SWARMING ROBOT

Muhammad Khairul Anwar bin Ibrahim
1917199

CONTENTS

1

Introduction & History

Introduction

Swarming robots refer to a group of robots that work together in a coordinated manner to achieve a common goal. The robots communicate with each other and make decisions based on their individual and collective observations.

The social behaviour of ants, bees, and termites serves as the basis for swarm robots. These insects are renowned for their social behaviour and their capacity to complete challenging tasks in groups.

History

Early 1990s

Researchers at the Santa Fe Institute began studying the behavior of groups of simple robots and their ability to solve problems collectively.

1995

The first swarm robotics workshop was held at the Massachusetts Institute of Technology (MIT).

Late 1990s

Researchers at the University of Southern California developed a swarm of robots that could work together to push objects.

History

Early 2000s

Research into swarm robotics continued to grow, with groups of robots being used for tasks such as exploration and mapping.

2004

The first Swarm Robotics Symposium was held in Santa Monica, California, bringing together researchers from around the world.

2006

The European Union funded the Swarmanoid project, which aimed to develop a swarm of robots that could work together to perform complex tasks.

History

2010s

Swarms of robots became increasingly common in research, with applications in agriculture, transportation, and military operations.

2018

Researchers at Harvard University developed a swarm of robots that could self-assemble into different shapes.

Present day

Swarm robotics continues to be an active area of research, with new advancements being made in areas such as swarm intelligence, collective decision making, and decentralized control.

2

Application of Swarm Robot

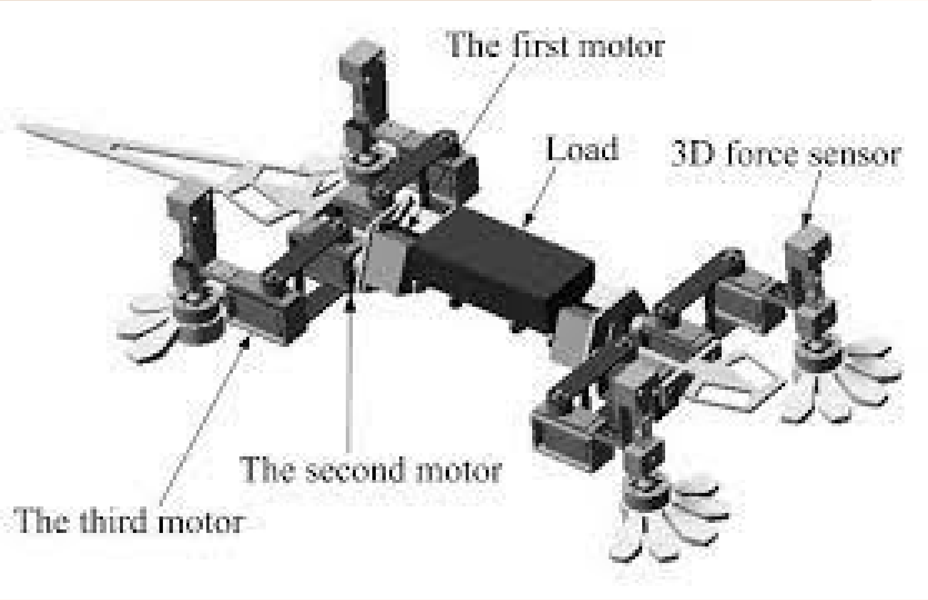
Application of Swarm Robot

Military operations

Swarms of robots can be used in military operations for tasks such as reconnaissance, surveillance, and combat. For example, the US military is developing a swarm of drones called "Perdix" that can be used for surveillance and battlefield monitoring.

Cleaning

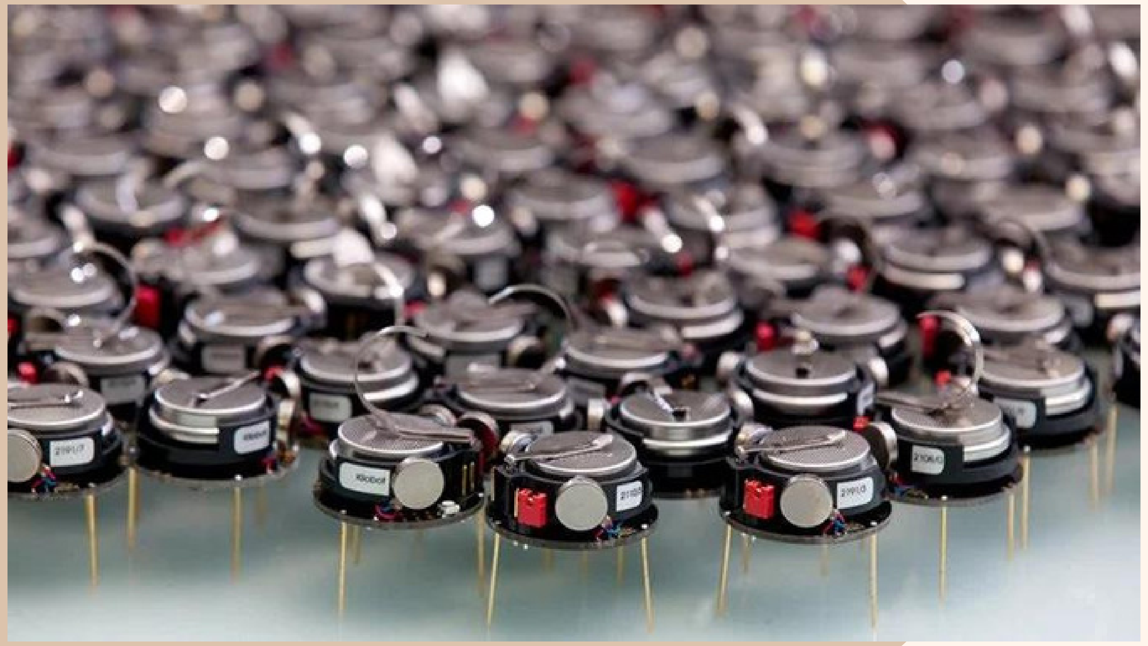
Swarms of robots can be used to clean large surfaces such as buildings or streets. For example, the researchers at Harvard University developed "RoboBees" which can be used for cleaning skyscrapers.



Application of Swarm Robot

Search and rescue missions

Swarms of robots can be used to explore disaster zones and search for survivors. For example, the researchers at Harvard University developed Kilobot, a low-cost swarm robot, which can be used to explore hazardous environments.



Precision agriculture

Swarms of robots can be used to monitor crops and optimize their growth. For example, the researchers at Georgia Tech developed a swarm of robots called "AgBots" that can perform tasks such as seeding, weeding, and harvesting.

Application of Swarm Robot

Transportation

Swarms of robots can be used to improve logistics and transportation systems. For example, researchers at the University of Pennsylvania developed a swarm of robots called "flying ambulances" that can transport medical supplies and equipment to remote locations.

3

Main Components

Body Design . Locomotion . Navigation . Data Collection . Communication . Power Management

Main Component

BODY DESIGN

CUBE SHAPE

ADVANTAGES

- Easy to manufacture and assemble.
- Can be stacked to save space.
- Offers a stable platform for sensors and other equipment.

DISADVANTAGES

- Limited mobility and flexibility.
- May not be suitable for all environments or tasks.

A simple and compact shape, a cube body design allows for easy stacking and efficient use of space.

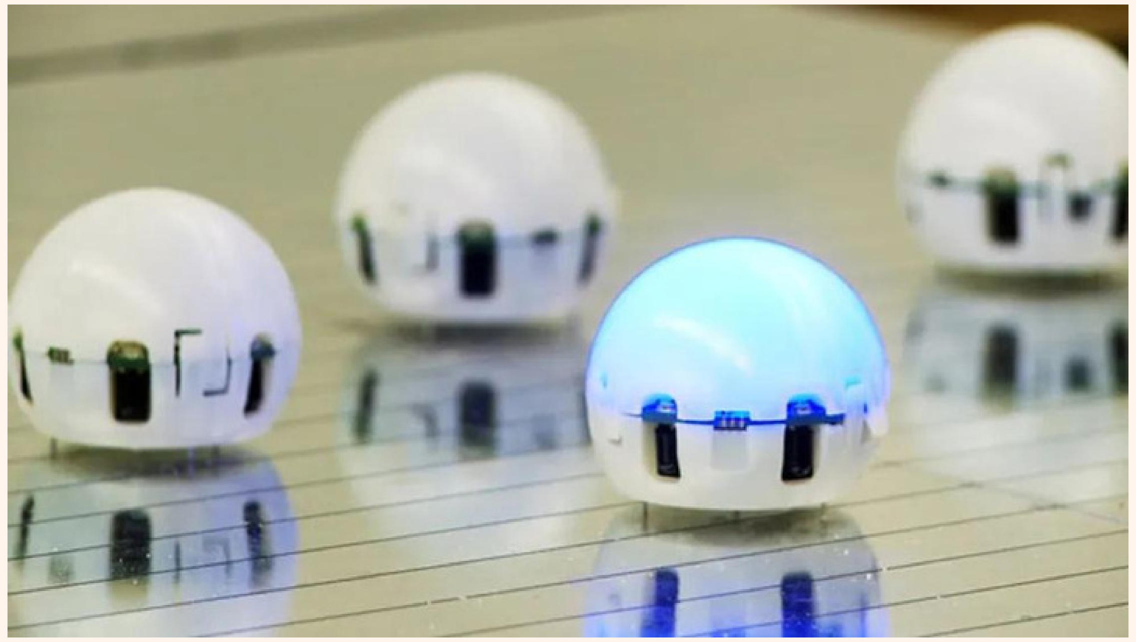
Main Component

BODY DESIGN

SPHERE SHAPE

ADVANTAGES

- Offers smooth and continuous motion.
- Can be useful for rolling or bouncing movements.
- Offers a stable platform for sensors and other equipment.



DISADVANTAGES

- Limited mobility in some environments.
- May not be suitable for tasks that require precise movements.

A round body design offers a smooth and continuous surface, which can be useful for rolling or bouncing movements.

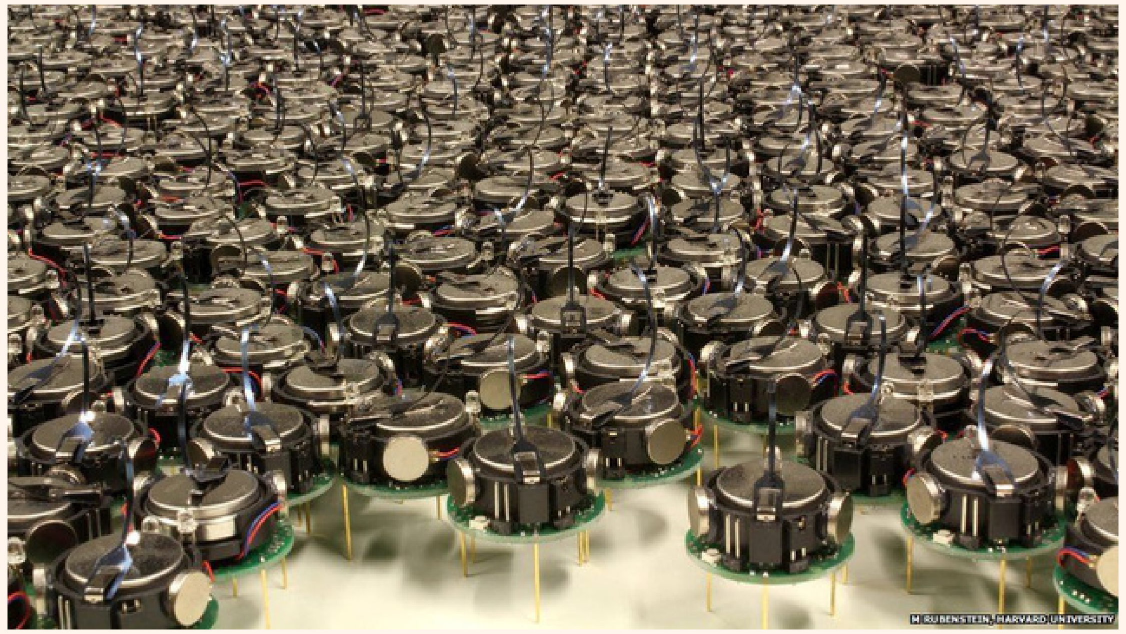
Main Component

BODY DESIGN

CYLINDRICAL SHAPE

ADVANTAGES

- Can move through narrow spaces.
- Offers a stable platform for sensors and other equipment.
- Can be used for various types of locomotion.



DISADVANTAGES

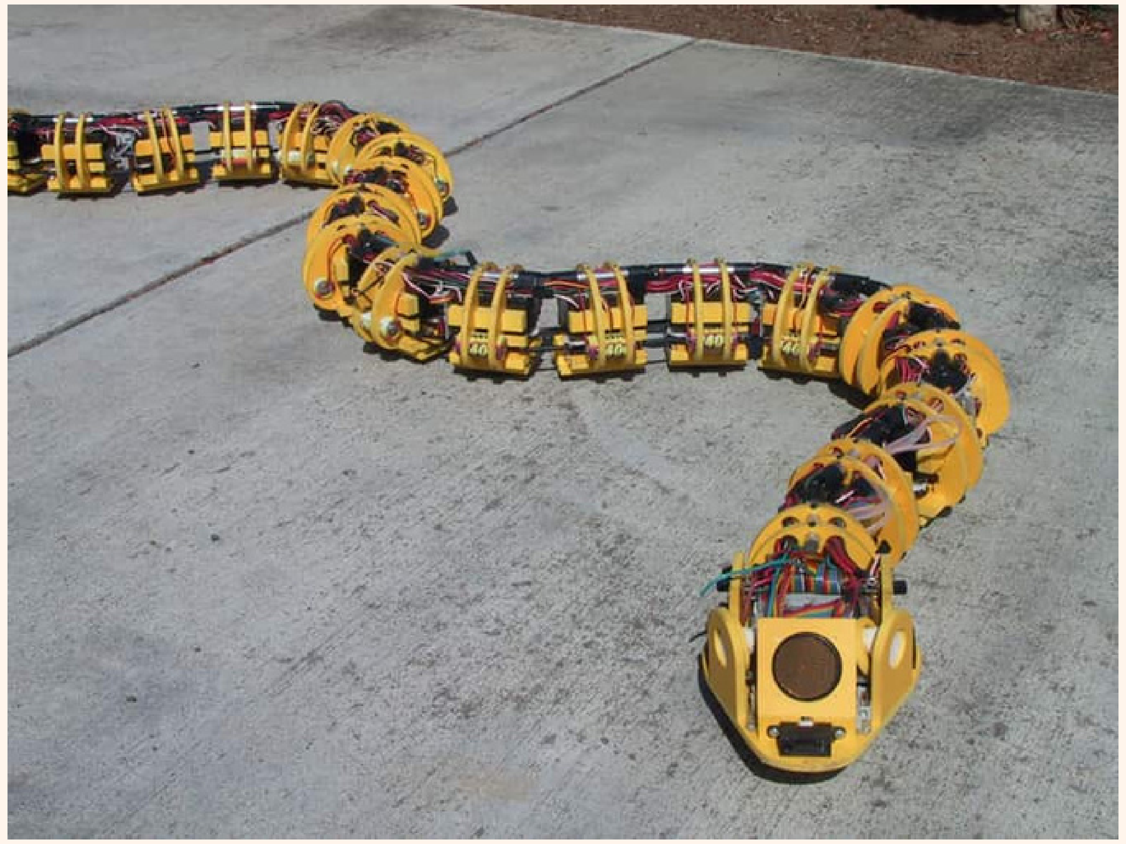
- Limited mobility in some environments.
- May not be suitable for tasks that require complex movements.

A cylindrical body design offers a stable and compact shape, which is well-suited for moving through narrow spaces.

Main Component

BODY DESIGN

SNAKE-LIKE SHAPE



ADVANTAGES

- Offers versatile movement and flexibility.
- Can navigate complex or uneven terrain.
- Offers a stable platform for sensors and other equipment.

DISADVANTAGES

- Can be more difficult and expensive to manufacture.
- May not be suitable for all environments or tasks.

A flexible, snake-like body design allows for versatile movement and can be useful for navigating complex or uneven terrain.

Main Component

BODY DESIGN

ANIMAL-LIKE SHAPE

ADVANTAGES

- Can mimic the form and movement of a particular animal.
- Can be useful for tasks that require specialized movement or behavior.
- Offers a stable platform for sensors and other equipment.

DISADVANTAGES

- Can be more difficult and expensive to manufacture.
- May not be suitable for all environments or tasks.

An animal-like body design can mimic the form and movement of a particular animal, which can be useful for tasks that require specialized movement or behavior.

Main Component

LOCOMOTION

WHEELED

These robots move on wheels or tracks and are suitable for traveling on flat surfaces. They are relatively simple and can be designed to be very fast and agile. However, they may struggle with uneven terrain and obstacles.

Advantages

simple, fast, and agile

Disadvantages

struggle with uneven terrain and obstacles

Main Component

LOCOMOTION

LEGGED

These robots use legs to move, like animals. They are more versatile than wheeled robots and can navigate a wide range of terrains. However, they can be complex to design and control.

Advantages

versatile and can navigate a wide range of terrains

Disadvantages

complex to design and control

Main Component

LOCOMOTION

These robots are designed to fly or hover, like drones. They can be very agile and can move over obstacles and difficult terrain. However, they have limited battery life and may be affected by wind and weather conditions.

FLYING

Advantages

agile and can move over obstacles and difficult terrain

Disadvantages

limited battery life and affected by wind and weather conditions

Main Component

LOCOMOTION

SWIMMING

These robots are designed to move through water. They can be useful for tasks such as ocean monitoring and cleaning. However, they may struggle with strong currents and waves.

Advantages

useful for tasks such as ocean monitoring and cleaning

Disadvantages

struggle with strong currents and waves

Main Component

NAVIGATION SYSTEM AND CONTROL

Microcontroller

A small computer that serves as the brain of the robot, controlling all its functions and movements.

LIDAR

A sensor that uses lasers to create a 3D map of the robot's surroundings, which can be used for navigation and obstacle avoidance.

Inertial Measurement Unit (IMU)

A sensor that measures the robot's orientation and movement in three dimensions.

GPS

A satellite-based navigation system that provides precise location data.

Magnetometer

A sensor that measures the magnetic field, which can be used for orientation and navigation.

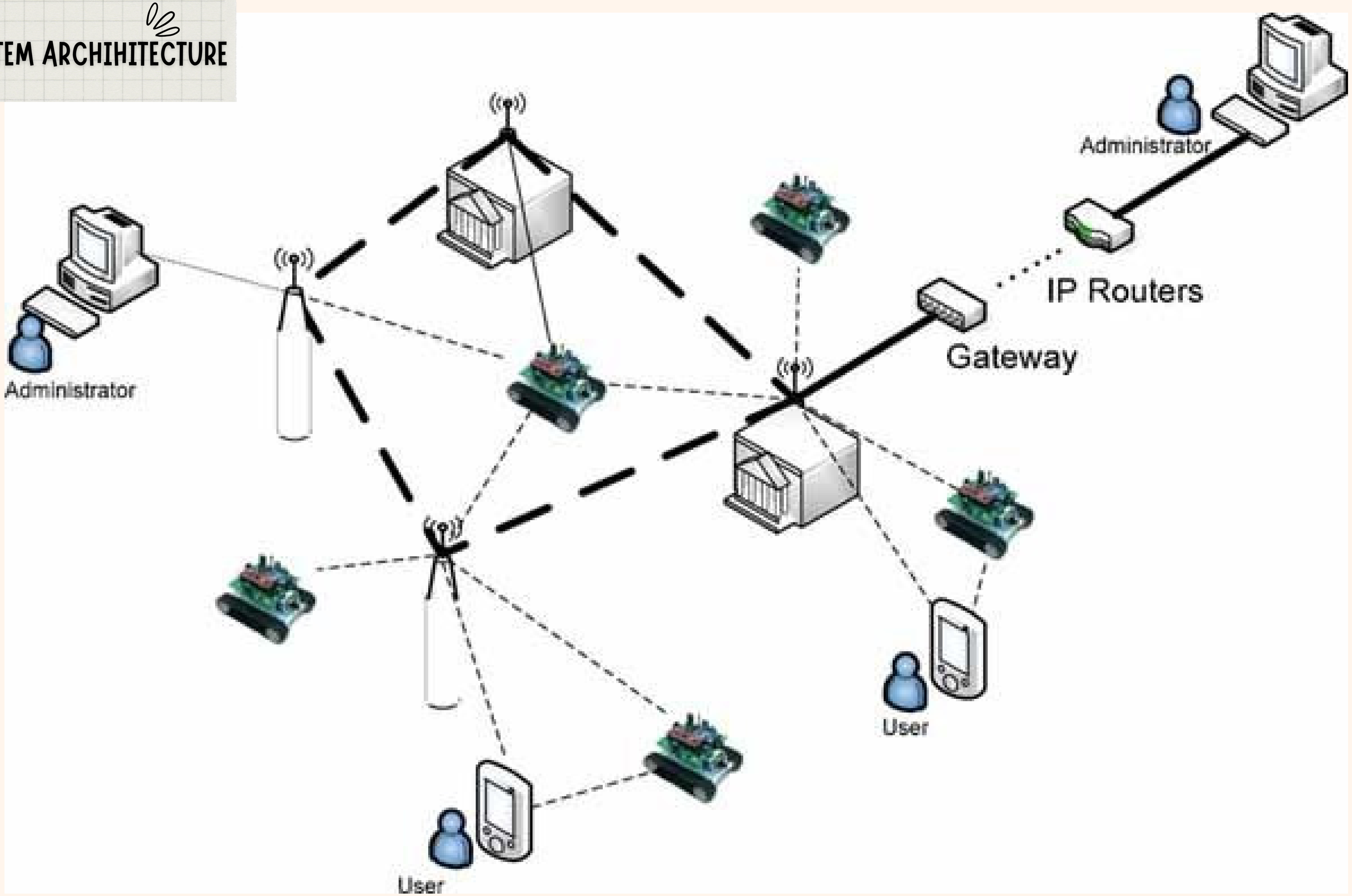
Camera

A sensor that captures visual data, which can be used for object recognition and navigation.

Main Component

NAVIGATION SYSTEM AND CONTROL

GENERAL SYSTEM ARCHIHITECTURE



Main Component

Data Collection (Payload)

Sensor

A device that detects and measures physical properties such as temperature, humidity, pressure, and light.

Actuator

A device that converts electrical signals into physical movement. Common types of actuators used in swarm robots include motors, servos, and solenoids.

Data Logger

A device that records data from sensors and other sources, storing it for later analysis. Data loggers can be used to collect information about environmental conditions, robot behavior, and other variables.

Microcontroller

A small computer that processes data from sensors and other sources, controlling the behaviour of the robot based on this information.

Main Component

Data Transmission (Comm)

Wireless Transceiver

A device that enables wireless communication between robots or between a robot and a central controller. Common types of wireless transceivers used in swarm robots include Bluetooth, Zigbee, and Wi-Fi.

Antenna

A device that sends and receives wireless signals. Antennas are used to transmit data between robots or between a robot and a central controller.

Cloud Computing Platform

A remote server that can be used to process and analyze data collected by swarm robots. Cloud computing platforms can be used to store data, run machine learning algorithms, and perform other computational tasks.

Main Component

Power Management

Battery Pack	A rechargeable battery pack is typically used to provide power to swarm robots. These batteries can be custom-designed to fit the specific power requirements of the robot.
Power management system	A power management system is responsible for regulating the power supply to the robot's components, such as the motors and sensors, to ensure they receive the appropriate voltage and current.
Voltage regulator	A voltage regulator is a component that maintains a constant voltage output regardless of changes in input voltage or current. It helps prevent damage to the robot's components from overvoltage or undervoltage.

Main Component

Power Management

Energy harvesting	Some swarm robots may use energy harvesting techniques, such as solar panels or piezoelectric materials, to generate power from their environment.
Power consumption optimization	Software algorithms can be used to optimize power consumption in swarm robots, for example, by reducing the power output of certain components when they are not in use.
Power-saving modes	Power-saving modes can be used to prolong battery life in swarm robots. For example, a sleep mode can be activated when the robot is idle to conserve power.

4

Advantages

Scalibility

Swarm robots can work in groups of any size, from just a few robots to thousands or more. This scalability makes swarm robots suitable for a wide range of applications, from small-scale environmental monitoring to large-scale search and rescue operations.

Robustness

Because swarm robots work in groups, they are less vulnerable to individual robot failures. If one robot malfunctions or is damaged, the swarm can continue to operate without interruption.

Flexibility

Swarm robots can adapt to changing environments and tasks more easily than individual robots. They can reconfigure themselves to form different structures or perform different tasks, depending on the situation.

5

Limitations

Complexity

The coordination and control of large groups of robots can be difficult and complex. It requires sophisticated algorithms and hardware, and a significant amount of computational power.

Communication

Effective communication among swarm robots is critical to their success. However, wireless communication channels can be limited by obstacles, interference, and other factors, which can affect the performance of the swarm.

Cost

The development and deployment of swarm robots can be expensive, especially for large-scale operations. The cost of hardware, software, and maintenance can be significant.

6

Conclusion

In conclusion, swarm robots are a promising technology that can offer a range of benefits, including scalability, robustness, flexibility, and efficiency. However, the coordination and control of large groups of robots can be complex, and there are limitations such as communication, cost, and ethical considerations that must be taken into account. Despite these challenges, the potential benefits of swarm robots make them an attractive option for a variety of applications, and ongoing research and development are expected to expand their capabilities and improve their performance.

THANK YOU