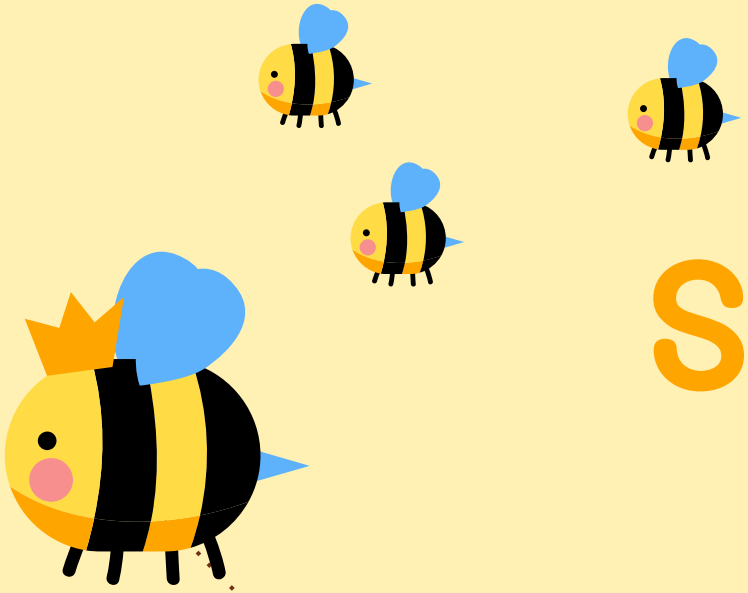


SWARMING ROBOT

By: Azizi Bin Mohamad Tambi (1919661)

Spelling bee infographics

01 INTRODUCTION

02 HISTORY & APPLICATION

03 MAIN COMPONENTS

04 BUILDING YOUR OWN

05 MALAYSIA MARKET

06 CONCLUSION

01

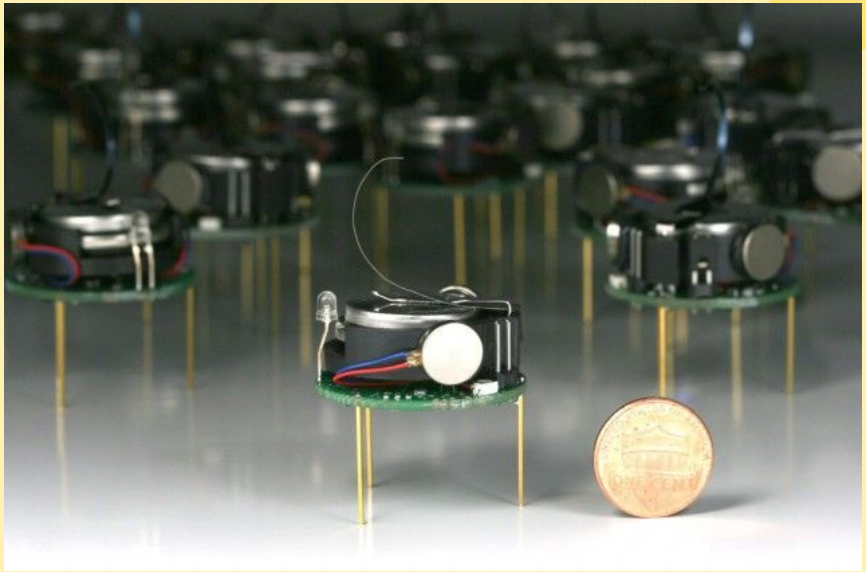
INTRODUCTION

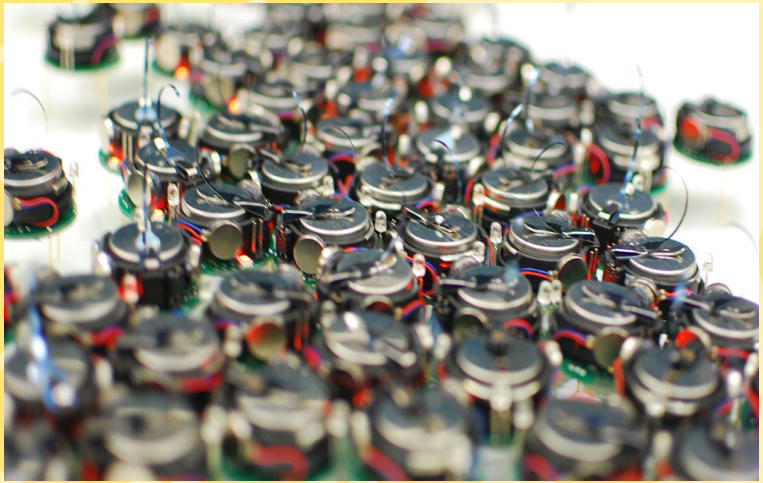
WHAT SHOULD YOU KNOW FIRST

- Swarming robots area a group of autonomous robots that are programmed to work together in a coordinated manner to achieve common goal.
- These robots communicate with each other to coordinate their movement and actions, allowing the to operate as a single entity with many different parts.
- Swarming robots can be used for a variety of tasks such as search and rescue missions, environmental monitoring and military operations.
- Swarming robots is their ability to adapt to changing environments and situations as they can communicate with each other, hence they can quickly adjust their behavior in response to new information or changing conditions.

RESEARCH BACKGROUND

- One of the earliest examples of swarming robots was developed in the 1990s by roboticist at MIT.
- The robots were called “Cogbots”, designed to mimic the behavior of insects, with each robot performing a specific task and communicating with its neighbors to achieve a common goal.
- Researchers have explored various algorithms for coordinating swarms, including behavior-based approaches, artificial neural networks, and particle swarm optimization.
- Swarming robots have been used widely, including disaster response, environmental monitoring, and precision agriculture.
- It also used for military purposes, such as surveillance and reconnaissance.

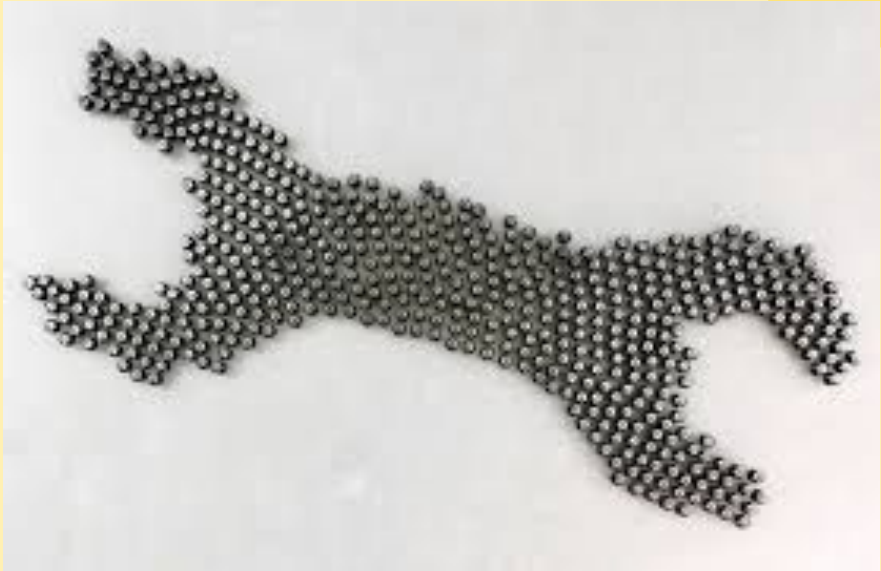




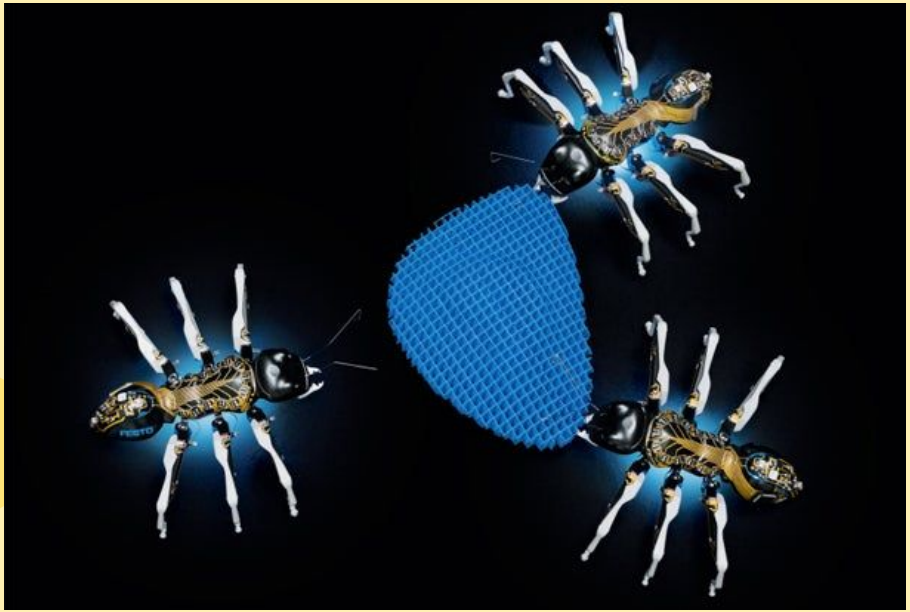
02 HISTORY & APPLICATIONS

COGBOTS

- Cogbots was developed by Rodney Brooks and his team at MIT.
- The name “Cog” is derived from “cognition”, as the robots were designed to mimic the behavior of insects, which exhibit simple forms of cognition.
- The Cogbots were small, wheeled robots that communicated with one another using infrared sensors where each robot was equipped with a small set of sensors and actuators, allowing it to perform simple tasks such as moving, avoiding obstacles, and detecting light.
- One of the key features of the Cogbots was their ability to operate without a centralized controller.
- The Cogbots were used for tasks such as environmental monitoring and disaster response.
- In one demonstration, it was used to locate and retrieve a target object in cluttered environment.



ROBOTIC ANTS



- Robotic ants is the first swarm robot developed by James McLurkin, a PhD student at MIT in 1995.
- McLurkin works in Rodney Brooks, who had previously developed a series of small robots known as “Cogbots” that were capable of swarming behavior.
- This robot was inspired by the behavior of ants in a colony where the robot was designed to be small and simple, with each unit measuring just a few inches in length and weighing less than a pound.
- It is equipped with basic sensors such as IR and light sensors, allowing them to detect and communicate with other robots.
- Each robot can move in a straight line or turn at a right angle.
- Each robot would communicate with its neighbors to determine the best course of action.

APPLICATION

- Search and Rescue
- Environmental Monitoring
- Precision Agriculture
- Military and Defense
- Manufacturing
- Construction
- Entertainment
- Disaster Response
- Exploration
- Transportation
- Social Interaction
- Education/ Research

03 MAIN COMPONENTS OF SWARMING ROBOT

I. Frame & Design

II. Propulsion System

III. Navigation & Control System

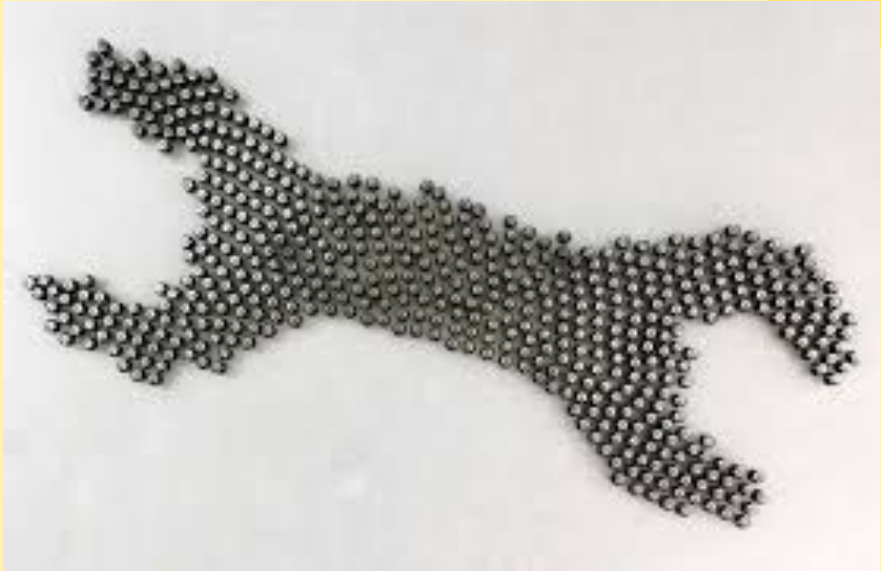
IV. Data Collection

V. Data Transmission

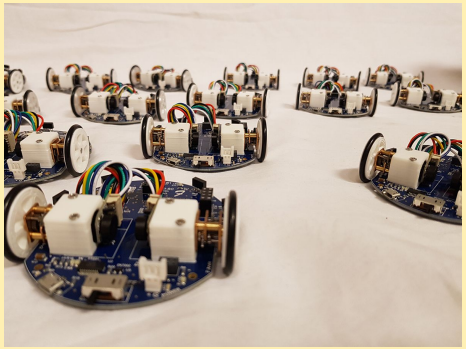
VI. Power Management

I. FRAME & DESIGN

- Swarm robot come in various shapes and sized, and their frame and design depend on their intended application and the environment in which they will operate.
- Swarm robots can be designed to have a modular or unitary structure.
- Modular robots consist of multiple interchangeable modules that can be combined in different configurations to achieve different functionalities.
- Unitary robots, on the other hand consist of a single unit that performs all the required tasks.

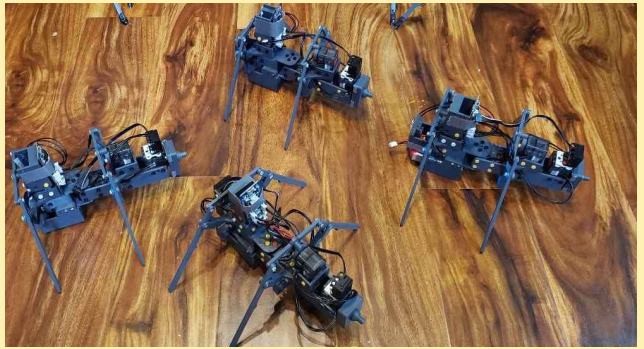


I. FRAME & DESIGN



Wheeled Robots

- Use wheels for locomotion and are suitable for operating on flat surfaces.
- Generally fast and agile, but their mobility is limited by the terrain they operate on.



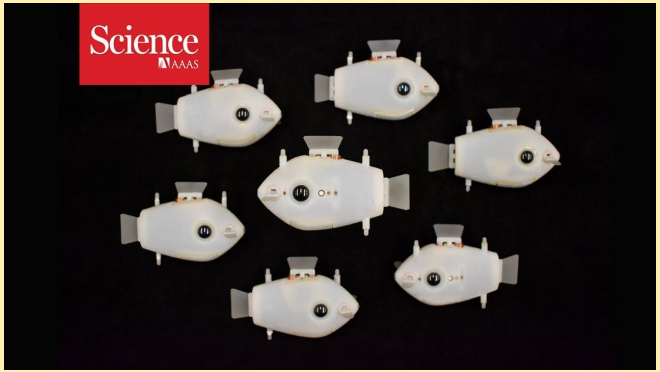
Legged Robots

- Use legs for locomotion and are suitable for operating in rough terrain.
- Generally slower than wheeled robots, but their mobility is not limited.

I. FRAME & DESIGN

Flying Robots

- Use rotors or wings for flight and are suitable for operating in aerial environments.
- Generally fast and agile, but flight time is limited by battery capacity.



Swimming Robots

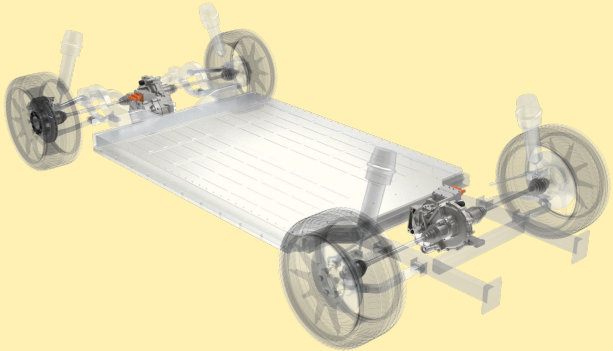
- Use fins or propellers for propulsing and are suitable for operating in underwater environments.
- Generally slower than wheeled or flying robots.

I. FRAME & DESIGN

Hybrid Robots

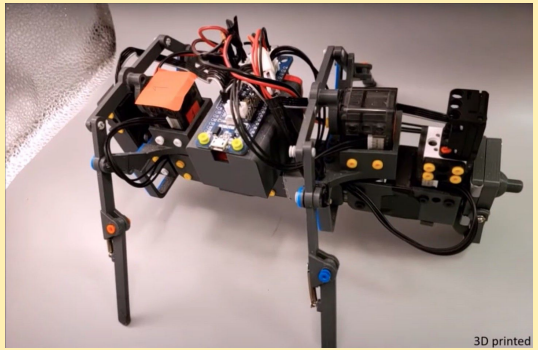
- Combine multiple types of locomotion to achieve greater versatility and adaptability.
- For instance, a wheeled robot can transform into a legged robot to overcome obstacles or a flying robot to survey a large area.

II. PROPULSION SYSTEM



Wheels

- Most common types of propulsion systems used by swarm robots.
- Wheels are driven by motors and provide movement on flat surfaces.
- Fast and efficient and its speed can be controlled easily.



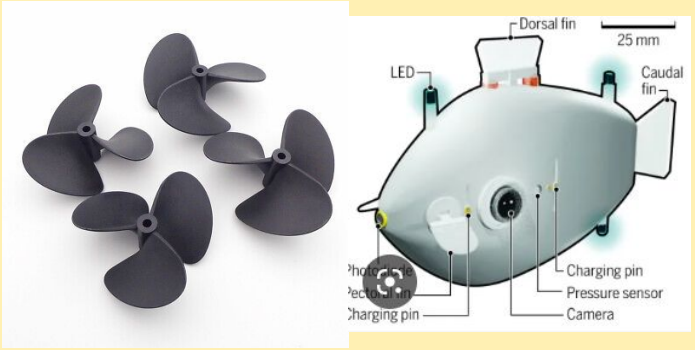
Legs

- Used in rough terrains such as forests, mountains, or disaster zones.
- Slower than wheeled robots, but can navigate difficult terrain.
- The legs can be designed to walk, crawl or climb.

II. PROPULSION SYSTEM

Propellers

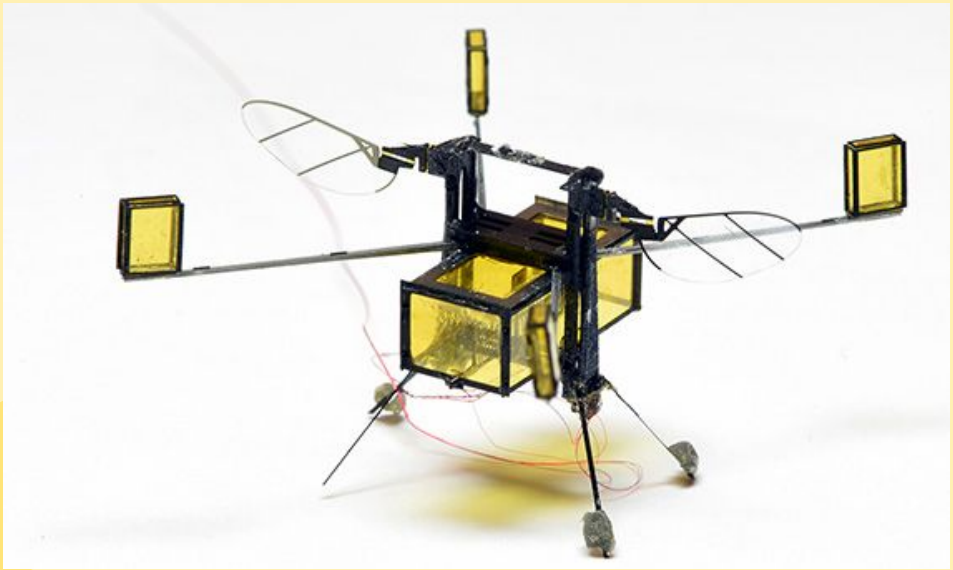
- Flying swarm robots use propellers or rotors to generate lift and thrust for flight.
- Efficient and fast, and can operate in aerial environments such as skied or indoor spaces.



Fins/Propellers

- Swimming swarm robots use fins or propellers to generate propulsion in water.
- Slower than wheeled of flying robots, but can operate underwater.

II. PROPULSION SYSTEM



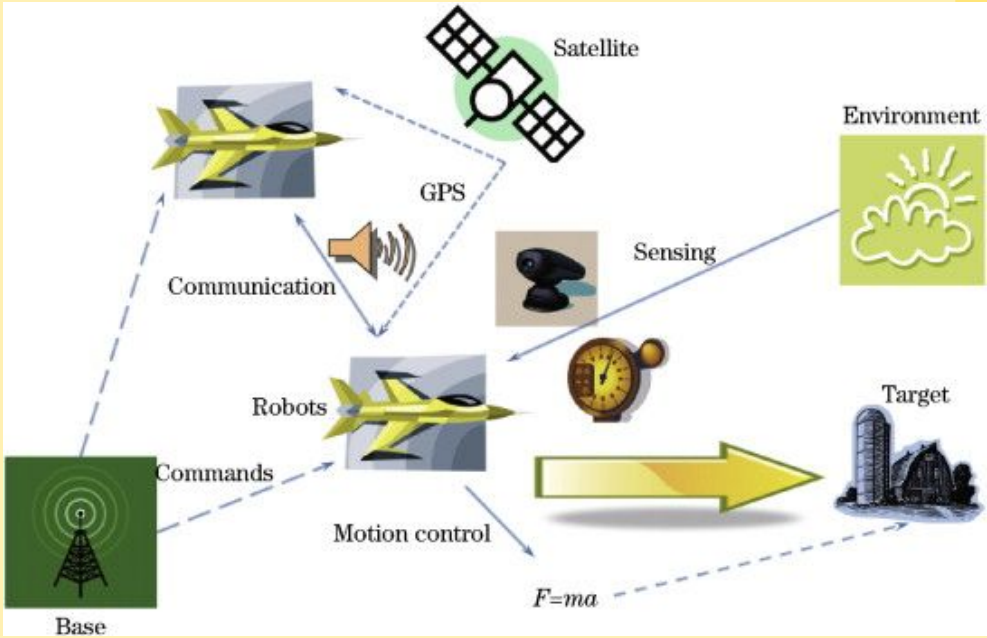
Hybrid

- Some swarm robots use a combination of propulsion systems to achieve greater versatility and adaptability.

III. NAVIGATION & CONTROL SYSTEM

GPS & Others

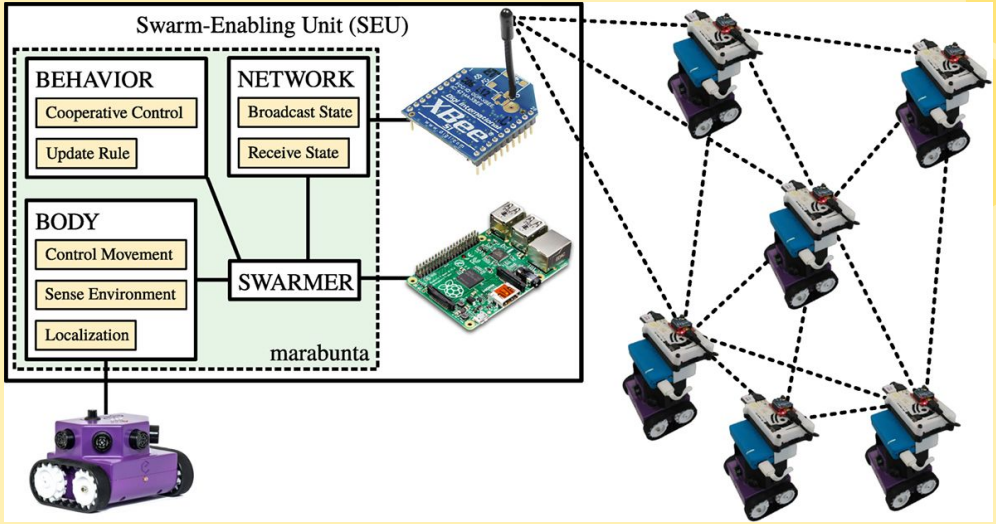
- Swarm robots can use GPS and other navigation sensors such as magnetometers, accelerometers, and gyroscopes to determine their position, velocity, and orientation.
- This information can be used to plan and execute movements, avoid obstacles, and collision, and coordinate with other robots.



III. NAVIGATION & CONTROL SYSTEM

Wireless Communication

- Swarm robots can communicate wirelessly with each other and with a central control system to exchange information and coordinate their actions.
- This allows them to share data, update their positions, and perform tasks in a distributed and coordinated manner.



III. NAVIGATION & CONTROL SYSTEM

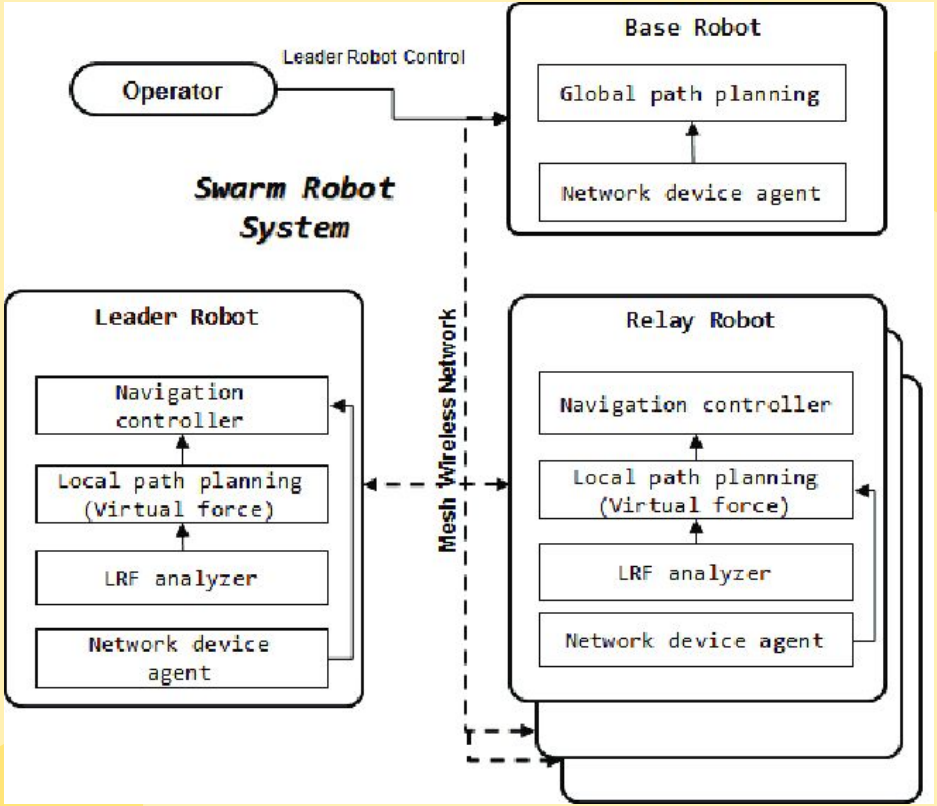
Artificial Intelligence

- Many swarm robots are equipped with AI systems that allow them to learn from their environment and adapt to changing conditions.
- This enables them to make intelligent decisions, such as selecting efficient path to reach a target, or adjusting their speed and direction to avoid obstacles.

III. NAVIGATION & CONTROL SYSTEM

Control Algorithms

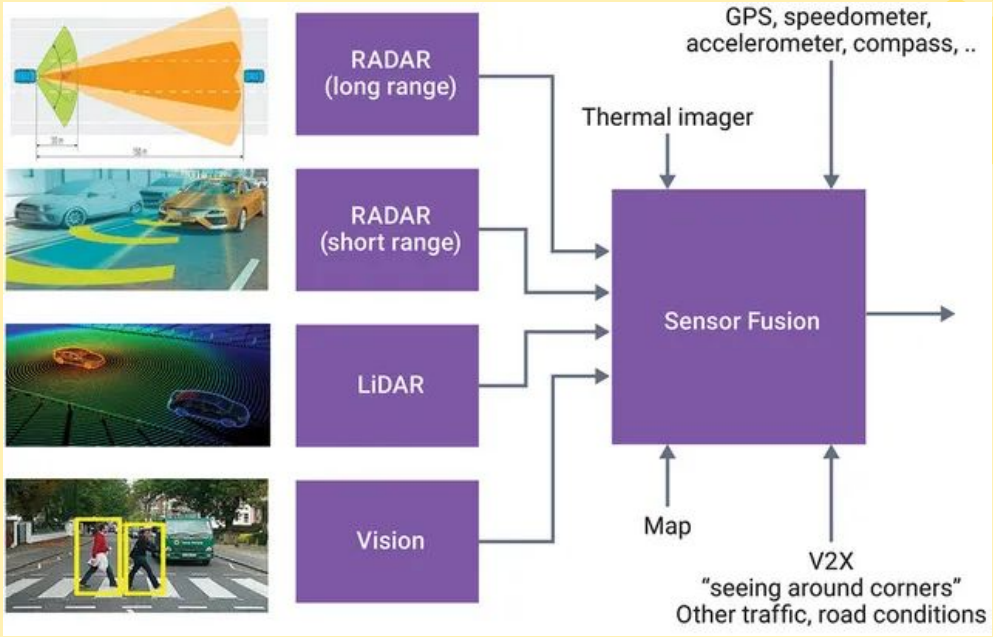
- Swarm robots use various control algorithms to coordinate their movements and perform tasks.
- These algorithms can range from simple rule-based systems to more sophisticated distributed control systems that allow the robots to work together as a team.



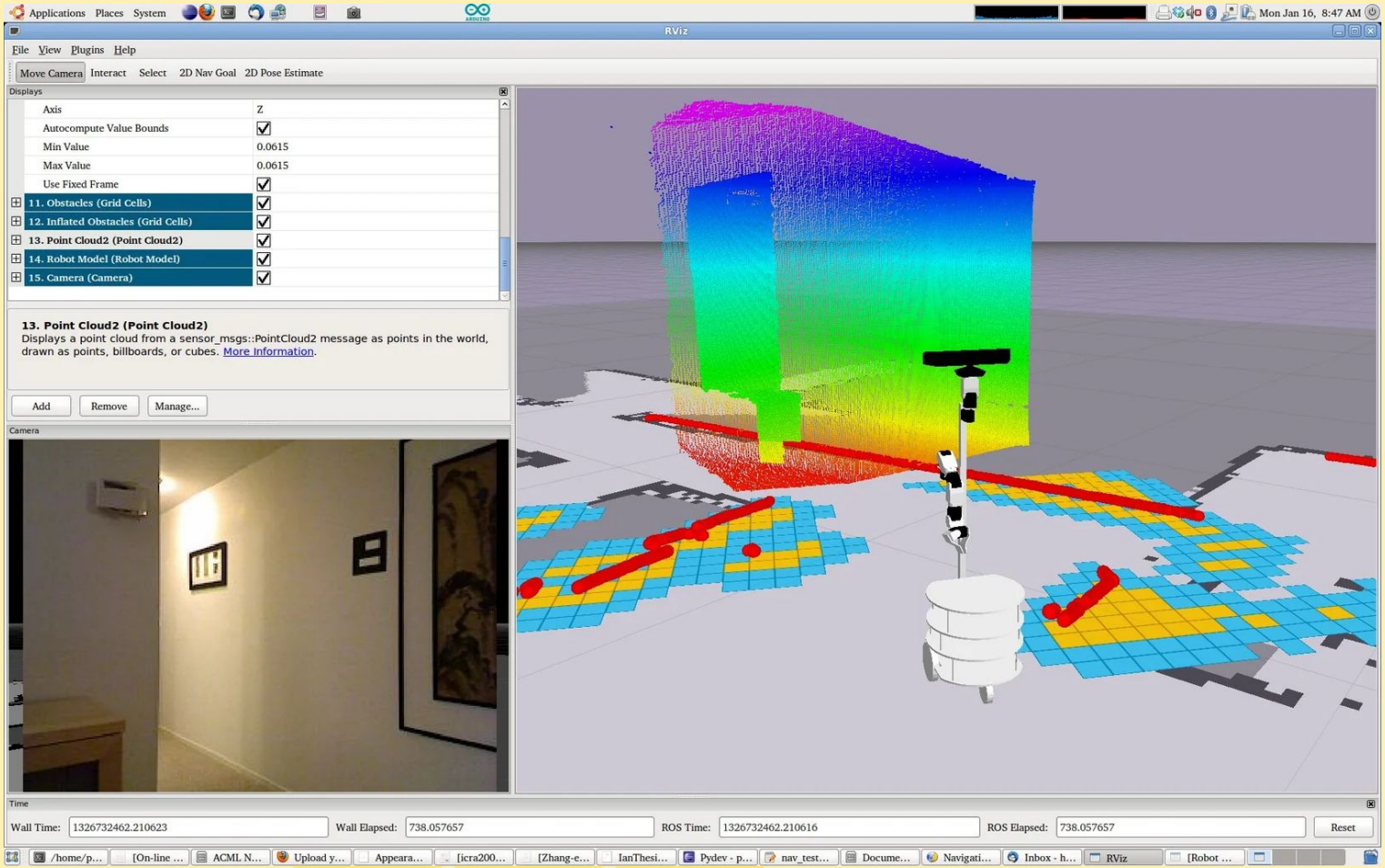
III. NAVIGATION & CONTROL SYSTEM

Sensor Fusion

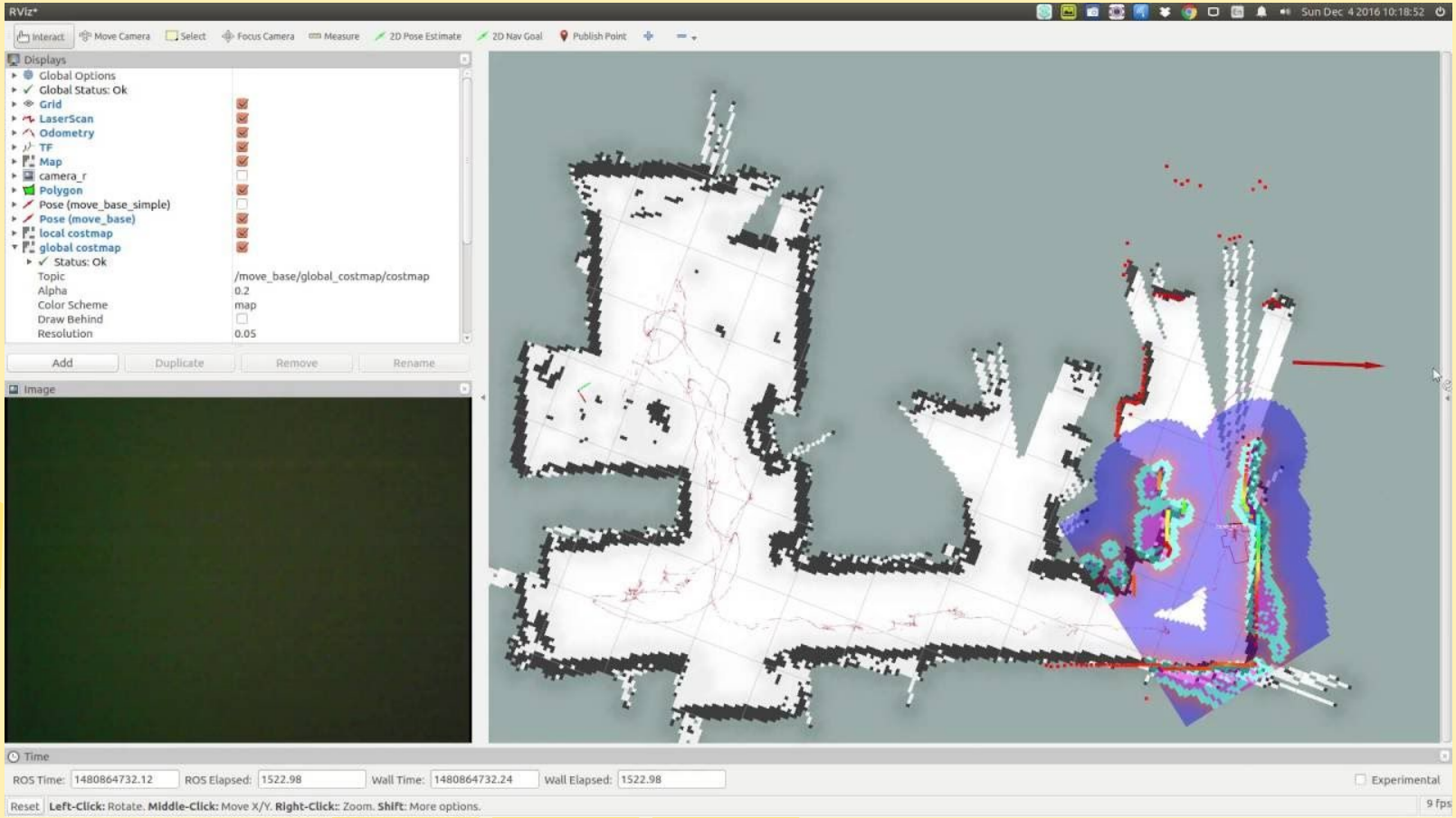
- Some swarm robots use sensor fusion techniques to combine data from multiple sensors and sources, such as cameras, lidar, and radar.
- This enables them to build a more accurate and complete picture of their environment, which in turn improves their navigation and control.



Navigation Software (ROS)

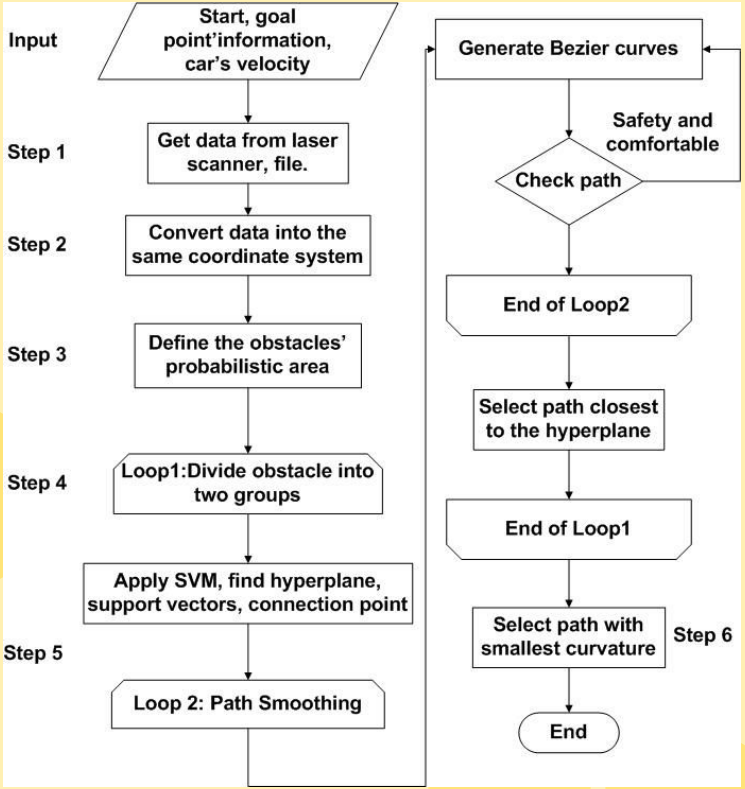


Navigation Software (SLAM)

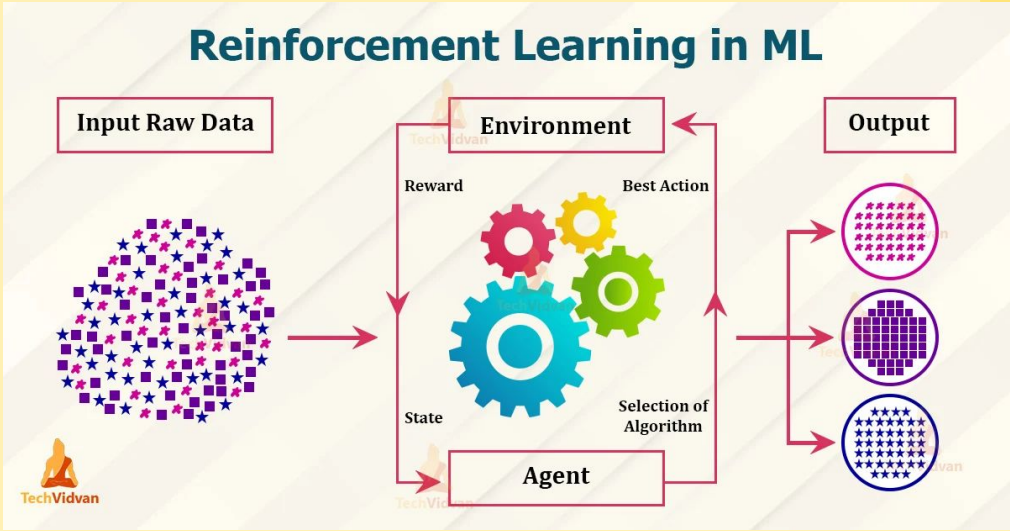


Navigation Software

Path Planning Algorithms:

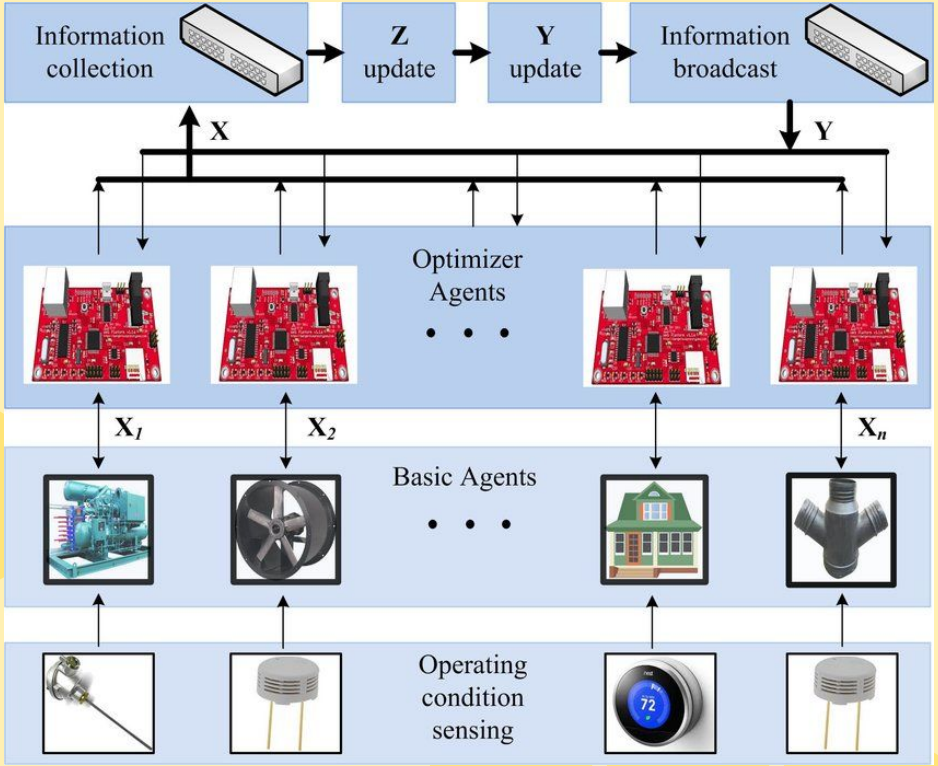


Reinforcement Learning:



Navigation Software

Multi-Agent Coordination:



IV. DATA COLLECTION

SENSORS

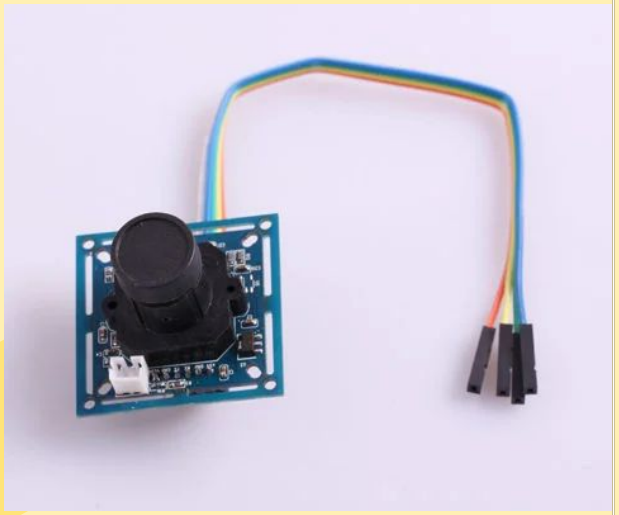
- Cameras
- LiDaR
- Inertial Measurement Units (IMUs)
- Proximity Sensors
- Microphones

ACTUATORS

- Legs
- Tentacles
  -Can be used to manipulate objects.
- Pneumatic/ Hydraulic systems
- Gripper
- Electrostatic Adhesion
  -Can be used to stick to surfaces.
- Shape Memory Alloys
  -Change the shape of the robot in response to external stimuli.
- Electroactive Polymers
  -Used as actuators to bend or flex the robot in response to an electric field.
- Magnetorheological Fluid
  -Used as actuators to change the stiffness or damping of the robot in response to magnetic field.

IV. DATA COLLECTION

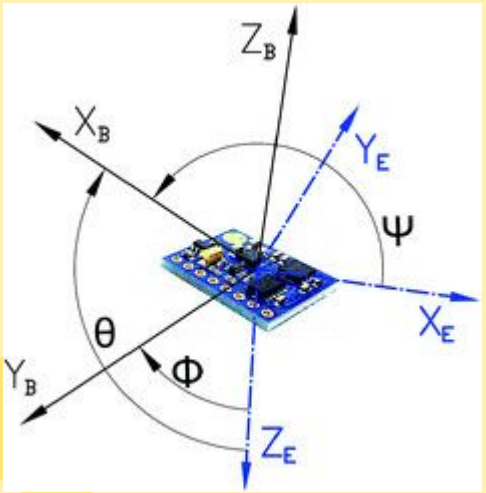
Camera:



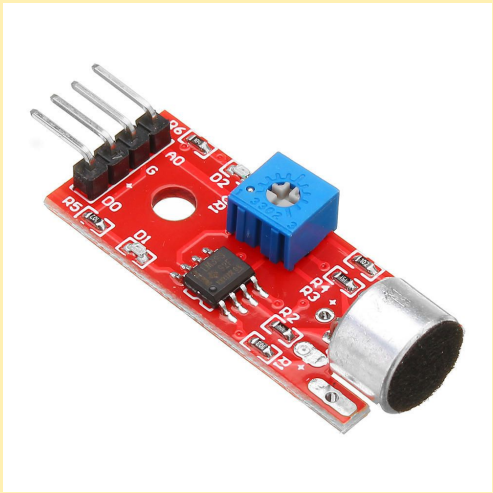
Lidar:

IV. DATA COLLECTION

IMUs:



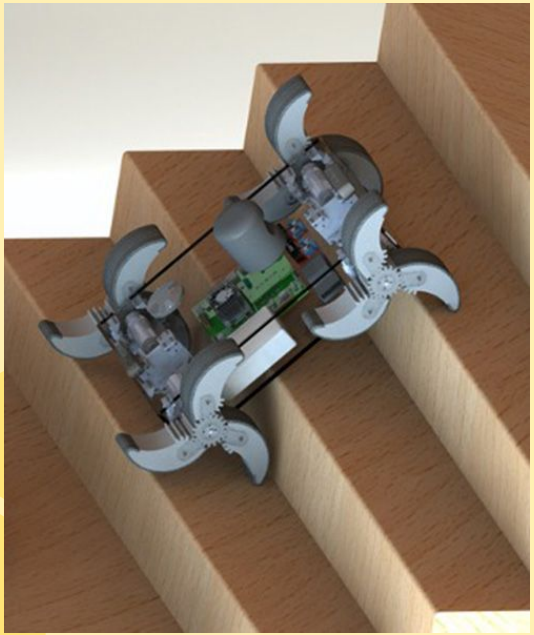
Microphone:



Proximity Sensor:

IV. DATA COLLECTION

Legs:

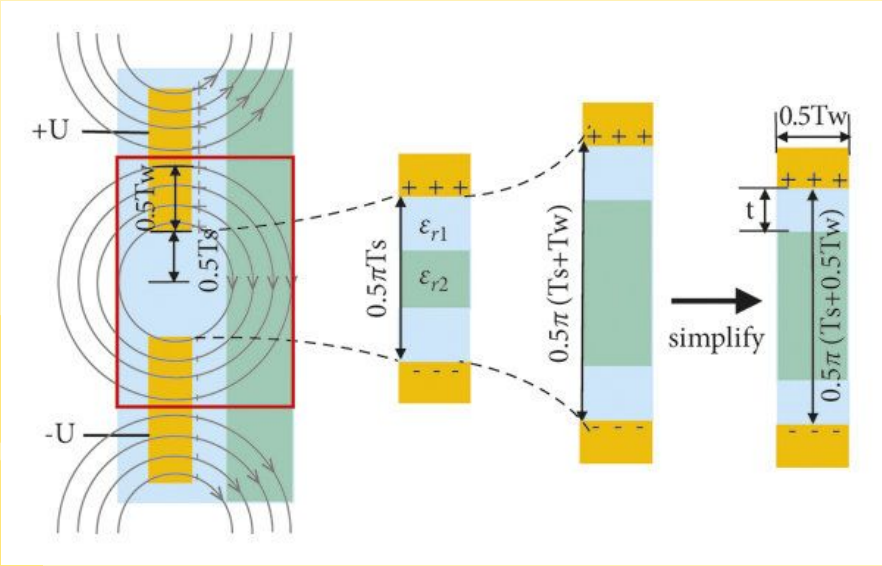


Tentacles:

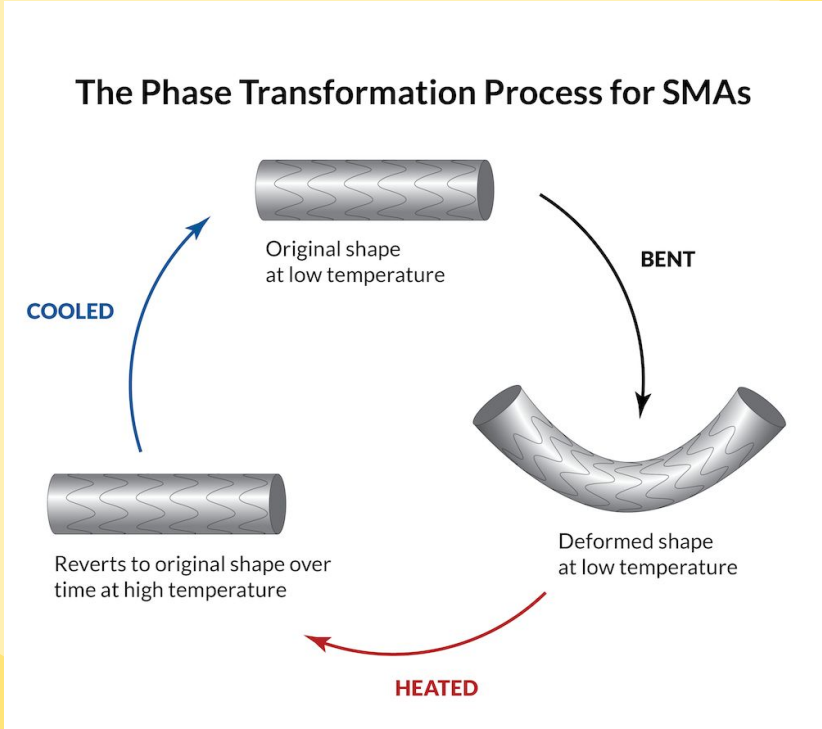
Gripper:

IV. DATA COLLECTION

Electrostatic Adhesion:



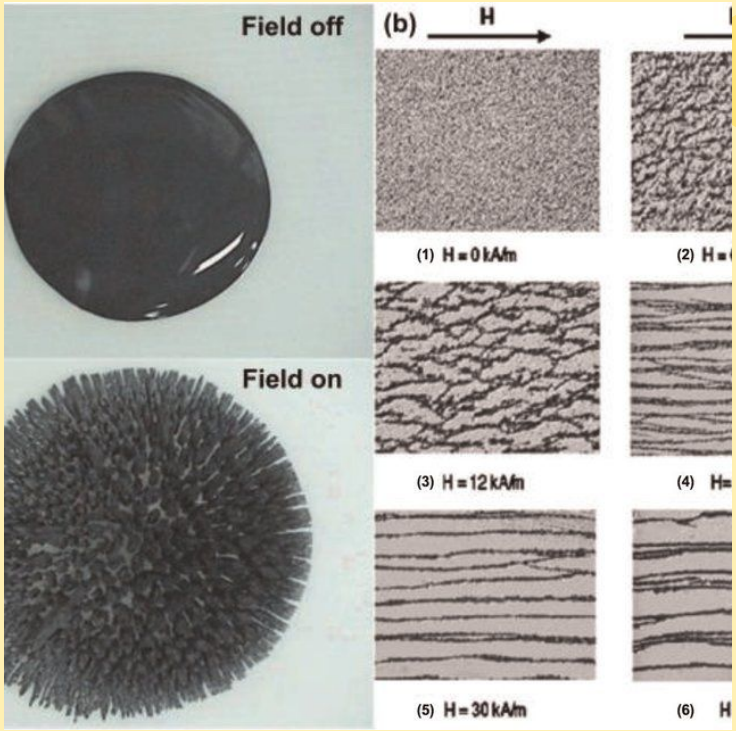
Shape Memory Alloys:



IV. DATA COLLECTION

Electroactive Polymers:

Magnetorheological Fluid:



V. DATA TRANSMISSION

WiFI

- Common form of wireless communication used by swarm robots to transmit data.
- Provide high-speed communication and can support multiple robots simultaneously.

Bluetooth

- Can be used to provide communication between nearby robots and can also be used to communicate with other devices such as smartphones or laptops.

IR

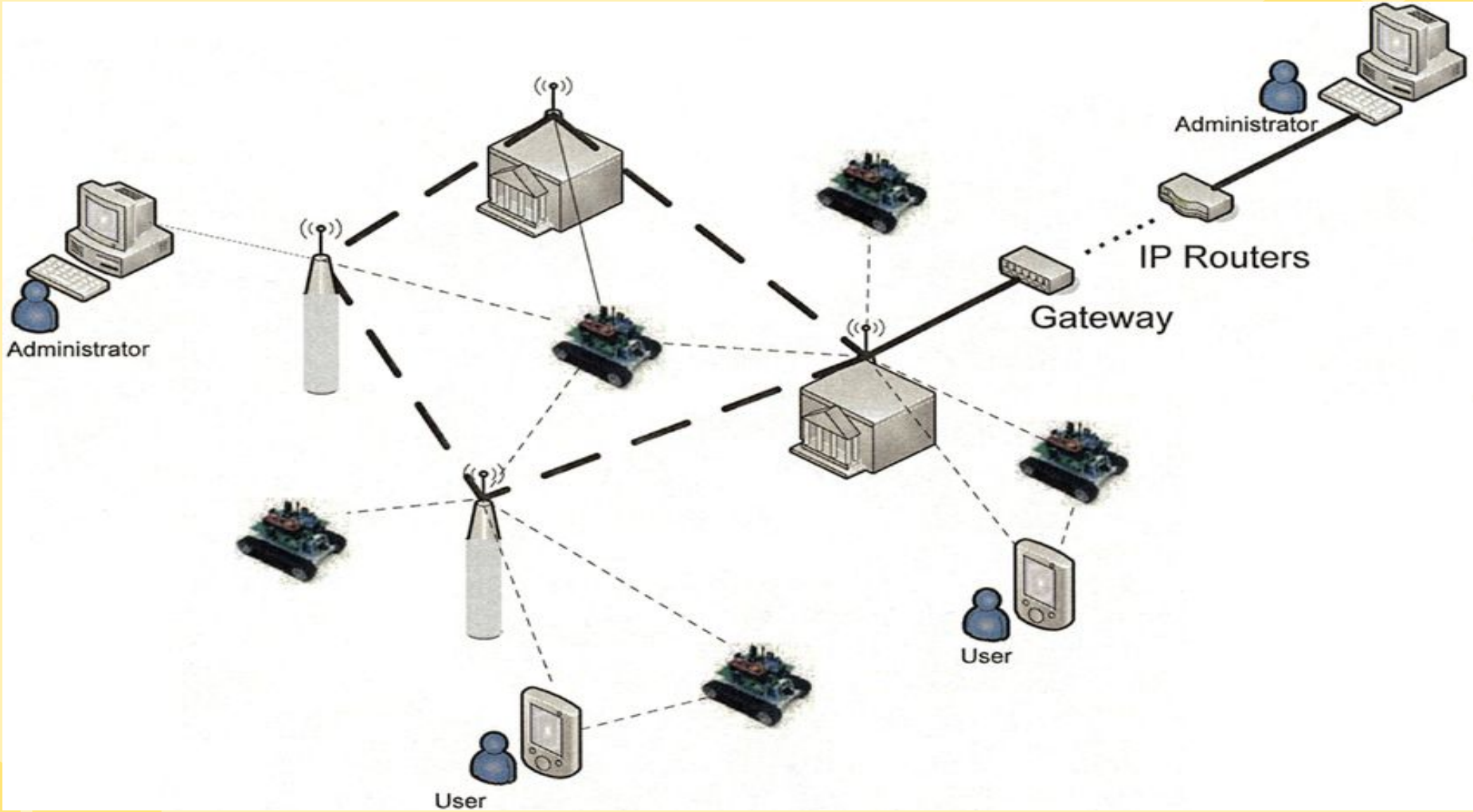
- Used when radio frequency communication is not feasible due to interference or power constraints.

Zigbee

- Zigbee is a wireless communication protocol designed for low-power and low-data rate applications.
- Allow communication between a large number of robots while consuming minimal power.

Radio Frequency

- Can be used to transmit data between swarm robots and the control system.
- Can transmit data over long distances, but may be affected by interference from other wireless devices.


Administrator
Administrator
IP Routers
Gateway
User
User

VI. POWER MANAGEMENT

Batteries

- Can be small and lightweight, and can provide high energy density.
- Have limited capacity and need to recharged or replaced periodically.

Solar Panel

- Lightweight and require no fuel, but may not be able to provide sufficient power in low light conditions when robot is in shade.

Fuel Cells

- Can power the robot longer than batteries.
- Convert energy from fuel such as hydrogen or methanol into electrical energy.
- Require source of fuel which can add weight to the robot.

Energy Harvesting

- Energy harvesting techniques can be used to generate power from environment.
- Piezoelectric materials can convert mechanical energy into electrical energy, which can be used to power actuators and sensors.

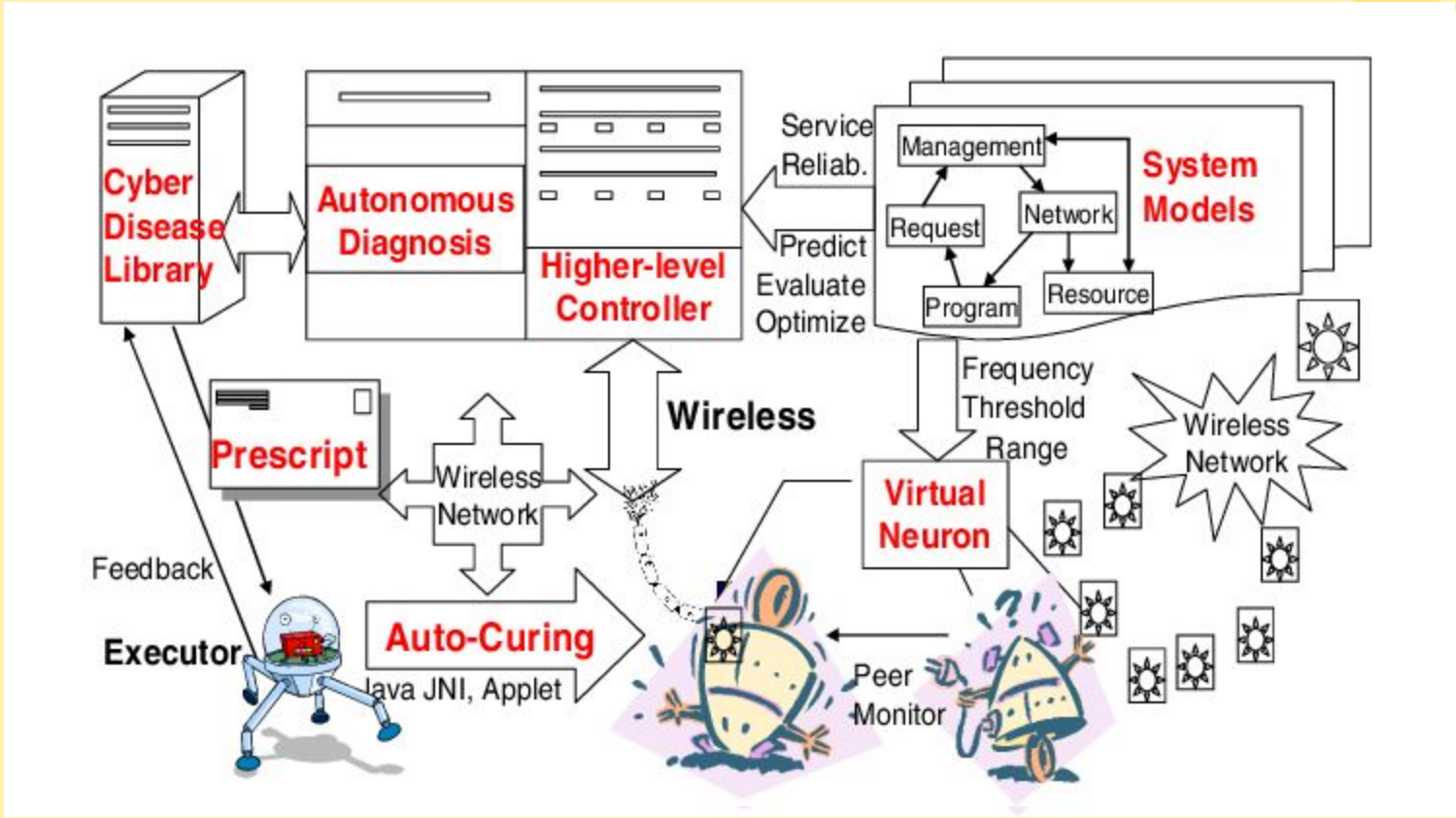
Wireless Charging

- Can be used to recharge swarm robots without the need for physical contact.
- Useful for robot that are difficult to access, such as those operating underwater or in hazardous environments.

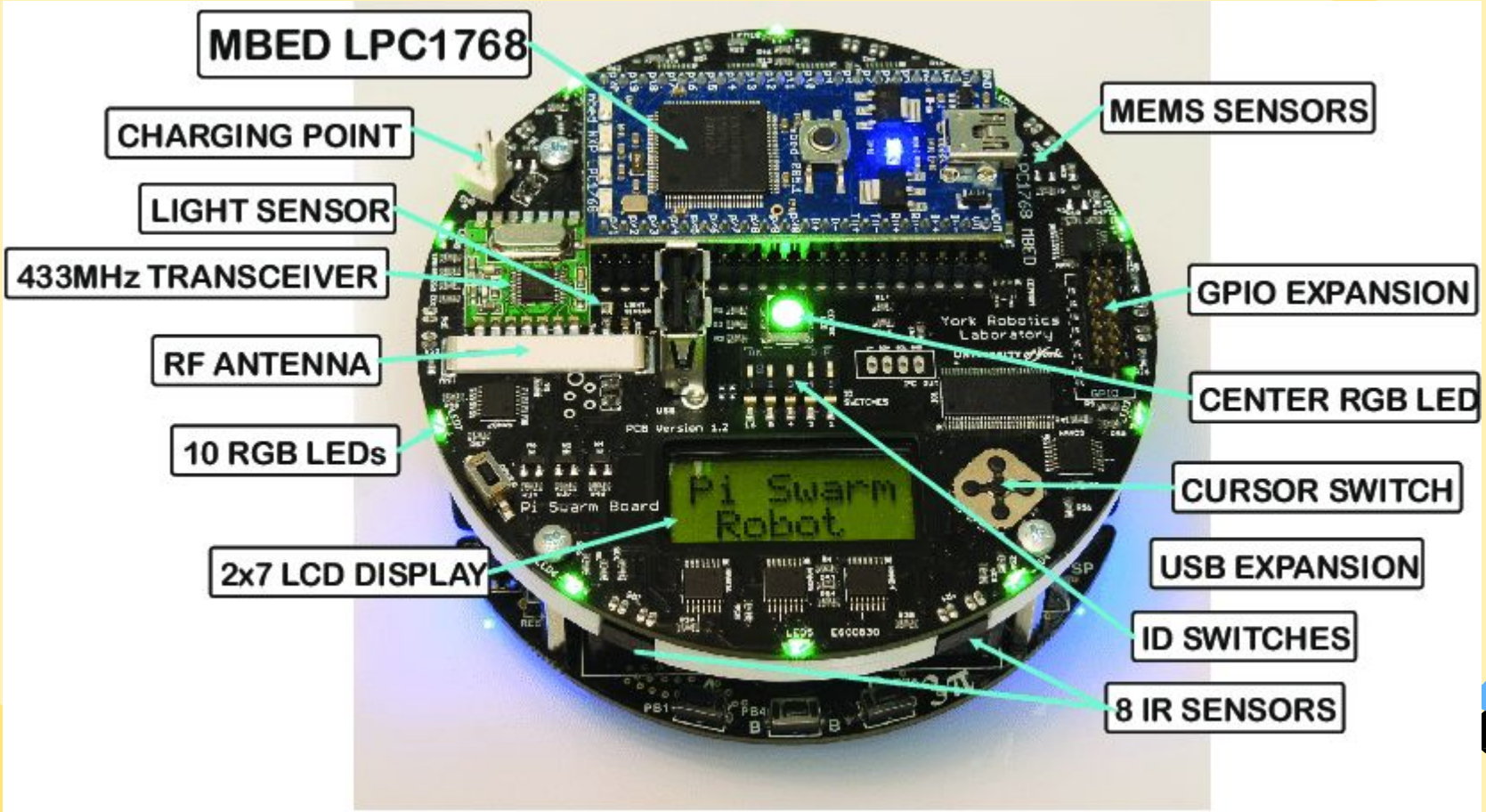
04

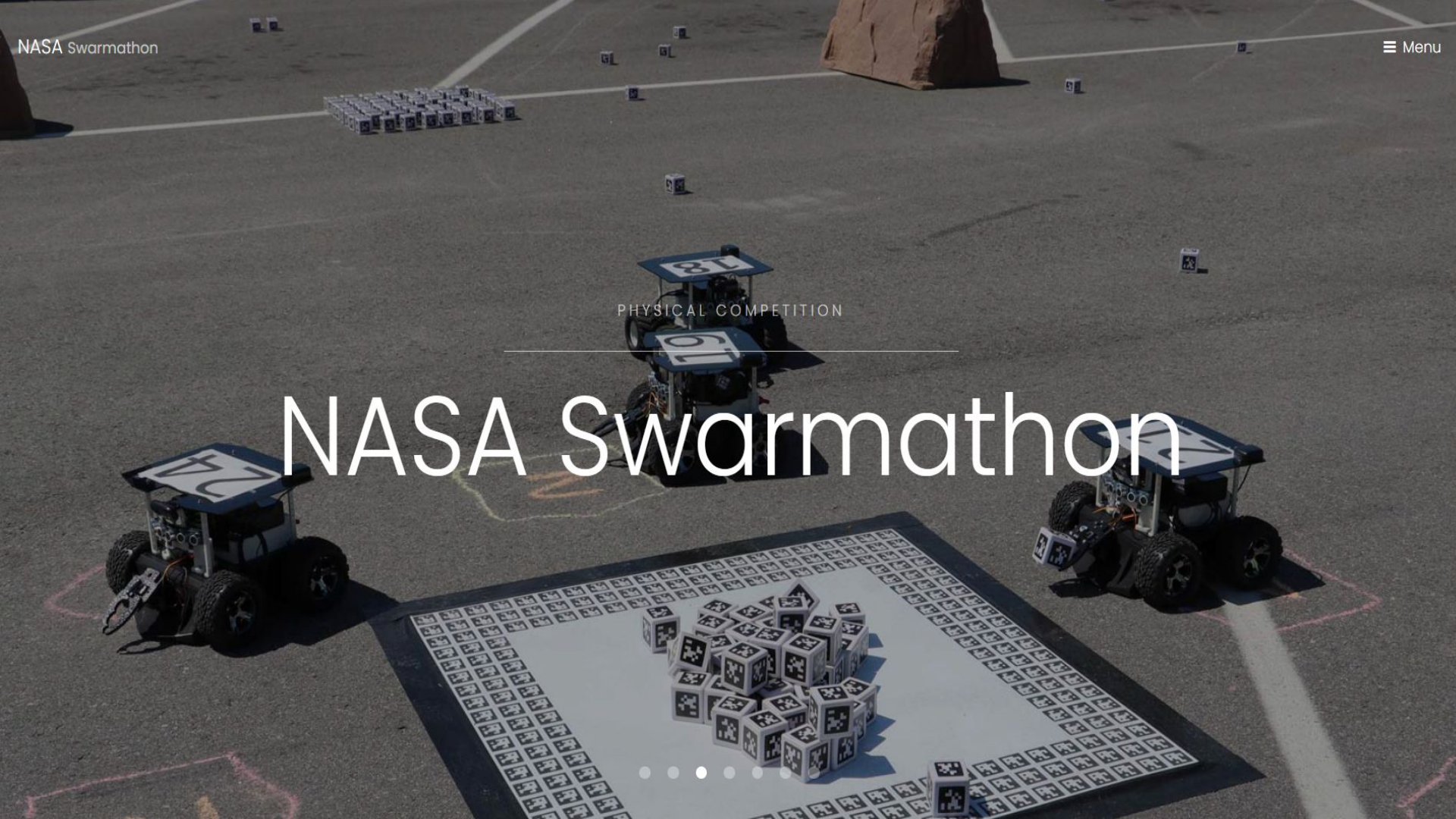
BUILDING YOUR OWN

Complete Swarm Robot System Architecture



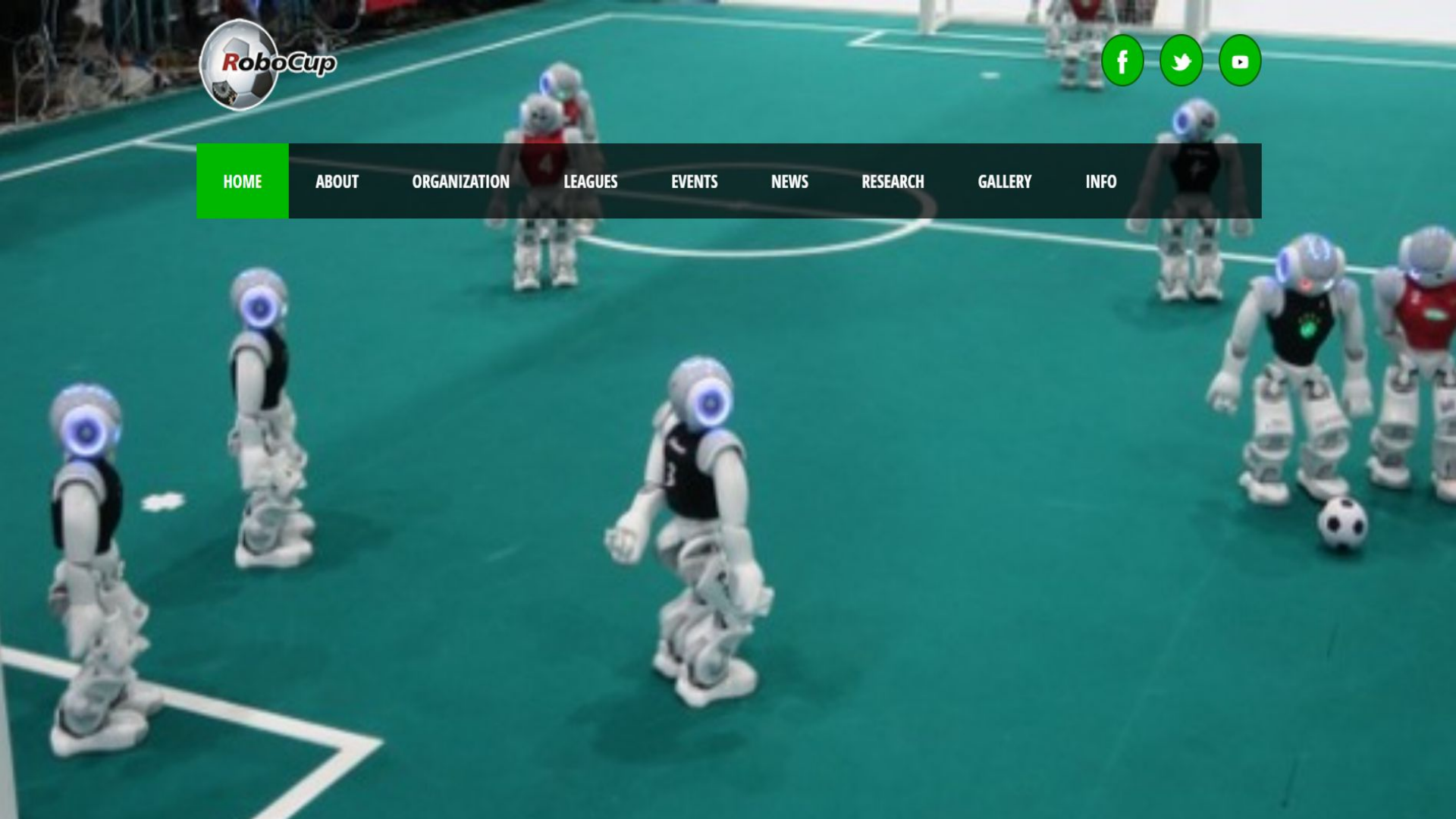
Hands On Session





PHYSICAL COMPETITION

NASA Swarmathon


RoboCup
HOME
ABOUT
ORGANIZATION
LEAGUES
EVENTS
NEWS
RESEARCH
GALLERY
INFO

Swarm Robots Competition

About the Competition

There is a growing need for Swarm Robots one of the most significant technologies of the near future. The importance of Swarm UAVs is becoming more and more manifest in both civilian and military use. For instance, a civil scenario could involve responding to forest fires much more efficiently with Swarm UAVs, and in the military scenario, one party could gain an advantage over an existing aerial, ground and marine manned platform by developing a set of alternative strategies and tactics.

The primary objectives of Swarm UAV Competition include developing software algorithms to organize UAV swarms that can perform the tasks assigned as per terms and conditions of the competition, and demonstrating the performance results of these algorithms with Swarm UAVs in a physical environment, as well as providing guidance to youth and helping them gain experience and knowledge.

Once these UAVs are organized, the teams are expected to fly virtual and real UAVs in swarms, and share videos of their flights.

The competition consists of theseUAV following tasks:

- UAV individual take-off, aerial formation
- Formation take-off
- Adding a drone to the swarm
- Removing a drone from a swarm

05 MALAYSIA MARKET

Market Player:

1. Cyberdyne Tech Exchange (CTX)
2. RoboVation Sdn Bhd
3. HSS Integrated Sdn Bhd
4. REKA Inisiatif Sdn Bhd
5. CAIRO, UTM

Who can use this?

1. Researchers
2. Private Companies
3. Agricultural Companies:
   -Sime Darby Plantation
   -FGV Holdings Berhad
4. Manufacturing Companies:
   -Intel
   -Infineon Technologies
5. Logistics Companies:
   -Pos Malaysia Berhad
   -DHL Express
6. Emergency response organizations:
   -Malaysia Fire and Rescue Department
   Malaysia Red Crescent Society

OBSTACLES



01

Cost

Swarm robotics technology is still relatively new and developing, and the cost of developing and implementing can be high.

02

Infrastructure

Some applications of swarm robots may require specific infrastructure such as communication networks, charging stations, or specialized sensors.

03

Regulation

The use of swarm robots may be subject to regulation or restrictions by government agencies in Malaysia.

04

Environmental Factors

Malaysia's tropical climate and terrain may pose challenges for the use of swarm robots in certain applications. For instance, heavy rain or flooding may damage swarm robots or hinder their mobility.

Top Things To Remember When Using Swarming Robot

Safety

- Ensure that proper safety protocols and guidelines are followed when operating Swarm robots.
- This includes wearing appropriate personal protective equipment and ensuring that the robot are operating within safe parameters.

Communication

- Effective communication between the robots is essential when operating swarm robots.

Environment

- Consider the environment in which the swarm robots are operating.
- This includes factors such as lighting, temperature, terrain, and potential hazards.

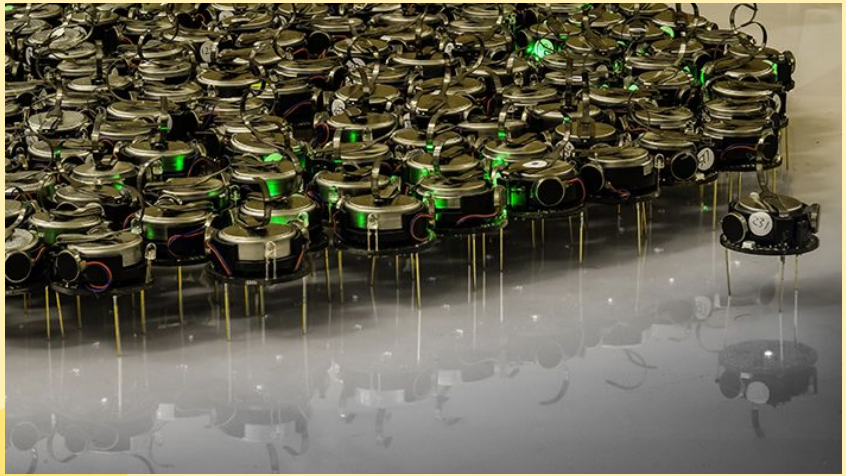
Power Management

- Ensure that the swarm robots have sufficient power to operate.
- This include using efficient power management strategies such as automatic charging or power-saving modes.

Data collection and Analysis

- Ensure that the data collected is accurate and reliable, and that appropriate analysis tools and techniques are used to make sense of the data.

06 CONCLUSION



In conclusion, swarm robotics is an emerging technology that has the potential to revolutionize a wide range of industries and applications. Swarm robots can work together in a coordinated and decentralized manner, allowing for greater efficiency flexibility, and resilience. It is possible that swarm robotics will become an increasingly important tool for organizations and businesses in Malaysia and around the world. The potential benefits of swarm robotics are vast, and the future of this technology is both exciting and promising.