DESIGN OF GROUND BASED SURVEILLANCE ROBOT FOR MILITARY AND SECURITY APPLICATIONS

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CERTIFICATE

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ABSTRACT

This project is about building a Snake and humanoid robot. In rapid change with technology a huge development of robots is competing equally with humans. The technology development has brought many changes in the field of manufacturing and research. Initially, the robots were used by humans to make their work easier, but today the robots are developed to replicate humans and substitute the labor in the fields where even human presence is difficult. The development does not only take place in the manufacturing of robots but simultaneously it focuses on control and optimization of the tasks that are done by the robots. The aspects of robots are unlimited in the field of medical, defense, education. The type of application defines the robot's construction and the requirement of systems.

Snake can move in irregular terrain, climb, and even glide in air by some species. They can move by undulating their bodies to exploit roughness in the terrain for locomotion which allows them to adapt in various sorts of situations. Fabricating a snake robot with such activity is a most attractive one. The development of such a robot is motivated by the way that diverse applications might be use in enemy detection, hazardous situations and search and rescue. It uses night vision camera by that we can use this robot in nighttime also.

Both humanoid and snake robots are being developed for various applications, such as search and rescue, industrial automation, and space exploration. While humanoid robots are better suited for tasks that require dexterity and fine motor control, snake robots are better suited for tasks that require flexibility and the ability to navigate through tight spaces.

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CHAPTER – 1

1.1 INTRODUCTION

Snake Robot:

A snake robot is a type of robot that mimics the movements of a snake to move around in different environments, such as in narrow or confined spaces. It is composed of several segments connected through flexible joints, allowing it to twist and turn just like a real snake. Snake robots are commonly used for various applications, such as search and rescue operations, pipeline inspections, and archaeological explorations.

This flexibility makes them well-suited for exploring tight areas and performing intricate operations. They can also be utilized for rescue operations, inspecting dangerous areas, and other activities that require extreme maneuverability. Snake robots use electric motors, pneumatic actuators, and hydraulics as their power sources. They can be controlled either by a person or on their own, with sensors and actuators that help them to avoid obstacles.

Humanoid Robot:

A humanoid robot is a type of robot designed to resemble the human body, with a head, torso, arms, and legs. These robots are often equipped with artificial intelligence and sensors to interact with humans and perform various tasks. Humanoid robots are used for a wide range of applications, including research and development, healthcare, education, and entertainment. Their human-like appearance and behavior make them suitable for social interactions with people, such as in customer service or companionship.

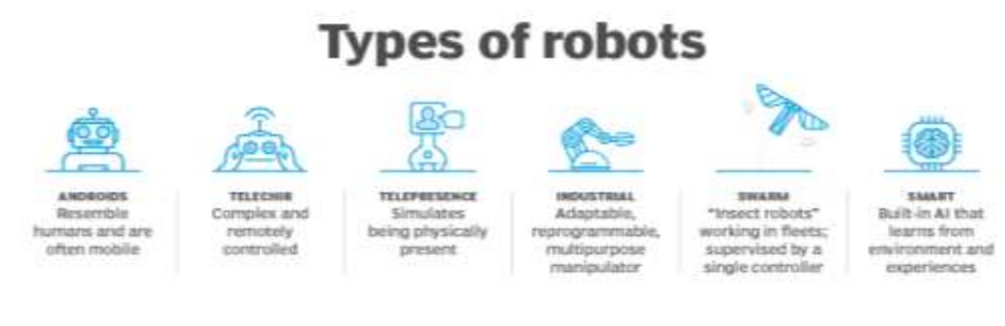


Figure 1.1: Types of Robots

Humanoid robots have been a topic of fascination for many years. For a long time, humanoid robots have been a subject of great interest. Their design, both in terms of their looks and behaviour, is such that they seem to be almost lifelike. Developers are creating automated systems to carry out tasks that are too risky or complicated for humans, as well as to offer support and help to those who require it.

Generation	**Timeframe**	**Characteristics**
First Generation	1970s – 1980s	Simple, single-function robots with limited mobility and sensing capabilities. Often used for research purposes.
Second Generation	1990s – 2000s	More advanced robots with improved mobility, sensing, and control capabilities. Often used for entertainment and education purposes,
Third Generation	2010s – 2020s	Highly advanced robots with advanced sensing and control capabilities, as well as more realistic appearance and movement. Often used for research, industry, and service applications.
Fourth Generation	2020s – 2030s	Robots that can learn and adapt to their environment, using machine learning and other Al techniques to improve their performance. More sophisticated sensing and control systems.
Fifth Generation	Future	Robots with even greater intelligence, adaptability, and versatility. May have more advanced materials and manufacturing techniques, allowing for more complex and flexible designs. Expected to have a wide range of applications in various industries, from healthcare to space exploration.

Table 1: Different generations of humanoid robots

1.2 AIM:

- To execute specific tasks with little or no human intervention and with speed and precision.
- To resemble and engineered to imitate authentic human interactions and movements.

- To act like a spy and for search and rescue operation.

1.3 OBJECTIVES:

- To build a humanoid robot and a snake robot to assist humans in a highly possible way.
- To record audio and video and transmit it and to replicate human beings**.**

1.4 PROBLEM STATEMENT

SNAKE ROBOT

Design, develop and control a snake-like robot that can traverse through challenging terrains and confined spaces, while maintaining stability and efficiency in its locomotion. The robot should be able to adapt to different environments, avoid obstacles, and potentially perform tasks such as inspection, search and rescue, or exploration. The challenge is to overcome the inherent difficulties of mimicking the complex and versatile motion of a biological snake, while ensuring the robot's mechanical and electronic components are robust, reliable, and energy efficient.

HUMANOID ROBOT

The development of humanoid robots presents many challenges that need to be addressed. One of the main problems is creating a robot that can effectively interact with the environment and humans. The robot needs to be able to walk and move in a manner that is natural and fluid, and it needs to be able to use its hands and arms to manipulate objects and perform tasks. Additionally, the robot needs to have advanced perception and sensing capabilities to perceive the environment and make decisions based on that perception.

Another challenge in creating humanoid robots is ensuring safety, both for the robot itself and for the humans it interacts with. The robot needs to be able to recognize potential hazards and avoid them, and it needs to be designed in such a way that it does not pose a danger to humans in its vicinity. Furthermore, the robot needs to be able to operate autonomously and make decisions without human intervention.

A further challenge is designing a robot that can operate in a wide range of environments. The robot needs to be able to navigate rough terrain, climb stairs, and perform other tasks in a variety of conditions.

Overall, the problem statement for humanoid robots involves creating a robot that can interact with its environment and humans in a safe and effective manner and can operate autonomously in a wide range of environments.

1.5 PROJECT SCOPE

The project scope for a snake robot and a humanoid robot would be quite different due to their distinct design and functionality. Here are some possible scopes for each project:

Snake Robot:

- Design and build a snake robot capable of slithering through tight spaces and climbing obstacles.
- Develop a control system to enable the snake robot to move in different directions, adjust speed and turn angles.
- Incorporate sensors and cameras to allow the robot to sense its environment and provide feedback to the control system.
- Explore potential applications for the snake robot, such as search and rescue missions, inspection of hard-to-reach areas, or medical procedures.
- Test the snake robot's capabilities and refine the design and control system, as necessary.

Humanoid Robot:

- Design and build a humanoid robot that can walk, balance, and interact with objects using its arms and hands.

- Develop a control system to enable the robot to move in different directions, adjust speed and turn angles, and perform tasks such as picking up and manipulating objects.
- Incorporate sensors and cameras to allow the robot to sense its environment and provide feedback to the control system.
- Explore potential applications for the humanoid robot, such as industrial manufacturing, healthcare, or personal assistance.
- Test the humanoid robot's capabilities, refine the design, and control system as necessary, with a focus on ensuring safe and reliable operation.

1.6 THESIS ORGANIZATION

Everything needed for this research is contained in this thesis. This report's Chapter 1 discusses project start and includes details on project priorities, scopes, and restrictions. The article's focus in Chapter 2 is on earlier studies that served as references for this endeavor. The technique of this project is covered in Chapter 3. The structure and purpose of the project, as well as all the details on the hardware and software required to create the project's outcomes, are covered in detail in each chapter. The base design and the robot's control systems are covered in Chapter 4. The overall conclusion, benefits, and drawbacks of this project are given in Chapter 5. This snake and the humanoid robot can both be employed as spying agents and for inspection, and the final chapter discusses the sources used throughout the project.

1.7 BACKGROUND

Snake Robot:

A snake robot is a type of robotic mechanism that imitates the movement of a snake. It consists of a series of connected segments that can move in a flexible and serpentine manner. These segments are typically controlled by motors, sensors, and algorithms that allow the snake robot to slither, climb, and even swim in a manner that resembles a real snake.

Snake robots have a wide range of potential applications, including search and rescue operations, exploration of difficult-to-reach environments, inspection of pipes and other narrow spaces, and even medical procedures. Their flexibility and ability to manoeuvre in tight spaces make them ideal for tasks that are difficult or impossible for traditional robots to perform.

Humanoid Robot:

A humanoid robot is a type of robot that resembles a human in shape and movement. These robots typically have two arms, two legs, and a head, and they are designed to interact with humans in a way that is natural and intuitive. They may be designed to perform a wide range of tasks, from simple household chores to complex manufacturing processes.

Humanoid robots are typically equipped with sensors, cameras, and other technologies that allow them to perceive and interpret their environment. They may also be programmed with artificial intelligence (AI) algorithms that enable them to learn from their experiences and adapt to changing circumstances. Some of the potential applications for humanoid robots include assisting people with disabilities, performing dangerous tasks in hazardous environments, and serving as companions for the elderly or those who live alone.

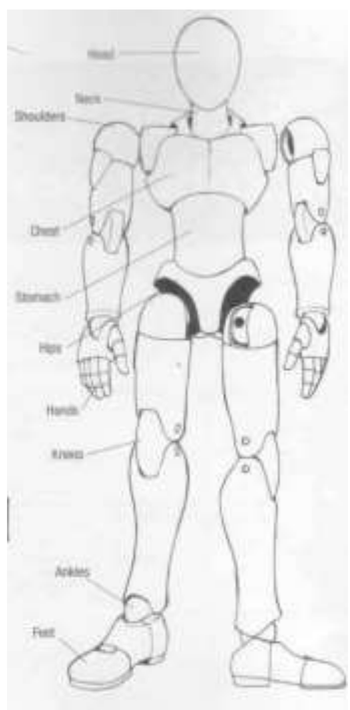


Fig1.2 Humanoid robot

CHAPTER – 2

LITERATURE SURVEY

2.1 "Design and Development of a Snake-Robot for Pipeline Inspection" 2019 IEEE Student Conference on Research and Development (SCOReD) October 15-17, 2019, Seri Iskandar, Perak, Malaysia.

In this paper, Robots are machines which performs mechanical and repetitive tasks with little to no interaction of human. Robots are designed to remove human factor from dangerous workplaces and to act in an inaccessible environment. When it comes to pipeline inspection, snake robots can easily access wide range of pipelines that includes pipes in the oil industries (thick diameter) to the sewer pipers (small diameter). This project focuses on the design, development and working of a snake robot (Slyder) which is inspired from real snakes. The snake robot consists of compact links (brackets) which allows Slyder to maintain smooth movements. Slyder is designed to inspect the pipelines and to check for damages or blockages. The most effective movement pattern such as crawling and slithering are implemented on this snake robot. Servo motors, wireless cam,

Arduino Nano and remote control are some of the components that were used to develop this prototype. To make the snake robot function like a real snake, it is constructed using many brackets. To cut down the cost, these brackets are designed on Fusion 360 and 3D printed using PLA material. Each bracket has a servo motor that enables the robot to have various degrees of freedom for different gaits. The modular design gives the robot flexibility to reach different territories and ability to move around in complex environments.

2.2 "Design, Implementation, and Controlling of a Humanoid Robot", 2020 International Conference on Computational Performance Evaluation (ComPE), North-Eastern Hill University, Shillong, Meghalaya, India. July 2–4, 2020

In this paper, Abstract—In rapid change with technology a huge development of robots is competing equally with humans. The technology development has brought many changes in the field of manufacturing and research. Initially, the robots were used by humans to make their work easier, but today the robots are developed to replicate humans and substitute the labor in the fields where even human presence is difficult. The development does not only take place in the manufacturing of robots but simultaneously it focuses on control and optimization of the tasks that are done by the robots. The aspects of robots are unlimited in the field of medical, defense, education. The type of application defines the robot's construction and the requirement of systems. This paper covers background of the robotics such as variety of robots, kinematics of robots, localization and mapping scenario, the trajectory of the robot's path. Also, the control systems used in robots like actuators, sensors and processing of the actuators, robots learning has been presented. The experiment with humanoid robots for civilians has designed through programming and controlled by microcontrollers for analyzing the results of degrees of freedom and positions of robots.

2.3 "Gesture Based Humanoid Robot Control Using Wireless Transceiver Feedback System". Rachana Gulhane, Prof. Nivedita Pande,2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS)

In this paper, we can see a lot of human-machine interaction. Due to new technologies human-machines gap is reduced. Gesture plays significant role to fill this gap amongst humans and machines. With advanced technology, robots now play substantial role in our daily lives. Robots are useful in industrial mechanization and monitoring system. With increase in new technology use of robots in different application is also increased. Working robots will help the people to makes their work more effortless and faster. Therefore, Human-Robot interaction becomes a crucial issue for research. This project explores the interaction of humanoid robot with gesture defined by the user. To fit robot in human life, robots should interpret messages from human. In this project the humanoid robot will be controlled wirelessly based on ZigBee technology.

2.4 “Optimal Bumping Avoidance for Snake-like Robot's Serpentine Movement Controlling”. Department of Information Engineering, Faculty of Engineering, King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand.

This paper shows the development of controlling system of snake robot's movement to make the Serpentine movement more effective when it goes into narrow path. Snake robot consists of many servo motors serially linked to each other and has its length like a medium-sized snake's. This controlling system measures the side lengths, which are inputs, from the sensors attached on the head of the robot. The robot then processes the inputs and uses them to control the width of crawling to perform the crawling at the best speed on limited path. The ways to control it to move forward, backward, left, right, and algorithms used to control are already explained. The result of this experiment, which is an achievement of movement in different locations, shows that it works effectively.

2.5 “Humanoid Robot HRP-5P: An Electrically Actuated Humanoid Robot with High-Power and Wide-Range Joints” Kenji Kaneko, Hiroshi Kaminaga, IEEE robotics and automation letters, vol. 4, no. 2, April 2019.

This letter introduces the humanoid robot HRP-5P, which stands for Humanoid Robotics Platform–5 Prototype. We have been developing the HRP series humanoid robots since 2000, and HRP-5P is the latest version of the HRP series as of 2018. It is developed as a prototype for our next generation humanoid robotics platform, aiming to realize the use of practical humanoid robots in place of humans within large-scale assembly industries such as construction sites, aircraft facilities, and shipyards. To realize it, electrically actuated high-power joints with wide movable range have been newly designed. Also, the arm configuration has also been redesigned to improve the physical ability of working on actual sites. The mechanism and the electrical systems are presented with its basic specification in this letter.

2.6 Summary

The reference work mentioned above shows various papers where authors created numerous bots with various ideologies. The planner uses realizer actions to find data to back up the hypothesis. Perception modules report concrete things at execution time. Re-planning makes use of the concrete item when the existence and relationships of the hypothetical object are realized. In the absence of an object, the robot's diagnostic criteria kick in to try and determine which hypotheses were false.

I. In the journal 1 It is intended to be transported through various sorts of pipelines. used various RF-controlled servo motors with a 15-minute runtime, as well as a Wi-Fi camera to view the environment and the Arduino UNO as the main component.

II. In journal 2 It has 15 degrees of freedom (15 DOF) and uses 15 servo motors with Arduino to imitate human facial expressions on an LCD display. They also utilized a Raspberry Pi in conjunction with a camera to allow the robot to interact with people.

III. In the journal 3 the robot is completely controlled by using gesture and the controlling system is ATMega32 with a complete 3-axis accelerometer where it measures the range and with the ZigBee and there would be a LCD and the software used is Sinaprog to upload the program.

IV. In journal 4 It is a automated robot where the sensors are attached at head and is more effective when it goes into narrow path it uses detection switches and the disadvantage is the robot has to hit at least one time in order to test the function.

V. In journal 5 the bots name stands for Humanoid Robotics Platform-5 and is a practical human robot used in construction sites within large-scale assembly industries it is the bigger robot with the height of a human and used hydraulic actuators for designing

CHAPTER – 3

METHODOLGY

3.1 Methodology

3.1.1 Problem identification

Snake Robot:

One of the main problems with snake robots is their limited mobility in certain environments. While they are well-suited for slithering across flat surfaces, they may struggle with climbing over obstacles or traversing rough terrain. Additionally, snake robots may require a significant amount of energy to operate, which can limit their battery life and overall endurance.

Another problem with snake robots is their lack of stability, particularly when navigating tight spaces or uneven terrain. Without a stable base to support them, snake robots may struggle to maintain their balance and may be prone to tipping over.

1. Navigation and control: One of the primary challenges for a snake robot is navigation and control. Because the robot lacks legs or wheels, it must move by undulating its body in a wave-like motion, which can be difficult to control.

2. Obstacle detection and avoidance: Another challenge for a snake robot is detecting and avoiding obstacles. The robot's long and flexible body can make it difficult to sense its surroundings, especially in tight spaces.

3. Power supply and endurance: The snake robot's complex motion requires a significant amount of energy, and it may be difficult to power the robot for extended periods without recharging or replacing batteries.

4. Payload capacity: The snake robot's slender design may limit its payload capacity, making it difficult to carry heavy equipment or sensors.

Humanoid Robot:

One of the main challenges with humanoid robots is their complexity. Humanoid robots must be able to move and operate in a similar manner to humans, which requires a high degree of engineering and programming expertise. This complexity can also make it difficult to repair or maintain humanoid robots, which may require specialized knowledge or equipment.

Another problem with humanoid robots is their limited dexterity. While they may be able to perform basic tasks such as grasping objects, they may struggle with more complex actions that require fine motor skills. This limitation can be particularly challenging in environments where precise movements are required, such as in manufacturing or medical settings.

Humanoid robots may also be limited by their physical design. For example, they may struggle with balance and stability when walking on uneven terrain and may be prone to falling over. Additionally, their size and weight can make them difficult to maneuver in tight spaces or narrow passageways.

1. Balancing and stability: One of the primary challenges for a humanoid robot is maintaining balance and stability. Because the robot has a bipedal design, it must be able to maintain its centre of gravity and adjust its movements to prevent falls.

2. Human-like motion: To perform tasks in human environments, the robot must have human-like motion and dexterity. This requires advanced control algorithms and complex mechanical designs.

3. Power supply and endurance: Like the snake robot, the humanoid robot requires a significant amount of power to perform its complex movements. It may be difficult to power the robot for extended periods without recharging or replacing batteries.

4. Interaction with human environments: The humanoid robot must be able to interact with human environments, including opening doors, using tools, and navigating cluttered spaces. This requires advanced sensors and perception algorithms.

3.1.2 Investigation or fact

1. Real-world applications: Snake robots have been used in various real-world applications, such as search and rescue missions, inspection of pipelines and other narrow spaces, and even in medical procedures such as endoscopies.

2. Inspiration from nature: The design of snake robots is inspired by the natural movement of snakes. The robots use a series of linked segments to simulate the undulating motion of a snake, allowing them to move through tight spaces and over obstacles.

3. Research challenges: Researchers continue to face challenges in developing snake robots with greater mobility, improved sensing capabilities, and increased payload capacity.

4. Advancements in technology: Advances in technology, such as the development of new materials and more powerful actuators, have enabled the creation of increasingly sophisticated snake robots.

Humanoid robot

1. Advancements in technology: Advances in robotics technology have led to the development of humanoid robots that can perform a wide range of tasks. These robots use advanced sensors and control algorithms to achieve human-like motion and dexterity.

2. Humanoid robots in the workplace: Humanoid robots are being used in various workplace environments, such as factories, hospitals, and warehouses, to perform tasks that are difficult or dangerous for humans.

3. Social acceptance: The development of humanoid robots has raised concerns about their impact on society, including their potential to take over jobs traditionally performed by humans. There is also a question of social acceptance of robots that closely resemble humans.

4. Ethical considerations: The development of humanoid robots raises ethical considerations, such as how to ensure that robots are designed and programmed to act ethically and not cause harm to humans. There are also questions about the ethical implications of creating machines that can mimic human behaviour and emotions.

3.1.3 Analysis

Analysis for snake robot

Snake robots are a promising technology with a wide range of potential applications, particularly in situations where mobility is limited. Their ability to move through tight spaces and over obstacles makes them ideal for tasks such as search and rescue missions, inspection of pipelines and other narrow spaces, and even in medical procedures such as endoscopies.

However, snake robots also face several challenges. One of the primary challenges is navigation and control, as the undulating motion of the robot can be difficult to control. Additionally, detecting and avoiding obstacles can be challenging, particularly in tight spaces. Power supply and endurance are also issues, as the robot's complex motion requires a significant amount of energy, and it may be difficult to power the robot for extended periods without recharging or replacing batteries. Finally, the slender design of the robot may limit its payload capacity, making it difficult to carry heavy equipment or sensors.

Despite these challenges, advances in technology have enabled the creation of increasingly sophisticated snake robots. As such, they have the potential to become an important tool in a wide range of industries and applications.

Approach	**Description**	**Advantages**	**Challenges**	**Applications**
Rectilinear	Uses linear actuators to create a snake-like motion	Simple design, easy to control	Limited mobility. can get stuck in tight spaces	Inspection, search and rescue
Lateral undulation	Uses lateral movement to create a wave-like motion	Efficient movement, can traverse rough terrain	Limited ability to turn, requires precise control	Exploration, military

Sidewinding	Uses a combination of lateral and vertical movements to move in a sidewinding motion	Efficient movement can climb inclines.	Complex control system, requires energy efficient actuation	Exploration, military
Concertina	Uses accordion-like motion to move forward and contract to fit into tight spaces.	Can navigate through narrow passages	Slow movement Limited mobility	Inspection, search and rescue
Hybrid	Combines multiple approaches to increase versatility and mobility	Can adapt to a variety of environments and challenges	Slow movement, Limited mobility	Research, industry, military

Table 3.1 : Some common approaches to designing and controlling snake robots.

Analysis for humanoid robot

Humanoid robots represent a significant advancement in robotics technology. They can perform a wide range of tasks in a variety of workplace environments, from factories to hospitals and warehouses. They use advanced sensors and control algorithms to achieve human-like motion and dexterity, making them ideal for tasks that are difficult or dangerous for humans.

However, humanoid robots also face several challenges. One of the primary challenges is balancing and stability, as the bipedal design of the robot requires it to maintain its centre of gravity and adjust its movements to prevent falls. Achieving human-like motion and dexterity can also be challenging, requiring advanced control algorithms and complex mechanical designs. Power supply and endurance are also issues, as the robot requires a significant amount of energy to perform its complex movements, and it may be difficult to power the robot for extended periods without recharging or replacing batteries. Finally, interacting with human environments can be challenging, requiring advanced sensors and perception algorithms.

Despite these challenges, humanoid robots are increasingly being used in a variety of workplace environments, and their potential applications continue to expand. However, there are also concerns about the ethical implications of creating machines that can mimic human behaviour and emotions and ensuring that robots are designed and programmed to act ethically and not cause harm to humans.

Type	**Description**	**Advantages**	**Challenges**	**Applications**
Bipedal	Resembles the human body with two legs and often two arms	Can navigate uneven terrain and climb stairs	Requires complex control systems for balance and stability	Research, education, entertainment
Quadrupedal	Resembles the human body with four legs and often a torso	Can move efficiently and navigate rough terrain	Requires complex control systems for balance and stability	Research, industry, agriculture
Android	A robot that is designed to resemble a human in appearance and behavior	Can interact with humans more easily due to human-like appearance and gestures	Requires advanced perception and control systems for realistic behavior	Customer service, education, entertainment
Cyborg	A robot that is designed to enhance or supplement human abilities	Can improve human abilities or assist with disabilities	Requires compatibility with human body and advanced control systems	Medical, research

Avatar	A robot that is designed to represent a remote user in a distant location	Can enable remote interaction and communication in real time	Requires advanced perception and control systems for realistic representation	Telepresence, education, entertainment
Social	A robot that is designed to interact with humans in a social or emotional capacity	Requires advanced perception and control systems for natural interaction	Can provide companionship or emotional support	Healthcare, education, entertainment

Table 2.2: Some common types of humanoid robots' table

3.1.4 Design

Design for snake robot:

Snake robots typically have a slender, flexible body consisting of multiple linked segments, which allows them to move through tight spaces and over obstacles. The robot's motion is achieved by the undulation of these segments, which is controlled by a series of actuators and sensors.

The design of a snake robot typically includes the following components:

- Body: The body of the robot is typically made up of multiple linked segments, which allow for flexible motion. The segments are connected by joints, which allow the robot to move in different directions.
- Actuators: Actuators, such as motors or hydraulic systems, are used to control the movement of the robot's body segments. These actuators work in concert to create the undulating motion that allows the robot to move.
- Sensors: Sensors, such as cameras or infrared sensors, are used to detect obstacles and other environmental factors that may affect the robot's movement. These sensors allow the robot to adjust its motion to avoid obstacles and navigate through tight spaces.
- Power supply: The robot's power supply typically consists of batteries or other rechargeable energy sources, which provide the energy necessary to power the robot's actuators and sensors.

Design for humanoid robot:

Humanoid robots are designed to resemble the human body in form and function. They typically have a bipedal body structure, with arms and legs that are capable of a wide range of motion.

The design of a humanoid robot typically includes the following components:

- Body: The body of the robot is typically designed to resemble the human body, with a head, torso, arms, and legs. The body is typically made of lightweight materials, such as carbon fiber or aluminium, to reduce weight and increase mobility.
- Actuators: Actuators, such as motors or hydraulic systems, are used to control the movement of the robot's limbs. These actuators work in concert to create human-like motion, including walking, running, and grasping.
- Sensors: Sensors, such as cameras, force sensors, and position sensors, are used to detect environmental factors and human interactions. These sensors allow the robot to adjust its motion and respond to changes in its environment.
- Power supply: The robot's power supply typically consists of batteries or other rechargeable energy sources, which provide the energy necessary to power the robot's actuators and sensors.
- Overall, the design of a humanoid robot is focused on achieving human-like motion and dexterity, while the design of a snake robot is focused on achieving flexibility and mobility in tight spaces.

3.2 CONCEPT

The concept of a snake robot involves creating a robot that can move like a snake, with a flexible, undulating body that allows it to navigate through tight spaces and over obstacles. The robot's body is typically made up of multiple linked segments, which are controlled by a series of actuators and sensors. The snake robot concept has potential applications in areas such as search and rescue, where the robot could be used to search for survivors in areas that are difficult or dangerous for humans to access.

The concept of a humanoid robot involves creating a robot that can resemble the human body in form and function, with a bipedal structure, arms, and legs that are capable of human-like motion and dexterity. The robot's body is typically made of lightweight materials, and its motion is controlled by a series of actuators and sensors. The humanoid robot concept has potential applications in areas such as manufacturing, where the robot could perform tasks that are difficult or dangerous for humans to perform, or in healthcare, where the robot could assist with patient care.

Overall, the concepts of snake robots and humanoid robots both involve creating robots that can perform tasks that are difficult or dangerous for humans to perform, either due to their physical limitations or the hazardous nature of the environment. These concepts represent exciting opportunities for robotics technology to advance and have a significant impact on a variety of industries and applications.

3.3 ALGORITHM

Algorithm for Snake Robot:

The algorithm for a snake robot typically involves the following steps:

[1] Initialize the robot's position and orientation.

[2] Use the robot's sensors to detect obstacles and other environmental factors.

[3] Determine the desired direction of motion based on the sensor data.

[4] Activate the robot's actuators to create the undulating motion required to move the robot in the desired direction.

[5] Repeat steps 2-4 until the robot reaches its target destination or encounters an obstacle that it cannot navigate around.

[6] If the robot encounters an obstacle that it cannot navigate around, use the sensors to detect the obstacle's size and shape, and adjust the robot's motion to navigate around it if possible.

[7] If the robot cannot navigate around the obstacle, stop the robot, and await further instructions.

Algorithm for Humanoid Robot:

[1] Define the task: to carry out a particular function, or group of functions, that call for the application of cutting-edge technology, artificial intelligence, and human-like traits like mobility, perception, and communication.

[2] Gather data: Gather information about the assignment. This might contain details about the surrounding area, the things involved, and any pertinent safety concerns.
Develop a control system:

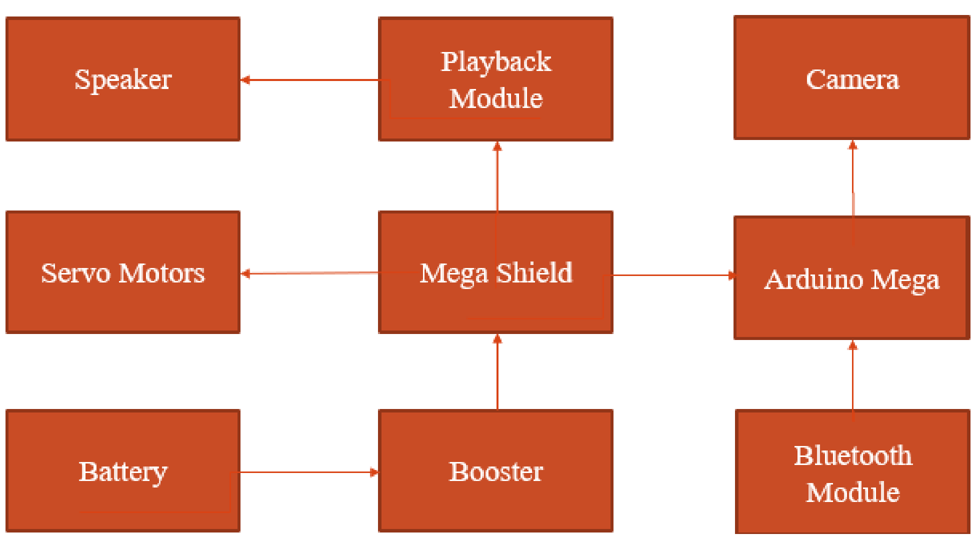
[3] Using path planning techniques, determine the robot's route to the desired position where the object will be placed.

[4] Test and refine: Perform functional testing, performance evaluations, user testing, algorithm refinement, and other types of testing. carry out safety evaluations and deploy.

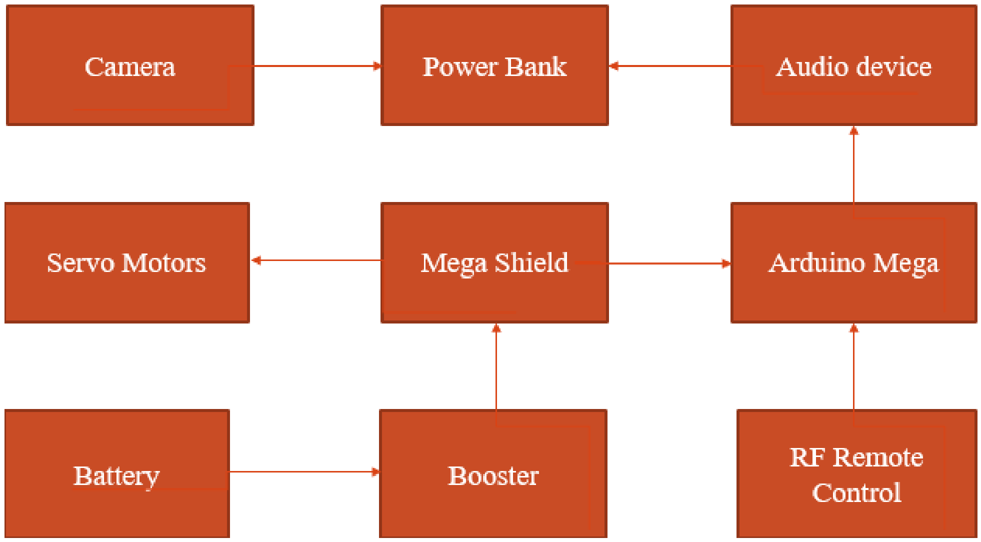
[5] Continuously improve: Keep track of the robot's performance and tweak the algorithm as necessary to enhance it over time.

3.4 BLOCK DIAGRAM

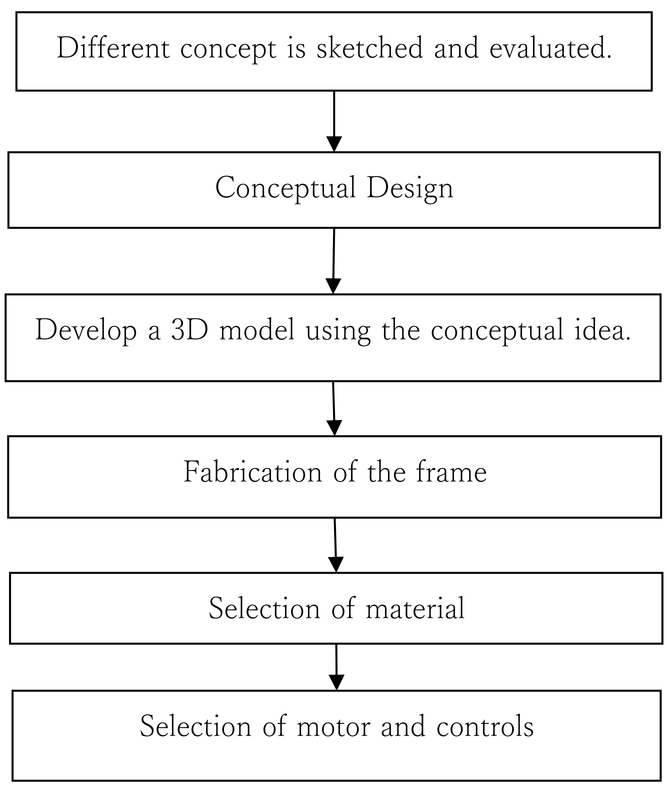
1. SNAKE ROBOT



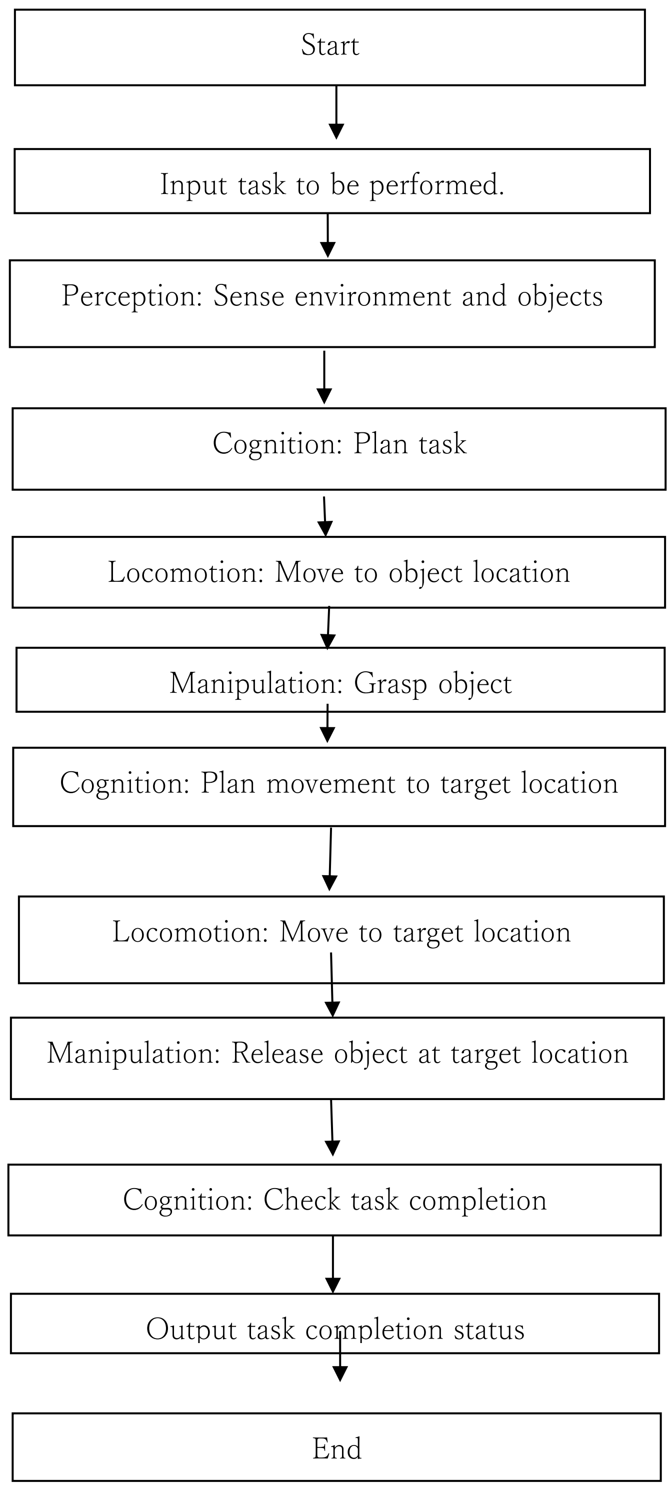
2. HUMANOID ROBOT



3.5 FLOWCHART



Humanoid robot



3.6 HARDWARE SPECIFICATIONS:

- Servo Motors [Big and Small]
- Robot Chassis
- DC-DC/Boost Converter
- Camera
- Arduino Mega
- Arduino Nano
- APR33A3 Recorder/Playback Module
- Speaker
- OLED Display Module 4 Pin
- Arduino mega shield
- Arduino nano shield
- Battery
- Bluetooth Module
- RF receiver and transmitter

SERVO MOTORS:

Figure 3.1: Servo motors

A servo motor is a type of motor that is commonly used in robotics and other applications where precise control of position and speed is required. Unlike a regular DC motor, a servo motor has a built-in feedback mechanism that allows it to accurately maintain its position and speed.

The basic components of a servo motor include a DC motor, a gear train, a control circuit, and a feedback mechanism. The motor is typically a brushed or brush-less DC motor, which provides the rotary motion. The gear train is used to reduce the speed and increase the torque of the motor, allowing it to deliver high levels of torque at low speeds. The control circuit is responsible for interpreting the input signals and generating the appropriate output signals to the motor. The feedback mechanism is usually a potentiometer or an encoder, which provides information about the current position and speed of the motor.

The operation of a servo motor involves sending a control signal to the motor, which determines the desired position and speed of the motor. The control signal is typically a pulse width modulated (PWM) signal, which consists of a series of pulses with varying widths. The width of the pulse corresponds to the desired position of the motor, while the frequency of the pulses corresponds to the desired speed. The control circuit then compares the position of the motor as measured by the feedback mechanism to the desired position and adjusts the output signal to the motor to bring it to the correct position.

One of the key advantages of servo motors is their ability to provide precise control over position and speed. This makes them well-suited for use in applications such as robotics, where precise movement is critical. Servo motors are also relatively small and lightweight, making them easy to integrate into a wide range of systems.

There are several types of servo motors available, including analog, digital, and continuous rotation servos. Analog servos are the most common type and are typically used in hobbyist and educational applications. Digital servos provide more precise control and faster response times, making them well-suited for more demanding applications. Continuous rotation servos are designed to rotate continuously in either direction, making them useful for applications such as wheeled robots and model vehicles.

In summary, servo motors are a type of motor that provide precise control over position and speed. They are commonly used in robotics and other applications where precise movement is critical. The basic components of a servo motor include a DC motor, a gear train, a control circuit, and a feedback mechanism. There are several types of servo motors available, including analog, digital, and continuous rotation servos.

ROBOT CHASSIS

Figure 3.2 Robot chassis

A humanoid robot chassis typically refers to the physical frame or structure of a robot that is designed to mimic human-like movements and behaviour. The chassis of a humanoid robot can be made from a variety of materials such as metal, plastic, or carbon fiber, and can be constructed using different manufacturing techniques like 3D printing, CNC machining, or injection moulding.

A basic humanoid robot chassis typically consists of a torso, a head, two arms, and two legs. The joints in these body parts allow the robot to move and perform tasks similar to those of a human. The chassis can also include various sensors, actuators, and motors that enable the robot to sense its environment, process information, and perform complex movements. When designing a humanoid robot chassis, it is important to consider factors such as weight, durability, and ease of assembly. The chassis should be sturdy enough to support the weight of the robot and withstand wear and tear from repeated use. It should also be lightweight enough to allow for efficient movement and maneuverability.

There are many resources available online for building a basic humanoid robot chassis, including tutorials, schematics, and CAD files. Some popular open-source platforms for building humanoid robots include ROS (Robot Operating System), Arduino, and Raspberry Pi.

DC-DC/BOOST CONVERTER

Figure 3.3: Dc-Dc booster converter

A DC-DC boost converter is an electronic circuit that is used to increase the voltage level of a DC power source to a higher voltage level. It is also known as a step-up converter, since it steps up the voltage level of the input source. A boost converter is a type of DC-DC converter that can be used to power devices that require a higher voltage than the input source can provide.

The basic components of a DC-DC boost converter include an inductor, a switching transistor, a diode, and a capacitor. The input voltage is applied to the inductor, which is then switched on and off at a high frequency by the switching transistor. When the transistor is switched on, the current flows through the inductor, storing energy in its magnetic field. When the transistor is switched off, the energy stored in the inductor is released, causing the voltage across the inductor to rise. This increased voltage is then fed through the diode and the capacitor, resulting in a higher output voltage.

The output voltage of a boost converter can be controlled by adjusting the duty cycle of the switching transistor. A higher duty cycle will result in a higher output voltage, while a lower duty cycle will result in a lower output voltage. The output voltage can also be regulated by using a feedback mechanism, such as a voltage divider and an op-amp, which compares the output voltage to a reference voltage and adjusts the duty cycle accordingly. Some of the key advantages of using a DC-DC boost converter include higher efficiency, smaller size, and lower cost compared to other voltage conversion methods. Boost converters are commonly used in a wide range of applications, such as battery-powered devices, LED lighting, and renewable energy systems.

In summary, a DC-DC boost converter is an electronic circuit that is used to increase the voltage level of a DC power source to a higher voltage level. It works by storing energy in an inductor and releasing it to create a higher output voltage. Boost converters are widely used in many applications due to their high efficiency, compact size, and low cost.

CAMERA ESP 32

Figure 3.4: ESP 32 camera

The ESP32 is a powerful and versatile micro-controller chip developed by Espressif Systems, a Chinese semiconductor company. It is designed for low-power, high-performance applications such as Internet of Things (IoT) devices, wearable electronics, and robotics.

The ESP32 chip features two 32-bit Xtensa LX6 CPU cores that can be clocked up to 240 MHz. It also has many peripherals, including 34 GPIO pins, two I2C interfaces, two SPI interfaces, two UART interfaces, 10 capacitive touch sensors, and an analog-to-digital converter (ADC). The chip also has built-in Wi-Fi and Bluetooth connectivity, making it an excellent choice for IoT applications.

The ESP32 is a powerful, low-cost, and versatile Wi-Fi and Bluetooth enabled micro-controller designed by Espressif Systems. It is based on a dual-core 32-bit Xtensa LX6 CPU with clock speeds of up to 240 MHz and includes built-in Wi-Fi, Bluetooth, and a host of peripheral interfaces, making it suitable for a wide range of applications such as IoT devices, home automation systems, industrial control systems, and wearable s.

The key features of the ESP32 include:

- Dual-core CPU: The ESP32 has a dual-core 32-bit Xtensa LX6 CPU with clock speeds of up to 240 MHz, which allows for efficient multitasking and processing of data.
- Wi-Fi and Bluetooth: The ESP32 includes built-in Wi-Fi and Bluetooth capabilities, with support for Wi-Fi 802.11 b/g/n, Bluetooth v4.2 BR/EDR, and Bluetooth Low Energy (BLE).
- Memory: The ESP32 has 520 KB SRAM and 4 MB Flash memory, which provides sufficient space for storing program code and data.
- Peripherals: The ESP32 includes a wide range of peripherals such as SPI, I2C, UART, ADC, DAC, PWM, and many more, making it suitable for interfacing with a variety of sensors and other devices.
- Security: The ESP32 includes hardware-based security features such as secure boot, flash encryption, and secure storage, which helps protect the device from external threats.
- Power management: The ESP32 includes several power management features such as a deep sleep mode and a low-power mode, which allows for efficient power consumption and longer battery life.

The ESP32 can be programmed using the Arduino IDE or using the ESP-IDF (Espressif IoT Development Framework), which provides a more comprehensive set of libraries and tools for developing IoT applications. The ESP32 can also be used with other programming languages such as Micro-Python and Lua.

Overall, the ESP32 is a powerful and versatile micro-controller that is ideal for a wide range of IoT and embedded applications. Its low cost, built-in Wi-Fi and Bluetooth, and extensive peripheral interfaces make it an attractive option for hobbyists, makers, and professional developers alike.

RF CAMERA

Figure 3.5: RF Camera

RF camera stands for "Rangefinder camera", which is a type of camera that uses a rangefinder mechanism for focusing. Unlike a single-lens reflex (SLR) camera, which uses a mirror and prism system to show the photographer an exact view of the scene through the lens, a rangefinder camera has a separate viewfinder window and a rangefinder mechanism that uses two slightly different views of the scene to determine focus.

In an RF camera, the rangefinder mechanism is typically located on the top of the camera body and consists of a split-image rangefinder and a microprism collar. When the photographer looks through the viewfinder, they see two slightly offset images of the same scene. By adjusting the focus until the images are aligned, the photographer can determine the correct focus distance.

RF cameras are popular among street photographers and photojournalists because they are generally smaller, quieter, and less obtrusive than SLR cameras. However, they do require some skill to use effectively, as the separate viewfinder and rangefinder can take some getting used to, especially when trying to focus quickly on fast-moving situations.

An RF camera is a type of camera that uses radio frequency (RF) signals to transmit images wirelessly. Here is some detailed information about RF cameras:

How it works: RF cameras capture images using a lens and image sensor, just like traditional cameras. However, instead of saving the images to a memory card, the camera sends the images wirelessly to a receiver or a computer using radio frequency signals.

1. Transmission range: The transmission range of an RF camera can vary depending on the environment and the model, but it typically ranges from a few hundred feet to several miles.
2. Applications: RF cameras are commonly used in surveillance systems, wildlife monitoring, and sports photography, among other applications. They are particularly useful in situations where running cables or wires would be difficult or impossible.
3. Advantages: RF cameras offer several advantages over traditional wired cameras. They are easier to install, more flexible in terms of placement, and can transmit images over longer distances. They are also less susceptible to interference from other electronic devices.
4. Disadvantages: RF cameras can be more expensive than traditional wired cameras, and they require a receiver or computer to receive the images. They are also susceptible to interference from other RF signals in the area, which can degrade image quality.

ARDUINO MEGA

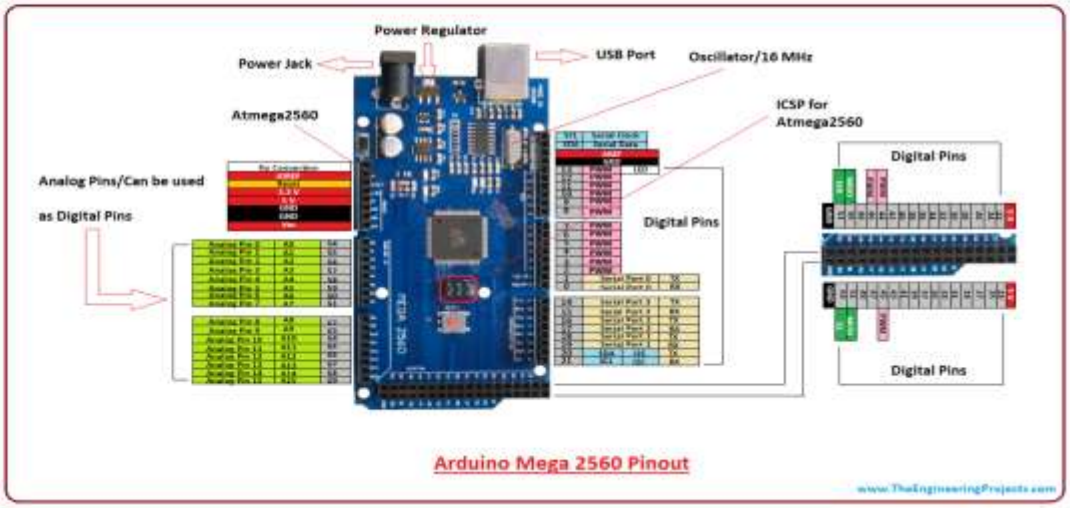


Figure 3.6: Arduino Mega pinout diagram

The Arduino Mega is a micro-controller board based on the ATmega2560. It has 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button.

Here is some detailed information about the Arduino Mega:

Micro-controller: The ATmega2560 is an 8-bit micro-controller with 256KB of flash memory, 8KB of SRAM, and 4KB of EEPROM. It has 86 I/O pins, 16 ADC channels, and supports SPI, I2C, and UART communication protocols.

Digital I/O Pins: The Arduino Mega has 54 digital I/O pins, which can be used as either input or output. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50 k ohms. The pins are labeled from 0 to 53.

Analog Input Pins: The Arduino Mega has 16 analog input pins, labeled from A0 to A15. These pins can be used to read analog voltage levels between 0 and 5V. Each pin has a 10-bit ADC (analog-to-digital converter), which means it can detect 1024 different levels of voltage.

UARTs (hardware serial ports): The Arduino Mega has four hardware UARTs (serial communication ports): Serial0, Serial1, Serial2, and Serial3. These can be used to communicate with other devices using the UART protocol (such as serial monitors, Bluetooth modules, or GPS modules).

Clock Speed: The Arduino Mega has a 16 MHz crystal oscillator, which provides the clock signal for the micro-controller. This determines the speed at which the micro-controller executes instructions.

USB Connection: The Arduino Mega has a USB connection, which can be used to upload code from the computer to the board and to communicate with the board using serial communication.

Power Jack: The Arduino Mega can be powered using a 9V DC power supply through the power jack. The board has a voltage regulator that can handle voltages up to 12V.

ICSP Header: The In-Circuit Serial Programming (ICSP) header can be used to program the micro-controller using an external programmer (such as the AVRISP mkII or the USBtinyISP).

Reset Button: The reset button can be used to reset the micro-controller. When pressed, the micro-controller is restarted, and the program starts from the beginning.

Here are the details of the pins on the Arduino Mega:

Digital I/O Pins: Pins 0-53 are digital I/O pins that can be configured as inputs or outputs.

Pins 0-15 are also capable of PWM (pulse width modulation) output.

Analog Input Pins: Pins A0-A15 are analog input pins with a 10-bit resolution (0-1023).

UARTs: The Arduino Mega has 4 hardware UARTs (Serial1-4) available on pins 0/1, 19/18, 17/16, and 15/14, respectively.

It also has a software serial library that can be used to create additional UARTs on any digital pins.

Other Pins:

The Arduino Mega has several other pins that serve different purposes:

AREF: Analog reference pin for the analog inputs

RESET: Reset pin for the micro-controller

5V and 3.3V: Power supply pins

GND: Ground pins

ICSP: In-Circuit Serial Programming header for programming the micro-controller.

VIN: Input voltage pin for external power supply

In addition to these pins, the Arduino Mega also has several other features, including multiple timers, interrupts, and communication protocols such as I2C, SPI, and CAN. Overall, the Arduino Mega is a powerful micro-controller board that is well-suited for complex projects that require many inputs and outputs.

Overall, the Arduino Mega is a powerful and versatile micro-controller board that can be used for a wide range of projects, from simple LED blinking to complex robotics applications. Its numerous digital and analog I/O pins, multiple UARTs, and high clock speed make it suitable for advanced applications.

ARDUINO NANO

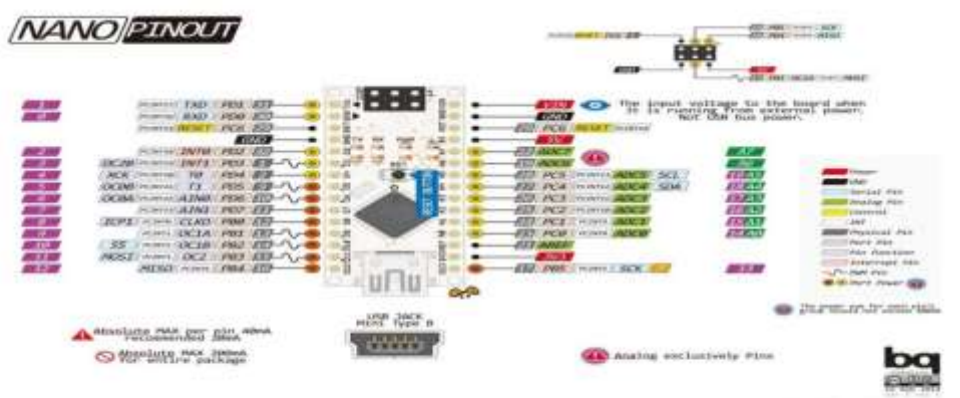


Figure 3.7: Arduino NANO pinout diagram

The Arduino Nano is a small, compact, and affordable micro-controller board that is based on the ATmega328 micro-controller. It is very similar to the Arduino Uno in terms of functionality but is smaller in size, making it an excellent choice for projects that require a smaller form factor.

The Arduino Nano board is designed to be used in a wide range of applications, from robotics and automation to electronics projects and home automation. It features 14 digital input/output pins, six analog inputs, and a 16MHz clock speed. It also has a USB interface for programming and serial communication.

Here are some of the key features and specifications of the Arduino Nano:

- Micro-controller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended): 7-12V.
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- Flash Memory: 32 KB (ATmega328) of which 2 KB is used by bootloader.
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

The Arduino Nano board is compatible with the Arduino IDE and can be programmed using the same syntax and functions as the Arduino Uno. It can also be programmed using other programming languages like Python and C++.

Here are some key features of the Arduino Nano:

1. **Compact size:** The Nano is one of the smallest Arduino boards available. Its compact size makes it ideal for projects where space is limited.

2. **Wide voltage range:** The Nano can operate with an input voltage range of 7-12V, making it suitable for a wide range of applications.

3. **High clock speed:** The ATmega328P microcontroller chip on the Nano runs at 16MHz, providing plenty of processing power for most projects.

4. **Digital and analog I/O**: The Nano has 14 digital I/O pins and 8 analog input pins, which can be used to interface with a variety of sensors and other devices.

5. **USB interface**: The Nano comes with a USB interface that allows it to be programmed and communicate with a computer.

6. **Easy to use:** The Nano is very easy to use, with a simple and intuitive programming environment that is compatible with Windows, Mac, and Linux.

Overall, the Arduino Nano is an excellent choice for beginners and advanced users alike who are looking for a compact and versatile micro-controller board for their projects.

APR33A3 RECORDER/PLAYBACK MODULE

Figure 3.8: APR33A3 RECORDER

The APR33A3 recorder is a voice recording and playback module that is commonly used in a wide range of electronics projects, including toys, security systems, and audio devices. This module is designed to provide high-quality audio recording and playback capabilities, making it a popular choice for projects that require sound recording and playback.

The APR33A3 recorder is a complete standalone device that requires only a power supply and a speaker to operate. It is based on a single chip, the APR33A3 IC, which provides all the necessary functions for audio recording and playback. The module has a built-in microphone for recording audio and a speaker output for playback.

In terms of technical specifications, the APR33A3 recorder has a sampling rate of 6kHz, which is sufficient for most voice recording applications. It can record up to 180 seconds of audio data, which is stored in non-volatile memory. The module supports multiple recording modes, including manual recording, trigger recording, and auto-recording.

One of the unique features of the APR33A3 recorder is its ability to play back multiple audio tracks. The module can store up to 8 audio tracks, which can be played back individually or in a sequence. This feature makes the module ideal for use in toys and other audio devices that require multiple audio tracks.

The APR33A3 recorder is also highly customizable, with a range of options for adjusting the audio quality and playback characteristics. It includes a built-in equalizer and tone control, allowing users to adjust the bass, treble, and midrange frequencies to suit their specific requirements. The module also supports a range of playback modes, including repeat, loop, and random playback.

Here are the key features of the APR33A3 Recorder:

1. **Non-volatile memory:** The APR33A3 has 8Mbits of non-volatile memory, which can store up to 180 seconds of high-quality audio.
2. **Low power consumption:** The chip has low power consumption, consuming only 1.2mA in recording mode and 20uA in standby mode, making it ideal for battery-powered devices.
3. **High-quality audio:** The recorder chip supports 4-bit ADPCM (Adaptive Differential Pulse Code Modulation) encoding and decoding, which provides high-quality audio with a sampling rate of 6.4kHz.
4. **Easy-to-use interface:** The APR33A3 has a simple interface that requires only a few external components to operate. It also supports both parallel and serial data transfer, providing flexible integration with various microcontrollers and other electronic systems.
5. **Flexible recording modes:** The recorder chip offers two recording modes: single message recording and multiple message recording. In single message recording mode, the chip records a single message that can be played back repeatedly. In multiple message recording mode, the chip can record up to 8 messages, which can be played back sequentially or randomly.

6. **Automatic message identification:** The APR33A3 supports automatic message identification, which means that the chip can automatically detect the end of each message and stop recording. This feature eliminates the need for external circuitry to detect message endings.

7. **On-chip clock generator:** The recorder chip has an on-chip clock generator, which eliminates the need for an external crystal oscillator or resonator.

8. **Low system cost:** The APR33A3 is a cost-effective solution for voice recording applications, as it eliminates the need for additional components such as amplifiers, filters, and analog-to-digital converters.

In summary, the APR33A3 Recorder is a versatile and easy-to-use voice recorder chip that offers high-quality audio, low power consumption, and a simple interface. It is a cost-effective solution for various embedded systems applications that require voice recording and playback capabilities.

SPEAKER

Figure 3.9: Speaker

A speaker is an electro-acoustic transducer that converts an electrical audio signal into sound waves. It is a device that produces sound by vibrating a diaphragm or cone at a certain frequency, which causes air molecules to vibrate and create sound waves that can be heard by the human ear.

Speakers consist of several main components, including the cone or diaphragm, a voice coil, a magnet, and a frame or basket. The cone or diaphragm is typically made of lightweight materials such as paper, plastic, or metal, and is responsible for producing sound waves. The voice coil is a coil of wire that is attached to the cone or diaphragm, and when an electrical audio signal is applied to it, it causes the coil to move back and forth rapidly. The magnet is used to create a magnetic field around the voice coil, which interacts with the electrical current flowing through the coil and causes it to move. The frame or basket holds all of the components together and provides a mounting surface for the speaker.

Speakers come in a variety of shapes and sizes, from small speakers used in portable electronic devices to large speakers used in concert sound systems. They are used in a wide range of applications, including home audio systems, car audio systems, public address systems, and musical instruments.

In summary, a speaker is an electro-acoustic transducer that converts an electrical audio signal into sound waves. It consists of several components, including a cone or diaphragm, a voice coil, a magnet, and a frame or basket, and is used in a variety of applications to produce sound.

OLED DISPLAY MODULE 4 PIN

Fig:3.10 OLED Display Module

OLED (Organic Light-Emitting Diode) is a self-light-emitting technology composed of a thin, multi-layered organic film placed between an anode and cathode. In contrast to LCD technology, OLED does not require a backlight. OLED possesses high application potential for virtually all types of displays and is regarded as the ultimate technology for the next generation of flat-panel display

This 2.44 cm (0.96 Inch) I2C/IIC 4pin OLED Display Module BLUE can be interfaced with any microcontroller using SPI/IIC/I2C protocols. It is having a resolution of 128x64. The package includes display board, display, 4 pin male header pre-soldered to board.

OLED monochrome 128x64 dot matrix display module. The characteristics of this display module are high brightness, self-emission, high contrast ratio, slim/thin outline, wide viewing angle, wide temperature range and low power consumption.

Interface pin for 4 PIN 128x64 OLED

1. VCC: 3.3 volts 5 Volts
2. GND: Ground
3. SCL: Serial Clock
4. SDA: Serial Data

Features:

1. Super High Brightness (Adjustable)
2. Super High Contrast (Adjustable)
3. Embedded Driver/Controller
4. Display size: 2.44 cm (0.96 Inch)
5. Resolution radio:128 x 64
6. Interface modes: I2C/IIC
7. working voltage: 3.3V
8. Control Chip: SSD1306

However, OLED display modules can be expensive compared to other display technologies, and they are also susceptible to burn-in, which occurs when a static image is displayed for too long and causes permanent damage to the screen. Despite these drawbacks, OLED display modules continue to be a popular choice for many applications due to their excellent image quality and design flexibility.

ARDUINO MEGA SHIELD

Figure 3.11: Arduino mega shield

The Arduino Mega Shield is an expansion board designed to be used with an Arduino Mega micro-controller board. It provides additional functionality and allows for the easy connection of various peripherals and sensors to the Arduino Mega.

Here are the details of the Arduino Mega Shield:

1. **Compatible with Arduino Mega:** The Arduino Mega Shield is designed to work with the Arduino Mega micro-controller board. It is not compatible with other Arduino boards.

2. **Multiple Pin Headers**: The Arduino Mega Shield features multiple pin headers that allow for easy connection of various peripherals and sensors. The pin headers include Digital I/O, Analog Input, PWM, UART, SPI, and I2C.

3. **Power Input:** The shield has a power input port that allows for easy connection of an external power supply. It can accept a voltage range of 7V to 12V DC.

4. **Power Indicator LED:** The Arduino Mega Shield features a power indicator LED that lights up when the shield is powered on.

5. **Reset Button:** The shield has a reset button that allows for easy resetting of the micro-controller board.

6. **SD Card Slot:** The Arduino Mega Shield has an SD card slot that allows for easy interfacing with SD cards. This can be used for data logging, storage, or other applications.

7. **Real-Time Clock:** The shield has a real-time clock module that allows for accurate timekeeping. This can be used for applications that require time-sensitive operations.

8. **Ethernet Port:** The Arduino Mega Shield has an Ethernet port that allows for easy networking capabilities. It can be used for applications that require remote access or communication.

9. **Bluetooth Module**: The shield has a Bluetooth module that allows for easy wireless communication with other devices. It can be used for applications that require wireless data transfer or control.

10. **LCD Display Connector:** The shield features an LCD display connector that allows for easy interfacing with LCD displays. It can be used for applications that require visual feedback or display.

Overall, the Arduino Mega Shield is a powerful expansion board that provides additional functionality and easy interfacing with various peripherals and sensors. It is an ideal choice for advanced projects that require more capabilities than what the basic Arduino board provides.

ARDUINO NANO SHIELD

Figure3.12: Arduino nano shield

An Arduino Nano Shield is an expansion board designed to be used with the Arduino Nano micro-controller board. It provides additional functionality and allows for the easy connection of various peripherals and sensors to the Arduino Nano.

Here are the details of the Arduino Nano Shield:

1. **Compatible with Arduino Nano**: The Arduino Nano Shield is designed to work with the Arduino Nano micro-controller board. It is not compatible with other Arduino boards.

2. **Multiple Pin Headers:** The Arduino Nano Shield features multiple pin headers that allow for easy connection of various peripherals and sensors. The pin headers include Digital I/O, Analog Input, PWM, UART, SPI, and I2C.

3. **Power Input:** The shield has a power input port that allows for easy connection of an external power supply. It can accept a voltage range of 7V to 12V DC.

4. **Power Indicator LED:** The Arduino Nano Shield features a power indicator LED that lights up when the shield is powered on.

5. **Reset Button:** The shield has a reset button that allows for easy resetting of the micro-controller board.

6. **SD Card Slot:** Some Arduino Nano Shields have an SD card slot that allows for easy interfacing with SD cards. This can be used for data logging, storage, or other applications.

7. **Real-Time Clock:** Some Arduino Nano Shields have a real-time clock module that allows for accurate timekeeping. This can be used for applications that require time-sensitive operations.

8. **Ethernet Port:** Some Arduino Nano Shields have an Ethernet port that allows for easy networking capabilities. It can be used for applications that require remote access or communication.

9. **Bluetooth Module:** Some Arduino Nano Shields have a Bluetooth module that allows for easy wireless communication with other devices. It can be used for applications that require wireless data transfer or control.

10. **LCD Display Connector:** Some Arduino Nano Shields feature an LCD display connector that allows for easy interfacing with LCD displays. It can be used for applications that require visual feedback or display.

Overall, the Arduino Nano Shield is a powerful expansion board that provides additional functionality and easy interfacing with various peripherals and sensors. It is an ideal choice for advanced projects that require more capabilities than what the basic Arduino board provides. However, the specific features of an Arduino Nano Shield can vary depending on the manufacturer and the model.

BATTERY

Figure 3.13: Battery of 2200MAh

A 2200mAh LiPo (Lithium Polymer) battery is a rechargeable battery commonly used in various electronic devices such as remote-controlled toys, quadcopters, drones, and other RC (remote-controlled) vehicles. The 2200mAh refers to the battery's capacity, which is measured in milliampere-hours (mAh). This value indicates how much energy the battery can store and supply.

LiPo batteries are known for their high energy density, lightweight, and low self-discharge rate, making them a popular choice for RC hobbyists. They can provide high discharge rates, allowing for powerful bursts of energy when needed. However, they also require careful handling and charging to avoid damage or even fire.

It is essential to use a compatible charger designed for LiPo batteries to charge them safely. It is also crucial to store and handle them carefully, as puncturing or damaging them can cause a fire. It is recommended to store them in a fireproof container or bag and never leave them unattended while charging.

Overall, a 2200mAh LiPo battery can provide a good balance between capacity and weight for many RC applications, but it is crucial to follow proper handling and charging procedures to ensure safe and reliable operation.

BLUETOOTH MODULE

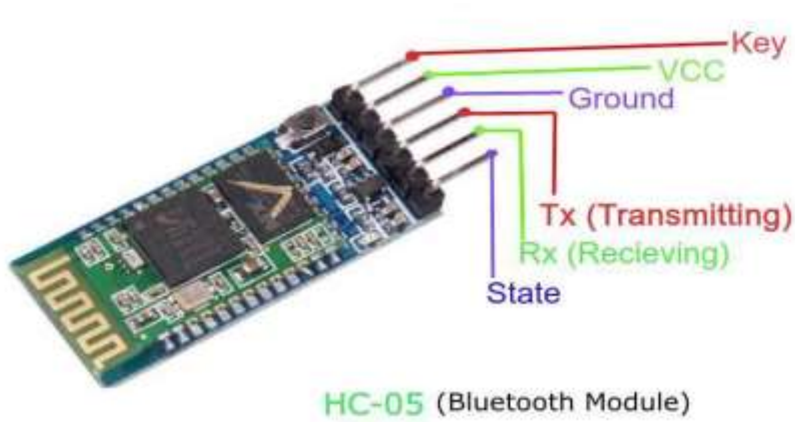


Figure 3.14: Bluetooth

A Bluetooth module is an electronic device that provides wireless communication capabilities between two or more devices using Bluetooth technology. Bluetooth modules can be integrated into a variety of electronic devices, such as smartphones, computers, and micro-controllers like the Arduino.

Bluetooth modules typically consist of a Bluetooth chip, antenna, and supporting circuitry. They use a serial communication protocol to communicate with other devices and can be configured to act as a master or slave device.

Bluetooth modules come in different shapes and sizes, ranging from small surface-mount modules that can be soldered onto a printed circuit board, to larger modules with breakout boards that can be connected to other devices using standard connectors.

There are several different types of Bluetooth modules, each with different capabilities and features. Some common types of Bluetooth modules include:

Classic Bluetooth modules - These modules use the classic Bluetooth protocol, which is designed for longer range and higher data transfer rates. They are commonly used in applications such as wireless headsets, speakers, and car stereos.

Bluetooth Low Energy (BLE) modules - These modules use the Bluetooth Low Energy protocol, which is designed for low power consumption and short-range communication. They are commonly used in applications such as fitness trackers, smart watches, and other wearable devices.

Bluetooth mesh modules - These modules use the Bluetooth mesh protocol, which is designed for large-scale, distributed networks of devices. They are commonly used in applications such as smart home automation and industrial control systems.

Overall, Bluetooth modules are widely used in a variety of electronic devices and applications to provide wireless communication capabilities. They are easy to use and offer a convenient way to connect devices and exchange data wirelessly.

It has 6 pins,

1. **Key/EN:** It is used to bring Bluetooth module in AT commands mode. By default, this pin operates in data mode. Key/EN pin should be high to operate Bluetooth in command mode. The default baud rate of HC-05 in command mode is 38400bps and 9600 in data mode. HC-05 module has two modes,

   - **Data mode:** Exchange of data between devices. Baud rate is 9600bps in data mode.

   - **Command mode:** It uses AT commands which are used to change setting of HC-05. Baud rate is 38400bps in command mode.

2. **VCC:** Connect 5 V or 3.3 V to this Pin.
3. **GND:** Ground Pin of module.
4. **TXD:** Connect with Micro-controller RXD pin of Micro-controller. Transmit Serial data (wirelessly received data by Bluetooth module transmitted out serially on TXD pin)
5. **RXD:** Connect with Micro-controller TXD pin of Micro-controller. Received data will be transmitted wirelessly by Bluetooth module.
6. **State:** It tells whether module is connected or not. It acts as a status indicator.

RF RECEIVER AND TRANSMITTER

Figure 3.15: RF Receiver and Transmitter

A radio frequency (RF) transmitter is an electronic device that is used to transmit radio signals through the air using electromagnetic waves. These signals can carry audio, video, or data information and are used for a wide range of applications including wireless communications, broadcasting, remote control, and telemetry.

The basic components of an RF transmitter include an oscillator, a modulator, and an amplifier. The oscillator generates a carrier signal at the desired frequency of operation, which is then modulated with the information signal to be transmitted. The modulator can use various techniques such as amplitude modulation (AM), frequency modulation (FM), or phase modulation (PM) to modulate the carrier signal. The modulated signal is then amplified to increase its power level before being transmitted through an antenna.

An RF receiver is an electronic device that is used to receive and decode radio signals that are transmitted by an RF transmitter. The basic components of an RF receiver include an antenna, a tuner, a demodulator, and an audio or data output.

The antenna is used to receive the radio signals from the transmitter, and the tuner is used to select the desired frequency of operation. The demodulator is used to extract the information signal from the modulated carrier signal, and the output stage is used to amplify and decode the signal to recover the original information.

In summary, an RF transmitter is used to transmit radio signals through the air using electromagnetic waves, while an RF receiver is used to receive and decode these signals. Both devices play a critical role in many modern communication and broadcasting systems.

3.7 SOFTWARE SPECIFICATIONS

MC Programming Language: Embedded C

Proteus 8.0 software

Operating system: Windows Family

3.7.1 MC Programming Language: Embedded C

This is the most widely used programming language for embedded processors/controllers. Assembly is also used but mainly to implement those portions of the code where very high timing accuracy, code size efficiency, etc. are prime requirements. Embedded C is perhaps the most popular languages among Embedded Programmers for programming Embedded Systems. There are many popular programming languages like Assembly, BASIC, C++ etc. that are often used for developing Embedded Systems, but Embedded C remains popular due to its efficiency, less development time and portability.

3.7.2 Proteus 8.0

The Proteus Design Suite is a proprietary software tool suite used primarily for electronic design automation. The software is used mainly by electronic design engineers and technicians to create schematics and electronic prints for manufacturing boards. It was developed in Yorkshire, England by Lab Center Electronics Ltd and is available in English, French, Spanish and Chinese languages. Schematic capture in the Proteus Design Suite is used for both the simulation of designs and as the design phase of a PCB layout project. It is therefore a core component and is included with all product configurations.

Use Proteus software with its strong function in the simulation and analysis to simulate the micro-controller and its peripheral equipment. Design, debug and modify hardware and software of the micro-controller system on the computer. Draw the physical circuit after the successful circuit simulation. It forms a new system design model is: schematic design - simulation circuit design and modification - physical production and testing. The model makes the flaws exposed early in the design, shorts design cycles and reduces experimental costs. While also maximizing student's learning initiative and innovation. It is of great significance in developing innovative and practical talent, reforming the traditional teaching model and improving the quality of experimental teaching.

The software is simple where the Arduino code is first converted to .hex file where it will be uploaded in the Arduino through the software and connecting each and every element are connected in the system software when the code is uploaded and when the program is uploaded and run the program give the input and output will be displayed.

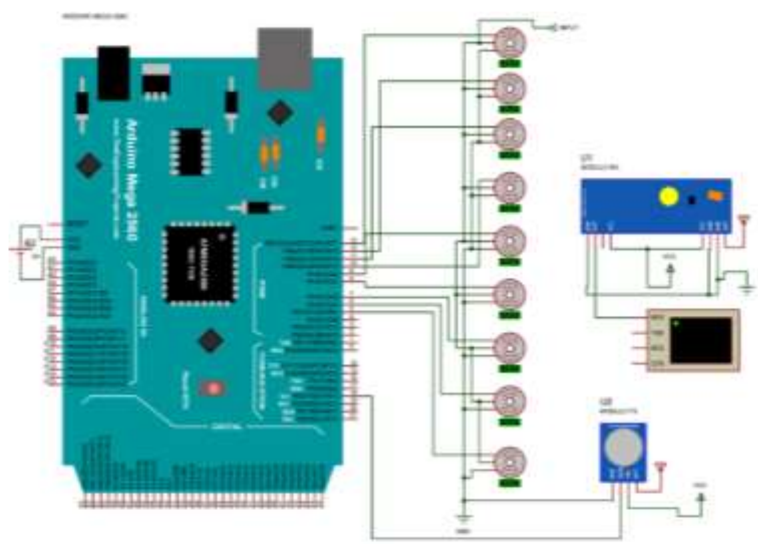


Figure 3.16: Proteus Schematic of Snake

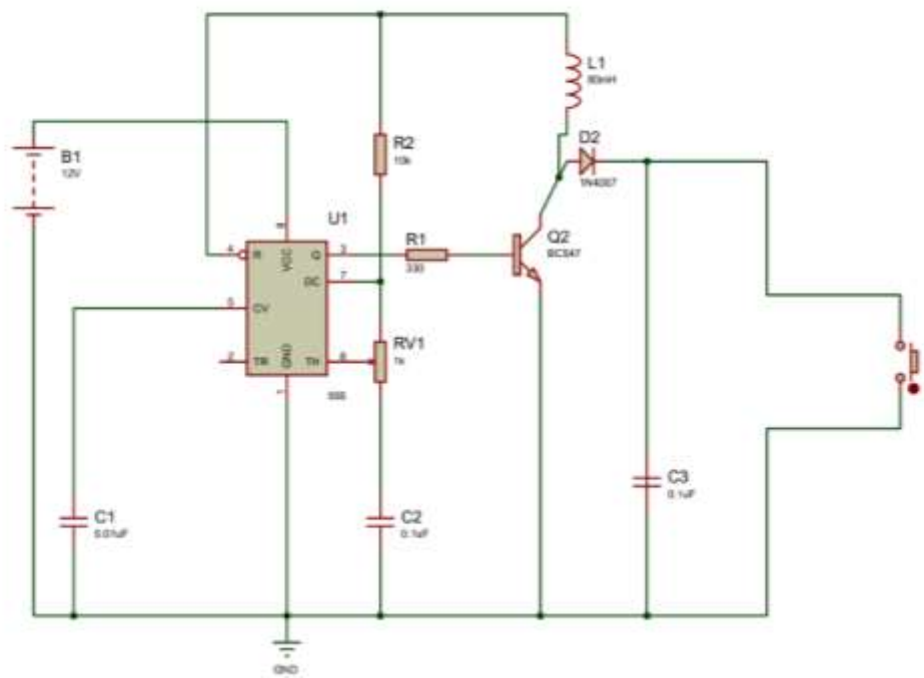


Figure 3.17: Proteus Schematic of Booster

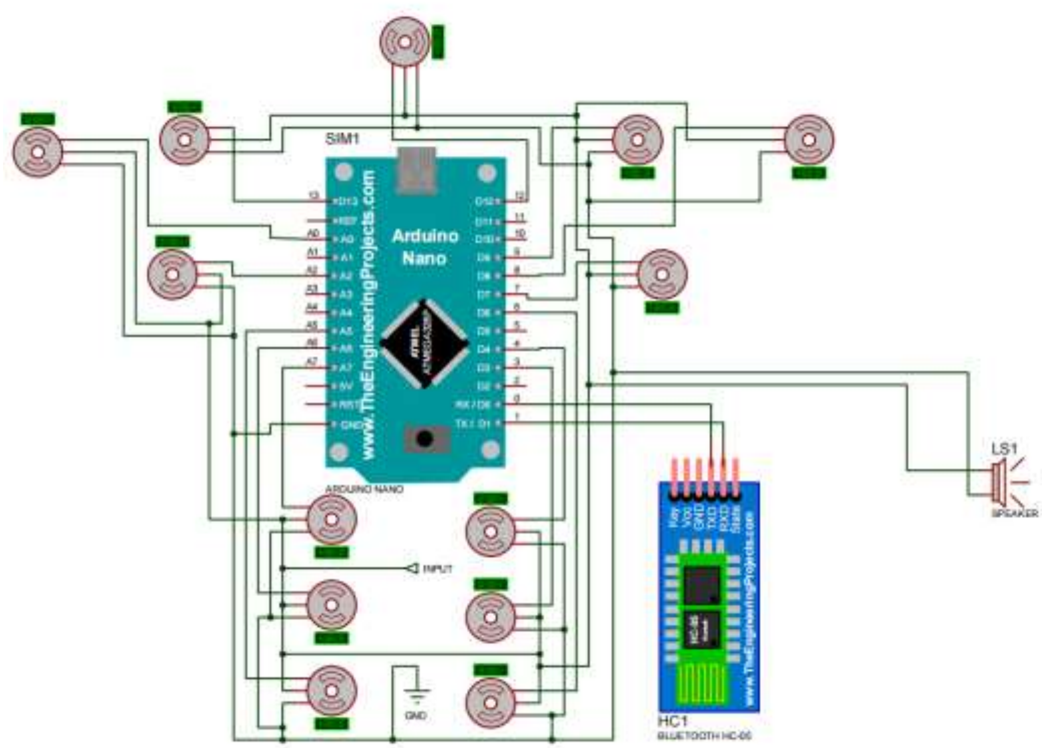


Figure 3.18: Proteus Schematic of Humanoid Robot

3.8 Technology Used

The design of the project is done in two stages, the hardware part and software section. The software part is achieved using Arduino IDE: Embedded C. The system block diagram and the system circuit diagram are shown in figures, respectively. The hardware (device) comprises of the Arduino Mega and Nano, servo motors, esp32 module, booster, lithium polymer battery.

3.9 Similar work

The Arduino-based humanoid robot Tonybot can be programmed. Its body has 16 high voltage bus servos and more than 10 action groups integrated into it, allowing it to perform various motions such as dancing, exercising, and walking. Tonybot has a flashing acceleration sensor and ultrasonic sensor. Using Arduino programming, secondary development is carried out. Although they serve varied purposes, humanoid robots have a similar form and are outfitted with acceleration and flashing ultrasonic sensors. By adding additional accessories, they can be modified to work in a variety of related domains for better experiences, giving them greater potential.

Introducing The Lake Erie Mamba: A Re-configurable Robot Snake This adaptable reptile, which uses off-the-shelf components, can move in a variety of ways, including slithering, inch worming, sidewinding, and rolling. The snake is made up of 12 segments that are connected by metal brackets and are driven by servo motors. Remote control for the snake is provided through a key fob transmitter with four buttons. The snake could move on its own. Such a robot can be built using a wide range of servos and bracket types. Serpentine motion, like an s-shaped curve, rectilinear motion, where only the initial segment is rotated 90 degrees, sidewinding motion, rolling motion, and autonomous motion are a few manifestations of the various motion kinds.

3.10 Embedded System

A system is an arrangement in which all its unit assemble work together according to a set of rules. It can also be defined as a way of working, organizing, or doing one or many tasks according to a fixed plan. For example, a watch is a time displaying system. Its components follow a set of rules to show time. If one of its parts fails, the watch will stop working. So, we can say, in a system, all its sub-components depend on each other.

As its name suggests, embedded means something that is attached to another thing. An embedded system can be thought of as a computer hardware system having software embedded in it. An embedded system can be an independent system, or it can be a part of a large system. An embedded system is a micro-controller or microprocessor-based system which is designed to perform a specific task. For example, a fire alarm is an embedded system; it will sense only smoke. An embedded system has three components:

It has hardware and has application software. It has Real Time Operating system (RTOS) that supervises the application software and provide mechanism to let the processor run a process as per scheduling by following a plan to control the latencies. RTOS defines the way the system works. It sets the rules during the execution of application program. A small-scale embedded system may not have RTOS. So, we can define an embedded system as a Micro-controller based, software driven, reliable, real-time control system.

3.11 Summary

The methodology for designing a ground-based surveillance robot for military and security purposes using an Arduino Mega for a snake robot and an Arduino Nano for a humanoid robot is summarised in this chapter. It can be designed with Proteus software, which allows the circuit to be done digitally after the code has been uploaded to the board using a hex file.

This chapter includes descriptions of the various kinds of software and hardware that are used, as well as diagrams of the tools that were used in the endeavour. There are project details describing the issues and ways in which this system was designed, as well as the block diagram, flowchart, and algorithm that were made for the project.

CHAPTER – 4

RESULT AND DISCUSSION

4.1 Operation

Operation of Snake Robot

The operation of a snake robot involves using its flexible, undulating body to move through its environment. The robot's body is typically made up of multiple linked segments, which are controlled by a series of actuators and sensors.

To operate the snake robot, the following steps may be taken:

1. Initialization: The robot's position and orientation are initialized, and its sensors are activated to detect environmental factors.
2. Obstacle Detection: The robot's sensors detect obstacles and other environmental factors in its path.
3. Determine Direction: Based on the sensor data, the robot determines the desired direction of motion.
4. Activate Actuators: The robot activates its actuators to create the undulating motion required to move the robot in the desired direction.
5. Repeat: The robot continues to repeat steps 2-4 until it reaches its target destination or encounters an obstacle that it cannot navigate around.
6. Obstacle Navigation: If the robot encounters an obstacle that it cannot navigate around, it uses its sensors to detect the obstacle's size and shape and adjusts its motion to navigate around it if possible.
7. Obstacle Encounter: If the robot cannot navigate around the obstacle, it stops and awaits further instructions.

8. Sidewinding is a movement utilized by snakes when they are on moving landscape, for example, sand. This movement is really a blend of the serpentine and rectilinear movements. To accomplish this movement the robot must be reconfigured.

9. A side section associating one fragment to the C-section of the following portion is unscrewed and pivoted 90 degrees. This is done along the whole length of the snake. The odd servos will be situated concerning serpentine movement and even servos will have situated with respect to rectilinear movement. Sidewinding movement is accomplished by sending a flat cosine wave down the odd numbered servos and a vertical cosine wave down the even numbered servos.

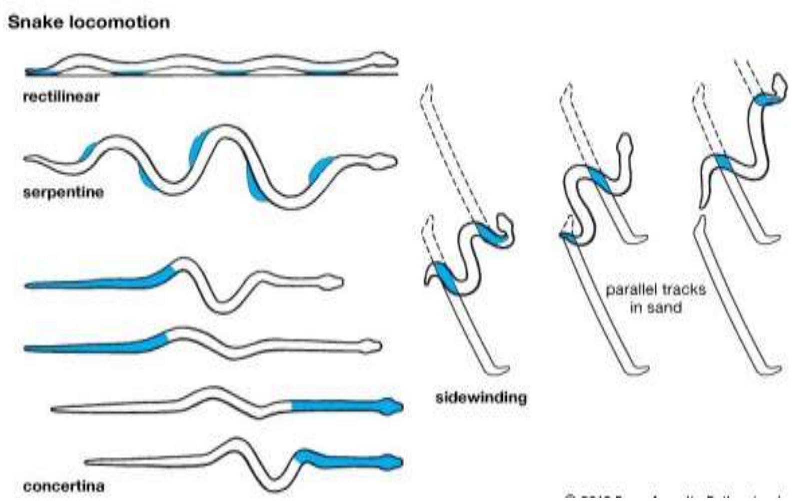


Figure 4.1: Case study of snake motions

1. The outcome is a sideways movement. Signal modulation changes a sine wave to encode information. The equation representing a sine wave is as follows.

$$\cos(2*\pi*f*t+\varphi) \text{ ---- } (1)$$

Where A is the amplitude, f is the frequency, t is the time and φ is the phase of sine wave.

serial.write(90+amp*cos(freq*count*π/180-n*lag)----□(2)

2. In the equation (2), the Arduino command is used in a loop to create the sidewinding motion. Where n is the quantity of the present segment and takes esteems from 1 to 12, amp decides how wide the wave is (i.e. how much the "S" shape is bended), freq (along

the variable delay Time) decide the speed of the snake, counter is the loop variable that takes the snake through its serpentine motion and lag is the consistent precise contrast

3. Overall, the operation of a snake robot involves using its flexible body to navigate through tight spaces and over obstacles. The robot's sensors and actuators work together to enable the robot to move in a smooth and controlled manner, even in challenging environments. The snake robot's unique design and operation make it well-suited for applications such as search and rescue, where it can access areas that are difficult or dangerous for humans to reach.

Operation of Humanoid robot

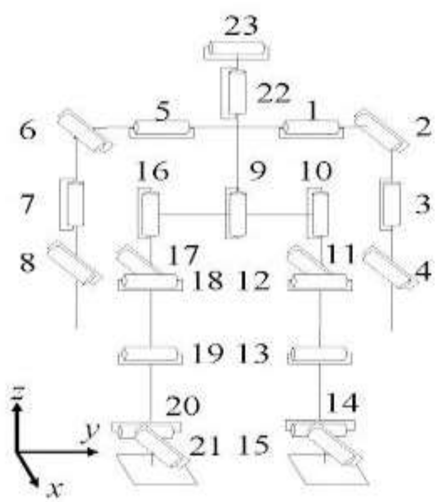


Figure 4.2: Different Motors attached in shape of Humanoid.

A humanoid robot is a machine that is designed to resemble and function like a human being. The operation of a humanoid robot involves several different components, including sensors, actuators, processing units, and software.

- Sensors: Humanoid robots are equipped with a variety of sensors, including cameras, microphones, touch sensors, and inertial measurement units. These sensors allow the robot to perceive and interact with its environment.
- Actuators: Humanoid robots use a variety of actuators, such as motors and hydraulics, to move their limbs and perform other physical actions.

- Processing Units: Humanoid robots are controlled by a central processing unit (CPU), which uses algorithms and software to control the robot's actions.
- Software: The software used to control a humanoid robot is typically programmed using a combination of high-level programming languages, such as Python or C++, and low-level control systems, such as ROS (Robot Operating System).

The operation of a humanoid robot involves a complex interplay between these different components, with the robot using its sensors to perceive its environment, its processing units to interpret that information, and its actuators to move and interact with the world around it.

4.2 Embedded C Programming:

4.2.1 Snake robot

```
#include <Servo.h>

Servo s1;

Servo s2;

Servo s3;

Servo s4;

Servo s5;

Servo s6;

Servo s7;

Servo s8;

Servo s9;

// Define variables

int forwardPin = 14;  // Remote control movement pins

int reversePin = 16;
```

```
int rightPin = 15;

int leftPin = 17;

int forwardVal = 0;  // Remote control variables

int reverseVal = 0;

int rightVal = 0;

int leftVal = 0:

int counter = 0; // Loop counter variable

float lag = .5712; // Phase lag between segments

int frequency = 1; // Oscillation frequency of segments.

int amplitude = 40; // Amplitude of the serpentine motion of the snake

int rightOffset = 5; // Right turn offset

int leftOffset = -5; // Left turn offset

int offset = 6; // Variable to correct servos that are not exactly centered

int delayTime = 7; // Delay between limb movements

int startPause = 5000;  // Delay time to position robot

int test = -3; // Test varialble takes values from -6 to +5

void setup()

{

// Set movement pins as inputs

  pinMode(forwardPin, INPUT);

  pinMode(reversePin, INPUT);
```

```
  pinMode(rightPin, INPUT);

  pinMode(leftPin, INPUT);

// Set movement pins to low

  digitalWrite(forwardPin, LOW);

  digitalWrite(reversePin, LOW);

  digitalWrite(rightPin, LOW);

  digitalWrite(leftPin, LOW);

// Attach segments to pins

   s1.attach(4);

   s2.attach(5);

   s3.attach(6);

   s4.attach(7);

   s5.attach(8);

   s6.attach(9);

   s7.attach(10);

   s8.attach(11);

// Put snake in starting position

  s1.write(90+offset+amplitude*cos(5*lag));

   s2.write(90+offset+amplitude*cos(4*lag));

   s3.write(90+offset+amplitude*cos(3*lag));

   s4.write(90+amplitude*cos(2*lag));
```

```
  s5.write(90+amplitude*cos(1*lag));
  s6.write(90+amplitude*cos(0*lag));
  s7.write(90+amplitude*cos(-1*lag));
  s8.write(90+amplitude*cos(-2*lag));
 delay(startPause);  // Pause to position robot
}
void loop() //
{
    for(counter = 0; counter < 10; counter += 1)  {
     delay(delayTime);
s1.write(90+offset+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180+5*lag));
s2.write(90+offset+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180+4*lag));
s3.write(90+offset+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180+3*lag));
s4.write(90+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180+2*lag));
s5.write(90+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180+1*lag));
 s6.write(90+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180+0*lag));
s7.write(90+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180-1*lag));
s8.write(90+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180-2*lag));
s9.write(90+.1*counter*rightOffset+amplitude*cos(frequency*counter*3.14159/180-3*lag));
   }
```

```
}
  for(counter = 360; counter > 0; counter -= 1)
  {
    delay(delayTime);
    s1.write(90+offset+amplitude*cos(frequency*counter*3.14159/180+5*lag));
    s2.write(90+offset+amplitude*cos(frequency*counter*3.14159/180+4*lag));
    s3.write(90+offset+amplitude*cos(frequency*counter*3.14159/180+3*lag));
    s4.write(90+amplitude*cos(frequency*counter*3.w14159/180+2*lag));
    s5.write(90+amplitude*cos(frequency*counter*3.14159/180+1*lag));
    s6.write(90+amplitude*cos(frequency*counter*3.14159/180+0*lag));
    s7.write(90+amplitude*cos(frequency*counter*3.14159/180-1*lag));
    s8.write(90+amplitude*cos(frequency*counter*3.14159/180-2*lag));
  }
}
```

4.2.3 Program for ESP32

```
#include "esp_camera.h"
#include <WiFi.h>
// Select camera model
//#define CAMERA_MODEL_WROVER_KIT
//#define CAMERA_MODEL_ESP_EYE
//#define CAMERA_MODEL_M5STACK_PSRAM
```

```
//#define CAMERA_MODEL_M5STACK_WIDE

#define CAMERA_MODEL_AI_THINKER

#include "camera_pins.h"

const char* ssid = "wifiusername”.

const char* password = "password”.

void startCameraServer ();

void setup() {

  Serial.begin(115200);

  Serial.setDebugOutput(true);

  Serial.println();

  camera_config_t config;

  config.ledc_channel = LEDC_CHANNEL_0;

  config.ledc_timer = LEDC_TIMER_0;

  config.pin_d0 = Y2_GPIO_NUM;

  config.pin_d1 = Y3_GPIO_NUM;

  config.pin_d2 = Y4_GPIO_NUM;

  config.pin_d3 = Y5_GPIO_NUM;

  config.pin_d4 = Y6_GPIO_NUM;

  config.pin_d5 = Y7_GPIO_NUM;

  config.pin_d6 = Y8_GPIO_NUM;

  config.pin_d7 = Y9_GPIO_NUM;
```

```
  config.pin_xclk = XCLK_GPIO_NUM;
  config.pin_pclk = PCLK_GPIO_NUM;
  config.pin_vsync = VSYNC_GPIO_NUM;
  config.pin_href = HREF_GPIO_NUM;
  config.pin_sscb_sda = SIOD_GPIO_NUM;
  config.pin_sscb_scl = SIOC_GPIO_NUM;
  config.pin_pwdn = PWDN_GPIO_NUM;
  config.pin_reset = RESET_GPIO_NUM;
  config.xclk_freq_hz = 20000000;
  config.pixel_format = PIXFORMAT_JPEG;
  //init with high specs to pre-allocate larger buffers
  if(psramFound()){
    config.frame_size = FRAMESIZE_UXGA;
    config.jpeg_quality = 10;
    config.fb_count = 2;
  } else {
    config.frame_size = FRAMESIZE_SVGA;
    config.jpeg_quality = 12;
    config.fb_count = 1;
  }
#if defined(CAMERA_MODEL_ESP_EYE)
```

```
  pinMode(13, INPUT_PULLUP);
  pinMode(14, INPUT_PULLUP);
#endif
  // camera init
  esp_err_t err = esp_camera_init(&config);
  if (err != ESP_OK) {
    Serial.printf("Camera init failed with error 0x%x", err);
    return;
  }
  sensor_t * s = esp_camera_sensor_get();
  //initial sensors are flipped vertically and colors are a bit saturated
  if (s->id.PID == OV3660_PID) {
    s->set_vflip(s, 1);//flip it back
    s->set_brightness(s, 1);//up the blightness just a bit
    s->set_saturation(s, -2);//lower the saturation
  }
  //drop down frame size for higher initial frame rate
  s->set_framesize(s, FRAMESIZE_QVGA);
#if defined(CAMERA_MODEL_M5STACK_WIDE)
  s->set_vflip(s, 1);
  s->set_hmirror(s, 1);
```

```
#endif
  WiFi.begin(ssid, password);
  while (WiFi.status()!= WL_CONNECTED) {
    delay (500);
    Serial. Print(".").
  }
  Serial.println("");
  Serial.println("Robojax Wi-Fi connected");
  startCameraServer ();
  Serial.print("Camera Ready! Use 'http://");
  Serial.print(WiFi.localIP());
  Serial.println("' to connect");
}
void loop () {
  // put your main code here, to run repeatedly:
  delay (10000);
}
```

4.3 OUTCOME

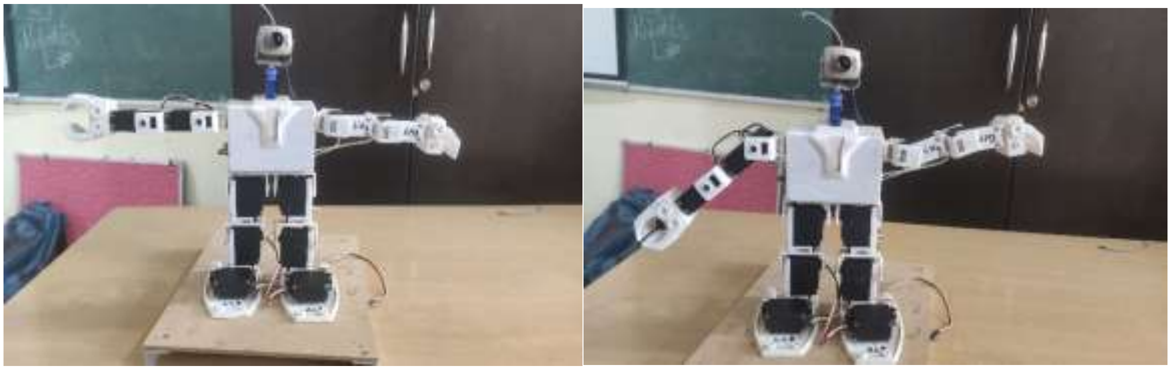


Figure 4.3: Final Prototype of Humanoid Robot

COMPONENETS	SPECIFICATIONS
Servo Motors	Weight 55g, Torque 10kg/cm
No of servo motors	14
Cost moderate	High
Maximum Speed	16 sec/60 degree
Degree of Freedom per segment	14 DOF
Battery time	60 Minutes
Operating Angle	360 degrees
Camera Operating voltage	DC - 9 V
Resolution	628 x 582 pixels
Range	50 meters
Night Vision	Supported

Table 4.1 Specifications of Humanoid Robot

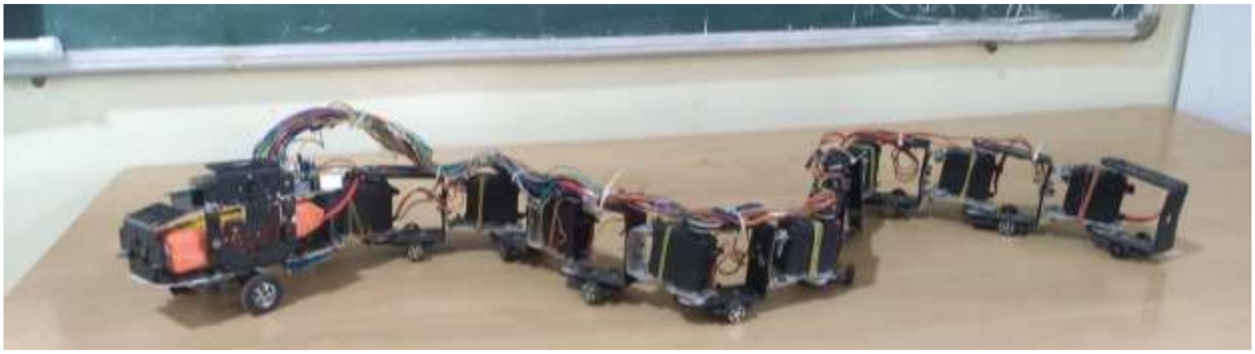


Figure 4.4: Final Prototype of Snake Robot

COMPONENETS	SPECIFICATIONS
Servo Motors	Weight 55g, Torque 10kg/cm
No of servo motors	9
Cost moderate	High
Maximum Speed	16 sec/60 degree
Degree of Freedom per segment	2 DOF
Battery time	60 Minutes
Operating Angle	One 360 degree and Eight 180
Camera Operating voltage	DC - 9 V
Required Pulse	900us – 2100us
Resolution	1600 x 1200 pixels
pixels Range	30 – 60 Feet

Table 4.1 Specifications of Snake Robot

CHAPTER-5

CONCLUSION

5.1 Conclusion

Snake robots and humanoid robots are two very different types of robots with their own unique capabilities and limitations.

Snake robots are typically designed to move in tight spaces and navigate difficult terrain that traditional wheeled or legged robots would not be able to access. Their ability to bend and twist in different directions allows them to move through narrow gaps and rough terrain, making them well-suited for tasks such as search and rescue, inspection of hazardous environments, and exploration of difficult-to-reach areas.

On the other hand, humanoid robots are designed to resemble and move like humans. They are typically equipped with arms, legs, and a head, and can perform tasks that require human-like dexterity and precision. They can be used in a variety of applications, such as manufacturing, healthcare, and entertainment.

While snake robots and humanoid robots may seem like they have very different applications, there are some areas where their capabilities overlap. For example, both types of robots could be used in search and rescue operations. A snake robot could navigate through narrow gaps and rubble to locate survivors, while a humanoid robot could be used to transport the survivors to safety.

Humanoid robots are an exciting and rapidly evolving field of technology. They have the potential to revolutionize many industries and provide valuable assistance and support to humans.

Overall, the choice between a snake robot and a humanoid robot will depend on the specific task at hand and the environment in which the robot will operate. Each type of robot has its own strengths and weaknesses, and the decision will ultimately come down to which robot is better suited for the task.

Category	**Humanoid Robot**	**Snake Robot**
Body Shape	Resembles human body with legs, arms, and torso	Resembles a snake with multiple segments
Locomotion	Bipedal or quadrupedal walking or running	Slithering or rolling motion
DOF (Degrees of Freedom)	Usually has more than 20 DOF for increased mobility	Varies, but typically has fewer DOF than humanoid robots
Sensing/Perception	Typically has visual, auditory, and tactile sensors	Typically has visual and/or infrared sensors
Control	Complex control systems for coordinated movements	Control systems may be simpler, but still require coordination
Applications	Customer service, education, healthcare, entertainment, research	Inspection, search and rescue, military, exploration, research

Table 5.1: some key differences between humanoid and snake robots

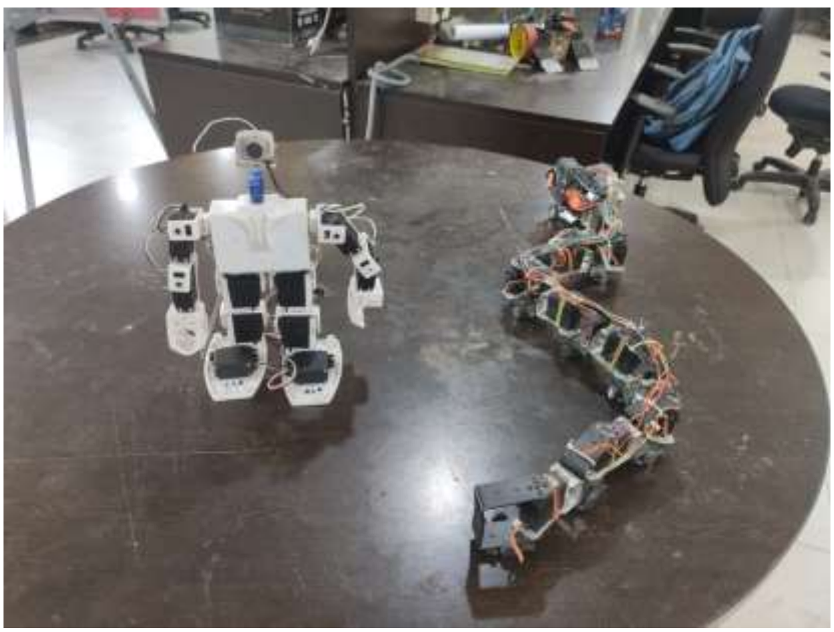


Fig 5.1: Prototype photo

5.2 Advantages

Both snake robots and humanoid robots have their unique advantages depending on the context and the task they are intended to perform.

Snake Robots:

- Highly manoeuvrable: Snake robots are designed with flexible joints that enable them to move through narrow and complex spaces. They can also wrap around obstacles and climb over uneven terrain, making them ideal for exploring difficult-to-reach locations.
- Versatile: Snake robots can be customized to suit a wide range of applications. For example, they can be used for inspection and maintenance tasks in industrial settings, for search and rescue operations, or for exploration of hazardous environments like deep-sea or outer space.
- Efficient: Snake robots are typically lighter and require less energy to operate than humanoid robots. This makes them ideal for applications that require long-duration missions or that need to be performed in remote locations where energy sources are limited.
- Remote Control: Snake robots can be controlled remotely, which makes them ideal for situations where it is difficult or dangerous for a human to be present.
- Flexibility: Snake robots are highly flexible and can easily move through tight spaces and navigate around obstacles, making them ideal for exploration in complex and challenging environments.
- Stability: Snake robots have a low center of gravity, which makes them very stable and allows them to climb over rough terrain without tipping over.

Humanoid Robots:

- Can perform human-like tasks: Humanoid robots are designed to move and interact in ways that are like humans. This makes them ideal for performing tasks that require a high level of dexterity, such as assembling products, performing surgery, or aiding people with disabilities.
- Good at social interaction: Humanoid robots are equipped with sensors and software that allow them to recognize and respond to human speech, gestures, and expressions. This makes them ideal for applications such as customer service, education, and entertainment.

- Can navigate complex environments: Humanoid robots are typically equipped with sensors and cameras that allow them to perceive their environment and avoid obstacles. This makes them ideal for applications that require navigation in complex environments, such as search and rescue operations or exploration of hazardous environments.
- Dexterity: Humanoid robots are designed to mimic the movements of humans, which makes them highly dexterous and capable of performing a wide range of tasks, including delicate operations and precise manipulations.
- Interaction: Humanoid robots are designed to interact with humans and can be programmed to recognize and respond to human gestures, expressions, and speech.
- Mobility: Humanoid robots can move on two legs, which allows them to navigate through environments designed for humans, such as homes, offices, and factories.
- Perception: Humanoid robots can be equipped with advanced sensors, such as cameras, microphones, and touch sensors, which allow them to perceive and interpret their environment, making them ideal for tasks such as monitoring, surveillance, and search and rescue operations.

Capability	**Description**
Perception	Ability to perceive the environment using sensors such as cameras, microphones, and touch sensors.
Locomotion	Ability to move and navigate through the environment using legs, arms, or other means of propulsion.
Manipulation	Ability to manipulate objects using hands or other appendages.
Communication	Ability to communicate with humans or other robots using speech, gestures, or other means.
Cognition	Ability to reason, learn and adapt based on experience or input from the environment.

Table 5.2: Capabilities of a humanoid robot

In summary, snake robots are highly manoeuvrable, versatile, and efficient, while humanoid robots are good at performing human-like tasks, social interaction, and navigating complex environments.

5.3 Disadvantages

Snake Robot:

- Limited mobility: Although snake robots are excellent at navigating tight spaces, they may have difficulty moving over rough terrain or climbing steep inclines.
- Energy consumption: Snake robots typically have many small actuators that consume a lot of energy. This can limit their endurance and make them less efficient than other types of robots.
- Complex control systems: Controlling a snake robot can be challenging due to the large number of degrees of freedom and the need for sophisticated control algorithms.
- Limited payload capacity: Snake robots have a limited ability to carry heavy payloads due to their relatively small size.
- Limited manipulation abilities: Although some snake robots have end-effectors that can be used for manipulation tasks, their ability to manipulate objects is generally more limited compared to other types of robots. This is because they do not have arms or hands.

Humanoid Robot:

- Complex mechanical design: Humanoid robots are often complex and expensive to build due to their human-like design and sophisticated control systems.
- Energy consumption: Humanoid robots typically have many degrees of freedom and require a lot of energy to operate. This can limit their endurance and make them less efficient than other types of robots.
- Maintenance: Maintaining humanoid robots can be difficult due to their complex mechanical design and the need for regular maintenance.
- Limited mobility: Although humanoid robots are designed to move like humans, they may have difficulty navigating certain types of terrain or performing tasks that require a high degree of mobility.

- Power consumption: Humanoid robots require a lot of power to operate, which can limit their battery life and make them less efficient than other types of robots for certain applications.

5.4 Future Scope

Snake robots and humanoid robots have immense potential for various applications in the future. Here are some possible scenarios for their future scope:

Snake Robot:

- Search and Rescue: Snake robots can be used in search and rescue operations in disaster-stricken areas where human access is limited or dangerous. They can navigate through rubble and debris to locate and assist trapped individuals.
- Medical Applications: Snake robots can be used in minimally invasive surgeries, where they can navigate through narrow and complex pathways within the body to perform delicate procedures.
- Exploration: Snake robots can be used in space exploration missions to navigate through narrow and hard-to-reach spaces, such as narrow caves or crevices on other planets.
- Industrial Applications: Snake robots can be used in industrial applications such as inspection and maintenance of pipelines, boilers, and other confined spaces where human access is limited.

Humanoid Robot:

- Healthcare: Humanoid robots can be used in healthcare settings to assist with patient care, such as helping with mobility, providing emotional support, and even assisting with basic medical procedures.
- Education: Humanoid robots can be used in education settings, such as language learning or teaching children with special needs.
- Manufacturing: Humanoid robots can be used in manufacturing to assist with assembly line tasks, such as handling materials or performing repetitive tasks.
- Service Industry: Humanoid robots can be used in the service industry to perform tasks such as cleaning, cooking, and serving customers.

Overall, the future scope of snake robots and humanoid robots is vast, and there are many potential applications for both types of robots. As technology continues to advance, we can expect to see more sophisticated and capable snake and humanoid robots being developed and deployed in a wide range of industries and applications.

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