3.10: Relay (Pin Diagram)

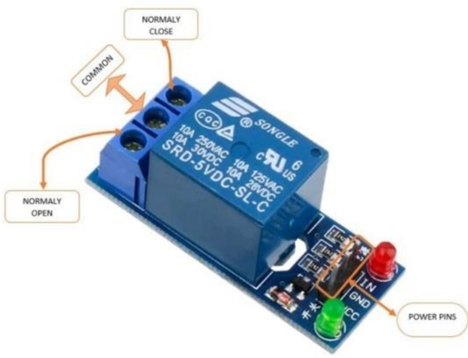

Fig3.11: Relay Module

3.3.10 Water Pump

This is a low cost, small size Submersible Pump Motor which can be operated from a 2.5 ~ 6V power supply. It can take up to 120 liters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.

Technical Specification:

- Input Voltage: DC3V–5V
- Flow Rate:1.2–1.6L/min
- OperatingCurrent:0.1–0.2A

- MaximumSuctionDistance:0.8m
- OutsideDiameterofWaterOutlet:7.5mm
- InsideDiameterofWateroutlet:5.0mm
- DiameterofWaterInlet:5.0mm
- WireLength:200mm
- Operating temperature: less than 80˚C

Fig 3.12: Water Pump Module

CHAPTER 4

SOFTWARE REQUIREMENT

4.1 **Introduction**

In this project we have used Arduino IDE, short for Integrated Development Environment. Arduino IDE serves as the primary tool for creating and manipulating code that controls various electronic components connected to an Arduino board. It supports the Arduino programming language, a simplified variant of C and C++. One of the key advantages of Arduino IDE is its cross-platform compatibility, available for Windows, macOS, and Linux operating systems. This enables users to work seamlessly on different machines while maintaining a consistent programming environment.

4.2 **Algorithm and flow chart**

4.2.1Algorithm

1. The Patrobot project operates through a multifaceted algorithm designed to ensure the security and well-being of residential societies. Initially, the system initializes its components, including surveillance cameras, motion sensors, soil moisture sensors, and communication modules.
2. Continuously, it monitors the surveillance feed, employing computer vision algorithms to detect any motion. Upon detection, it verifies the authorization of the movement; if unauthorized, alerts are triggered.
3. Simultaneously, the system monitors soil moisture levels, activating irrigation systems when levels fall below predefined thresholds to maintain plant health.
4. Data from both surveillance and environmental sensors are logged for analysis, facilitating optimization of watering schedules and surveillance parameters.
5. Real-time alerts are generated and disseminated to designated stakeholders via SMS or mobile app notifications, ensuring prompt response to security breaches or environmental concerns
6. . A user-friendly interface allows residents to monitor feeds, view sensor data, and customize system settings according to their preferences.

4.2.2 Flow chart

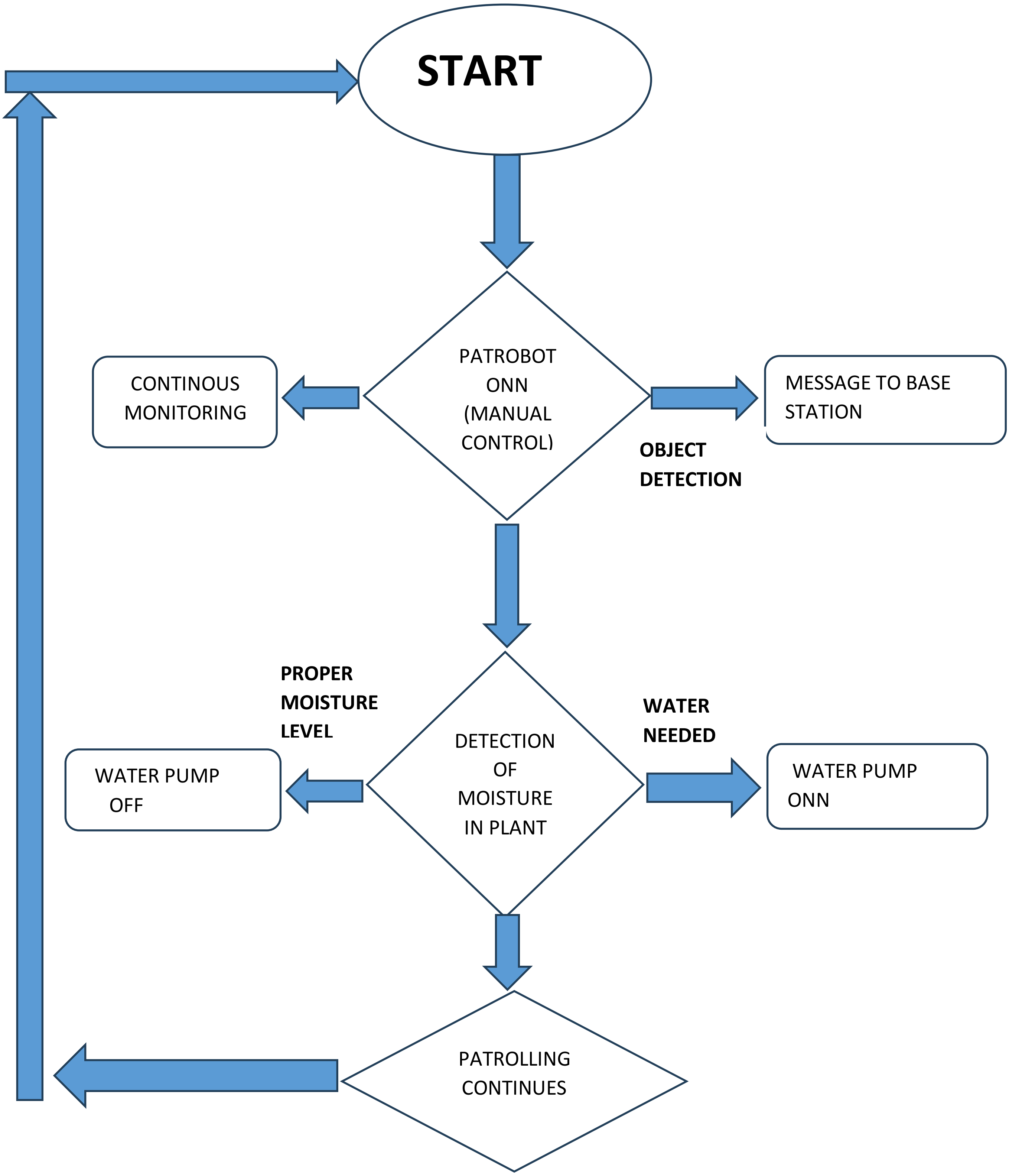

Fig4.1: Flow chart of working model

4.3 **Arduino Software (IDE)**

Arduino IDE is a software development environment specifically designed for programming Arduino boards. It contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It provides a user-friendly interface that allows users to write, compile, and upload code to Arduino microcontrollers. The IDE supports the Arduino programming language, a simplified version of C and C++, making it accessible to beginners and experienced programmers alike. The Arduino IDE is cross-platform compatible to Windows, macOS, and Linux operating systems. This flexibility allows users to work on different machines without any compatibility issues. The IDE features a text editor with syntax highlighting, making it easier to write and debug code. One of the notable features of Arduino IDE is its extensive library collection. Libraries are pre-written code snippets that simplify complex tasks, such as controlling sensors, motors, and displays. These libraries can be easily imported into the IDE, saving time and effort in coding.

The compilation and uploading process in Arduino IDE is seamless. Once the code is written, it is compiled into machine-readable instructions. The compiled code is then uploaded to the Arduino board via a USB connection, enabling the microcontroller to execute the programmed tasks in real-time. Arduino IDE also has a thriving community of users who actively share projects, code examples, and provide support to fellow Arduino enthusiasts. This collaborative environment encourages learning and creativity, as users can explore various projects and gain inspiration from others.

Overall, Arduino IDE provides a powerful and intuitive platform for developing projects with Arduino boards. Its simplicity, versatility, and strong community support make it an excellent choice for hobbyists, students, and professionals interested in electronics and physical computing.

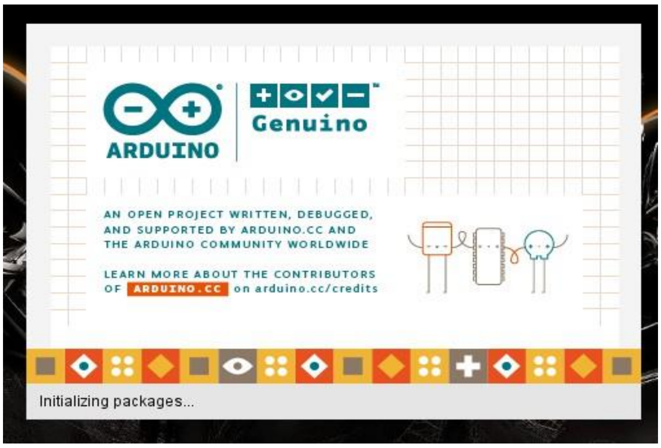

Fig4.2: Arduino IDE installation interface.

4.4 Easy EDA

Easy EDA is an easier and powerful online PCB design tool that allows electronics engineers, educators, students, makers, and enthusiasts to design and share their projects. This is a design tool integrated LCSC components catalog and JLCPCB PCB service that helps users to save time to make their ideas into real products.

Features

- Simple, Easier, Friendly, and Powerful general drawing capabilities
- Schematic Capture
- PCB Layout
- Working Anywhere, Anytime, Any Device
- Real-time Team Cooperation
- Sharing Online
- Thousands of open source Projects
- Direct Links to LCSC Components for Selection
- Integrated PCB Fabrication
- Import Altium/Kicad/Eagle,PNG,DXF

Fig4.3: Easy EDA

4.5 Bluetooth Electronics

Control your electronic project with an android device. This app communicates using Bluetooth to an HC-06 or HC-05 Bluetooth module in your project. Since version 1.2 of the app, it will now also communicate to Bluetooth low energy modules such as the HC-08 and via USB- serial connection.
This app comes with a library containing 11 Bluetooth examples for Arduino. See the electronics page for examples.
It can also be used with Raspberry Pi or any other rapid prototyping system in which you have included a suitable Bluetooth module to your project.
• Ideal for learning electronics in a fun way.
• Ideal for rapid prototyping a new idea.
• Ideal for exhibiting your project.
Large selection of controls available including buttons, switches, sliders, pads, lights, gauges, terminals, accelerometers and graphs, Drag and drop them onto the panel grid. Then edit their properties.20 customisable pannels available. Discover Pair and connect to Bluetooth devices. Then click Run to use the panel.

Fig4.4: Bluetooth Electronics

4.6 Ezykam+

It is a security surveillance application that allows users to watch CCTV Cameras on Computers from any location.

The software allows you to playback and watch recordings, take snaps, communicate to the person at the camera end and pan, tilt, zoom the device, etc from anywhere.
The user also receives alert messages and alarms sensing any threat. It is a complete solution for your security. Surveillance app is good for our safety and security.
Here, we will analyse the features and functions of the software.

- It gives us real-time video. There is no time lag.
- The advanced data technology gives seamless data transfer in low network areas. The video is never interrupted.
- The user can operate the device from any location. You can also operate a PTZ camera. You can pan, tilt and zoom from your location.

- Smart sensors are powerful. They detect sound and movement. Any suspicious motion and audio are tracked.
- It gives you alert signals sensing any threat. You get alert messages and alarms.
- The user can also pre-set security zones. When any person enters those areas, the application alerts you.
- You can access the device from remote locations.
- It supports 4 channel playback at a time.
- The CMS supports Cloud Server Recording.
- The two-way audio function is very helpful. It allows you to communicate two-way.

Fig4.5: Ezykam+

CHAPTER 5

WORKING AND SIMULATION

5.1 Introduction

Introducing Patrobot, your all-in-one solution for monitoring society and nurturing plants with precision. Patrobot is not just a surveillance system; it's a sophisticated robot designed to enhance security while promoting environmental sustainability.

At its core, Patrobot is a comprehensive surveillance platform, employing state-of-the-art sensors to monitor and analyse activity in various environments. Whether it is a bustling urban area, a corporate campus, or a residential neighbourhood, Patrobot provides real-time insights and alerts to ensure safety and security.

But Patrobot does not stop there. In addition to its surveillance capabilities, it doubles as an intelligent plant care system. With integrated moisture sensors and watering mechanisms, Patrobot can monitor the moisture levels of plants and deliver water precisely when needed. This ensures optimal growth and health for plants, whether they are indoors or outdoors.

5.2 Code with comments/brief description of fragments of statements:

5.2.1For the robot

```
  char t;

void setup() {
pinMode(13,OUTPUT);   // motors
pinMode(12,OUTPUT); //motors
pinMode(11,OUTPUT);   // motors
pinMode(10,OUTPUT);  // motors
pinMode(9,OUTPUT);
pinMode(8,OUTPUT);
pinMode(7,OUTPUT);
pinMode(6,OUTPUT);
pinMode(5,OUTPUT);
pinMode(4,OUTPUT);
pinMode(3,OUTPUT);
pinMode(2,OUTPUT);
Serial.begin(9600);

}
void loop() {
if(Serial.available()){
  t = Serial.read();
```

```
  Serial.println(t);
}


if(t == 'F'){  //forword
  digitalWrite(13,HIGH);
  digitalWrite(11,HIGH);
}
 else if(t == 'B'){  //revers
  digitalWrite(12,HIGH);
  digitalWrite(10,HIGH);
}
if(t == 'X'){  //lift round
  digitalWrite(13,HIGH);
  digitalWrite(10,HIGH);
}
 else if(t == 'Y'){ //right round
  digitalWrite(12,HIGH);
  digitalWrite(11,HIGH);
}
else if(t == 'L'){ //turn lift forword
  digitalWrite(11,HIGH);
}
else if(t == 'R'){    //turn right forword
  digitalWrite(13,HIGH);
}
else if(t == 'A'){
  digitalWrite(9,HIGH);
}
else if(t == 'a'){
  digitalWrite(9,LOW);
}
 else if(t == 'C'){
  digitalWrite(8,HIGH);
}
else if(t == 'c'){
  digitalWrite(8,LOW);
}
else if(t == 'D'){
  digitalWrite(7,HIGH);
}
else if(t == 'd'){
```

```
  digitalWrite(7,LOW);
}
 else if(t == 'E'){
  digitalWrite(6,HIGH);
}
else if(t == 'e'){
  digitalWrite(6,LOW);
}
 else if(t == 'G'){
  digitalWrite(5,HIGH);
}
else if(t == 'g'){
  digitalWrite(5,LOW);
}
 else if(t == 'H'){
  digitalWrite(4,HIGH);
}
else if(t == 'h'){
  digitalWrite(4,LOW);
}
 else if(t == 'I'){
  digitalWrite(3,HIGH);
}
else if(t == 'i'){
  digitalWrite(3,LOW);
}
else if(t == 'J'){
  digitalWrite(2,HIGH);
        delay(150);
}
 else if(t == 'j'){
  digitalWrite(2,LOW);
        delay(150);
}
else if(t == 'S'){      //STOP (all motors stop)
  digitalWrite(13,LOW);
  digitalWrite(12,LOW);
  digitalWrite(11,LOW);
  digitalWrite(10,LOW);
}
delay(100);
}
```

5.2.2 For the irrigation system

```
int moisture = 0;

void setup()
{
  pinMode(A0, OUTPUT);
  pinMode(A1, INPUT);
  Serial.begin(9600);
  pinMode(8, OUTPUT);
  pinMode(9, OUTPUT);
  pinMode(10, OUTPUT);
  pinMode(11, OUTPUT);
  pinMode(12, OUTPUT);
}
void loop()
{
  // Apply power to the soil moisture sensor
  digitalWrite(A0, HIGH);
  delay(10); // Wait for 10 millisecond(s)
  moisture = analogRead(A1);
  // Turn off the sensor to reduce metal corrosion
  // over time
digitalWrite(A0, LOW);
  Serial.println(moisture);
  digitalWrite(8, LOW);
digitalWrite(9, LOW);
digitalWrite(10, LOW);
  digitalWrite(11, LOW);
  digitalWrite(12, LOW);
  if (moisture < 200) {
    digitalWrite(12, HIGH);
  } else {
    if (moisture < 400) {
      digitalWrite(11, HIGH);
    } else {
      if (moisture < 600) {
        digitalWrite(10, HIGH);
      } else {
        if (moisture < 800) {
          digitalWrite(9, HIGH);
        } else {
```

```
        digitalWrite(8, HIGH);
      }
    }
  }
}
delay(100); // Wait for 100 millisecond(s)
}
```

5.3 Circuit Diagram

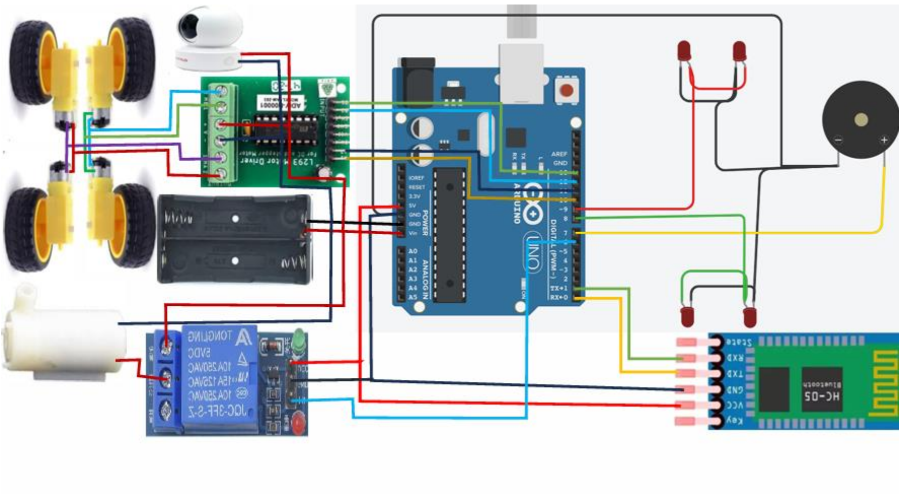

Fig5.1: Patrobot Circuit Diagram

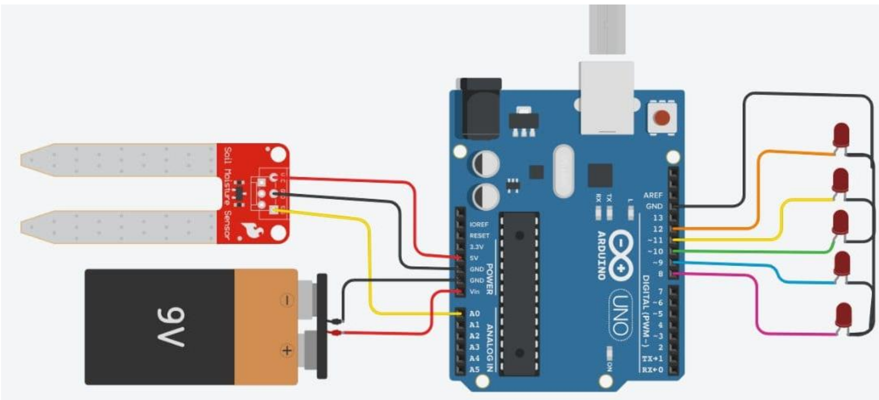

Fig5.2: Irrigation System Circuit Diagram

5.4 Working Pictures

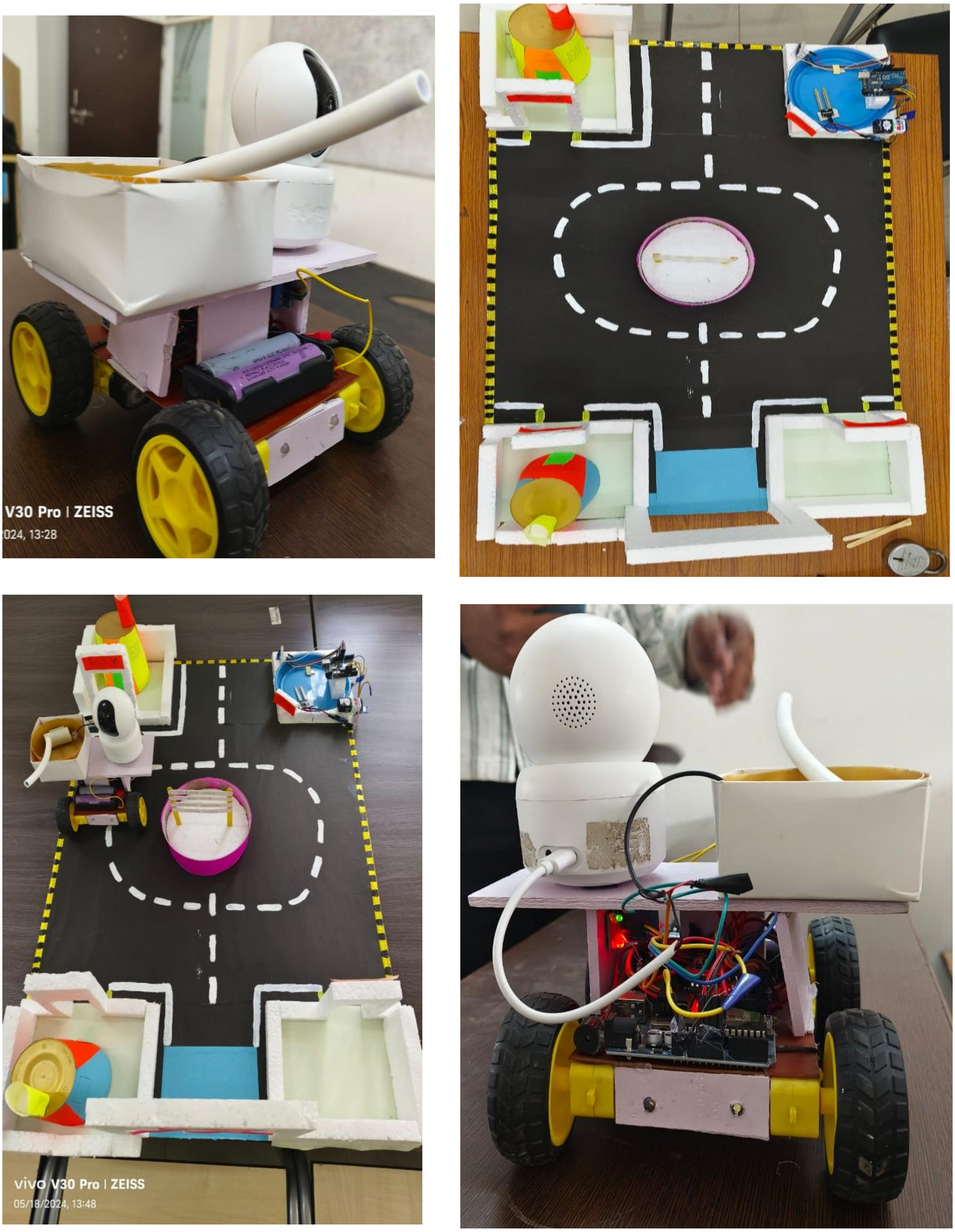

Fig5.3: Working Model Prototype

5.5 Connection Diagram and Connection Netlist

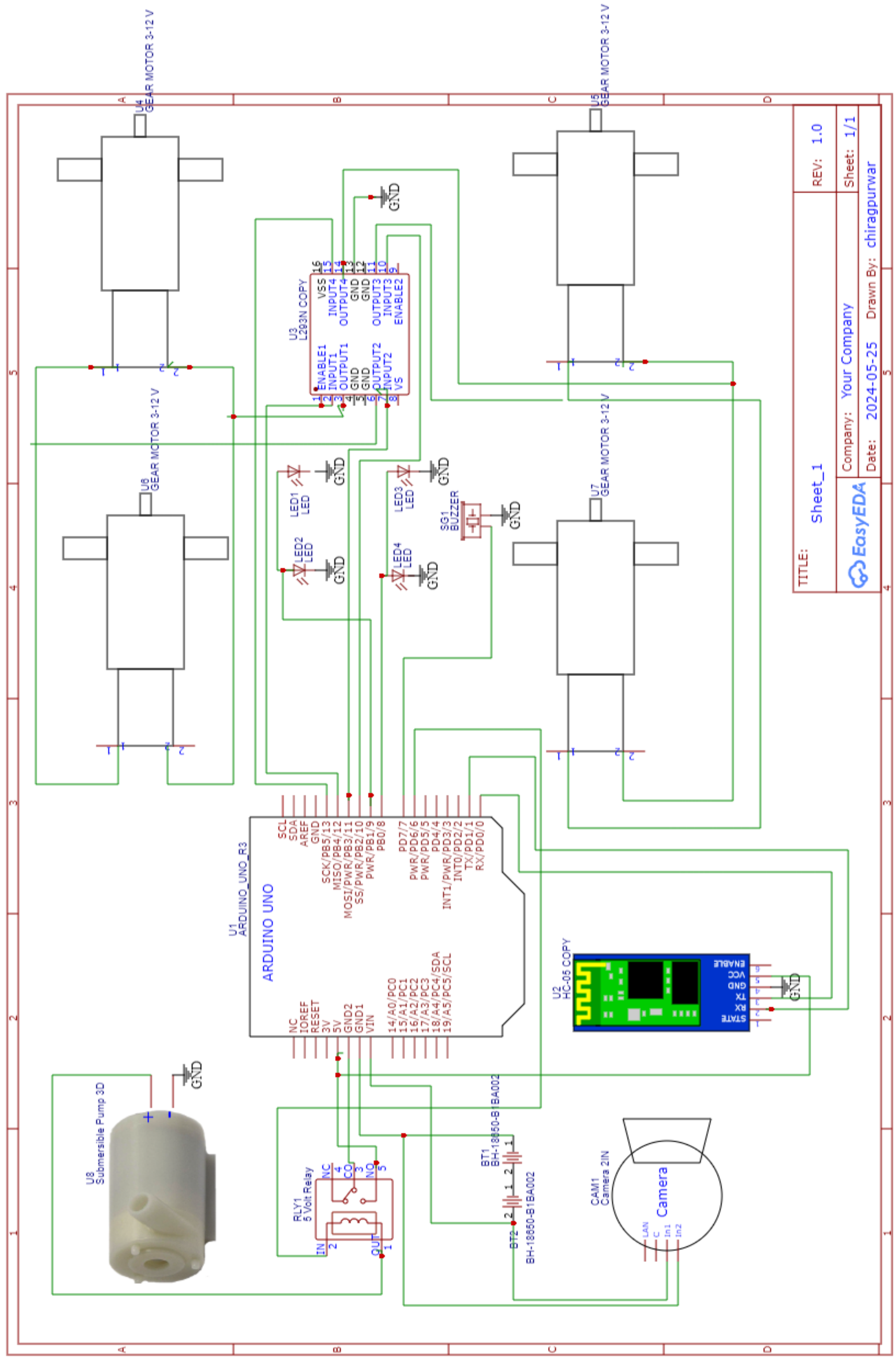

Fig5.4: Patrobot Connection Diagram

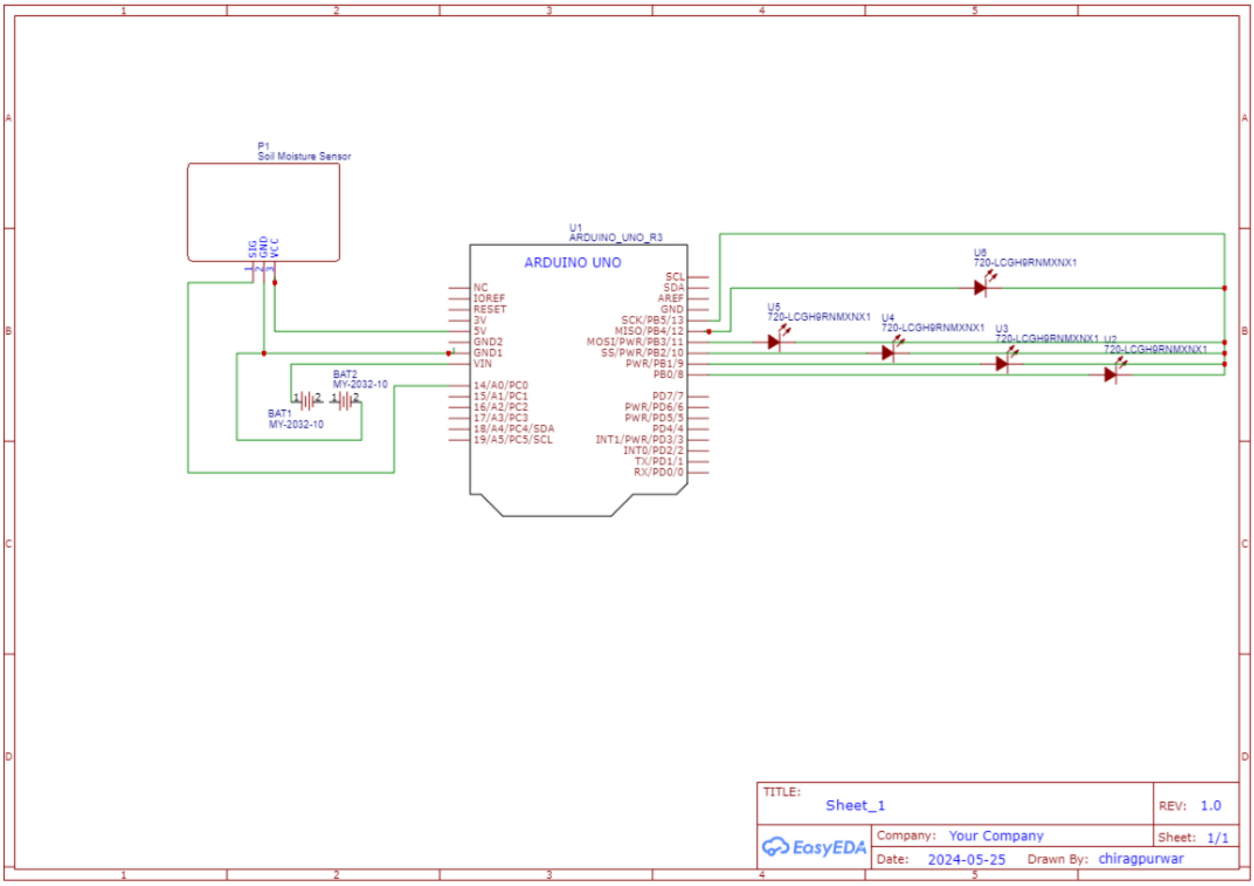

Fig5.5: Irrigation System Connection Diagram

CHAPTER 6

CONCLUSION AND SCOPE FOR IMPROVEMENT

6.1 Conclusion

The development and deployment of the Patrobot represent a significant advancement in integrating security and environmental monitoring within community settings. By combining advanced surveillance technologies with precise plant moisture detection systems, the Patrobot addresses two critical needs of modern urban living: ensuring the safety of residents and promoting sustainable environmental practices.

The Patrobot design leverages a robust and adaptable chassis, reliable power supply options, and sophisticated navigation systems to enable autonomous operation across various terrains. Its security functionalities, powered by high-resolution cameras, infrared sensors, and motion detectors, provide continuous monitoring and real-time alerts, enhancing the overall security infrastructure of the community.

Simultaneously, the integration of soil moisture sensors and environmental monitors ensures that the robot can accurately assess and report the hydration needs of plants, facilitating timely irrigation and contributing to the health and aesthetics of communal green spaces. The real-time data transmission capabilities ensure that both security breaches and environmental conditions are promptly communicated to relevant stakeholders, enabling swift and informed responses.

Field trials have demonstrated the Patrobot's efficacy in maintaining high standards of security while promoting efficient water use and plant care. This multifunctional approach not only maximizes the utility of the robot but also offers a cost-effective solution for community management, reducing the need for separate systems for security and environmental monitoring.

In conclusion, the Patrobot stands out as a valuable asset for modern communities, providing a comprehensive solution that enhances safety, supports sustainable practices, and improves the quality of life for residents. Its successful implementation underscores the potential for robotics to play a transformative role in urban management, paving the way for smarter, safer, and greener communities.

6.2 Future Scope

The Patrobot, with its dual functionality of security patrolling and plant moisture detection, holds significant potential for future advancements and broader applications. Here are several areas where the Patrobot can evolve and expand:

6.2.1 Enhanced AI and Machine Learning Capabilities:

Improved Surveillance: Integrating advanced AI algorithms can enhance object and facial recognition, enabling the Patrobot to identify and differentiate between residents, visitors, and potential intruders more accurately.
Predictive Maintenance: Machine learning can be used to predict and schedule maintenance tasks for the robot itself, ensuring minimal downtime and longer operational life.

6.2.2 Expanded Environmental Monitoring:

Additional Sensors: Incorporating sensors for air quality, temperature, humidity, and light intensity can provide more comprehensive environmental data, aiding in the management of urban green spaces and overall environmental health.
Integration with Smart Irrigation Systems: The data collected by the Patrobot can be integrated with automated irrigation systems to optimize water usage based on real-time soil moisture levels.

6.2.3 Improved Navigation and Autonomy:

Advanced Mapping Technologies: Using LIDAR, SLAM (Simultaneous Localization and Mapping), and more sophisticated GPS systems can enhance the robot's navigation capabilities, allowing it to operate more effectively in complex and dynamic environments.
Obstacle Avoidance: Upgraded sensors and AI can improve the robot's ability to navigate around obstacles and adapt to changes in its environment, increasing its reliability and safety.

6.2.4 Scalability and Adaptability:

Modular Design: Developing a modular hardware and software architecture would allow for easy upgrades and customization based on specific community needs, such as adding new sensors or communication modules.
Inter-Robot Communication: Enabling multiple Patrobots to communicate and coordinate with each other can create a network of robots working collaboratively to cover larger areas and share data more effectively.

6.2.5 Integration with Smart City Infrastructure:

IoT Connectivity: By integrating with the Internet of Things (IoT) frameworks, the Patrobot can become part of a larger smart city ecosystem, sharing data with other smart devices and systems to enhance overall urban management.
Public Safety and Emergency Response: The robot can be programmed to assist in emergency situations, such as directing people to safety during an evacuation or providing real-time data to first responders.

6.2.6 User Interaction and Community Engagement:

User-Friendly Interfaces: Developing more intuitive mobile apps and web interfaces can enhance user interaction with the Patrobot, making it easier for community members to access data and control the robot.
Community Feedback Integration: Incorporating feedback mechanisms where residents can report issues or suggest improvements can help in continuously refining the robot's functionalities.

6.2.7 Sustainable and Renewable Energy Sources:

Advanced Power Management: Implementing more efficient power management systems and exploring renewable energy sources, such as more effective solar charging technologies, can extend the robot's operational time and reduce its environmental footprint.

6.2.8 Expansion to Other Applications:

Agricultural Use: Beyond urban settings, the Patrobot can be adapted for use in agriculture, where it can monitor crop health, soil conditions, and security on farms.
Industrial and Commercial Security: The robot can be employed in industrial and commercial settings for security patrols and environmental monitoring, offering a versatile solution for various sectors.
By pursuing these advancements, the Patrobot can significantly enhance its functionality, adaptability, and value, making it a critical component of future smart community ecosystems. The continuous evolution of the Patrobot promises to contribute to safer, greener, and more efficiently managed living environments.

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APPENDIX

PRICE LISTING OF ALL THE COMPONENTS USED

S.NO.	NAME	UNIT	PRICE
1	TT GEAR with wheels	4	400
2	L 298n motor shield	1	120
3	LED	9	10
4	Camera	1	1299
5	HC 05 Bluetooth	1	260
6	Soil moisture sensor	1	50
7	Relay	1	50
8	Arduino Uno	2	1030
9	Buzzer	1	10
10	Battery	3	180
11	Water pump	1	65
12	Jumper wire	20	20

Patrobot Circuit Netlist

PADS-PCB
PART
BT1 BATTERY-SMD_18650-1S-L77.1-W20.7-1
BT2 BATTERY-SMD_18650-1S-L77.1-W20.7-1
CAM1 IR CAMERA
LED1 P-LCC-2-TOPLED-RG
LED2 P-LCC-2-TOPLED-RG
LED3 P-LCC-2-TOPLED-RG
LED4 P-LCC-2-TOPLED-RG
RLY1 RELAY-TH_SRD-XXVDC-XL-C
SG1 BUZZER-12MM-KIT
U1 UNO_R3;WO ARDUINO UNO
U2 NEW_FOOTPRINT
U3 DIP-16_L19.8-W6.5-P2.54-LS7.6-BL
U4 GEAR MOTOR 3-12 V
U5 GEAR MOTOR 3-12 V
U6 GEAR MOTOR 3-12 V
U7 GEAR MOTOR 3-12 V
U8

NET
SIGNAL BT1_2
BT1.2 BT2.1
SIGNAL U1_25
U1.25 CAM1.3 BT2.2
SIGNAL U1_26
U1.26 BT1.1 CAM1.4
SIGNAL GND
U3.13 SG1.- U2.4 U8.2 LED3.C LED2.C
SIGNAL U1_9
LED3.A U1.9 LED4.A
SIGNAL RLY1_1
U8.1 RLY1.1
SIGNAL U1_8
U1.8 SG1.+
SIGNAL U1_27
RLY1.3 U1.27
SIGNAL U1_10
LED1.A LED2.A U1.10
SIGNAL U1_7
RLY1.2 U1.7

SIGNAL U1_1
U2.3 U1.1
SIGNAL U1_28
U1.28 RLY1.5 U2.5
SIGNAL U1_2
U1.2 U2.2
SIGNAL U1_13
U1.13 U3.2 U3.1
SIGNAL U3_3
U4.2 U3.3
SIGNAL U1_12
U1.12 U3.7
SIGNAL U1_11
U1.11 U3.10
SIGNAL U3_14
U5.2 U3.14
SIGNAL U1_14
U1.14 U3.15
SIGNAL U4_1
U4.1
SIGNAL N102

SIGNAL U3_6
U3.6
SIGNAL U3_11
U3.11
END

Irrigation System Circuit Netlist

PART

BAT1 BATTERY-SMD-MY-2032

BAT2 BATTERY-SMD-MY-2032

P1 SOIL MOISTURE SENSOR

U1 UNO_R3;WO ARDUINO UNO

U2 LED-SMD_SD65-120-LED

U3 LED-SMD_SD65-120-LED

U4 LED-SMD_SD65-120-LED

U5 LED-SMD_SD65-120-LED

U6 LED-SMD_SD65-120-LED

NET

SIGNAL U1_25

U1.25 BAT1.1

SIGNAL U1_26

BAT2.2 U1.26 P1.2

SIGNAL U1_28

U1.28 P1.3

SIGNAL U1_24

P1.1 U1.24

SIGNAL U1_14

U6.1 U2.1 U3.1 U4.1 U5.1 U1.14

SIGNAL U1_13

U6.2 U1.13

SIGNAL U1_9

U1.9 U2.2

SIGNAL U1_10

U1.10 U3.2

SIGNAL U1_11

U1.11 U4.2

SIGNAL U1_12

U1.12 U5.2