SWARMING ROBOT

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01 INTRODUCTION

- Swarming robots are a type of robots that work in groups to accomplish a common goal.
- Inspired by social insects such as ants, bees, and termites.
- Can communicate with each other, share information, and coordinate their actions.
- They can adapt and respond to changing environments and tasks.
- However, there are challenges associated with swarming robots, such as communication and coordination issues, and the need for sophisticated algorithms and sensors.
- The development of swarming robots has the potential to revolutionize various industries and applications in the future.

02

HISTORY

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HISTORY OF THIS DAY

1989

Craig Reynolds developed the concept of "boids", a computer simulation of the flocking behavior of birds.

1990s

Swarm robotics began to emerge as a field of study, with researchers exploring the collective behavior of groups of simple robots.

2000s

Swarming robots were developed for military applications, such as the iRobot Packbot and the US Army's SWORDS robot.

2010s

Swarming robots were used for search and rescue operations, such as the RoboBees developed by Harvard University for disaster response.

2015

he European Union launched a project called "SwarmRobot", which aimed to develop swarming robots for precision agriculture.

2017

The US Navy tested a swarm of 30 autonomous boats, called "swarmboats", for port security and surveillance.

2019 - now

Researchers at MIT developed a swarm of small robots that can work together to form various shapes and structures and it keep developed in various field

03

APPLICATION

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MILLITARY

- Swarming robots can be used for reconnaissance, surveillance, and target identification.
- They can also carry out search and rescue missions in hazardous areas, and detect and disarm explosive devices.

MANUFACTURING

- Swarming robots can work together to assemble products, package goods, and transport materials.
- They can also adapt to changes in demand and work collaboratively with human workers.

AGRICULTURE

- Swarming robots can monitor crops and soil conditions, identify pests and diseases, and spray targeted areas with pesticides.
- They can work in tandem with human farmers to increase efficiency and reduce labor costs.

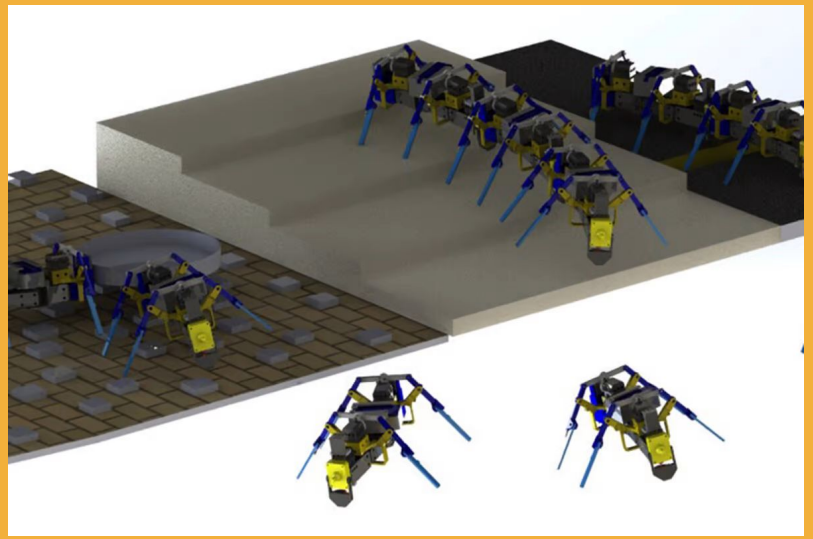
CONSTRUCTION

- Swarming robots can be used to inspect construction sites for safety hazards and monitor the progress of construction projects.
- They can also work collaboratively to carry out complex construction tasks, such as laying bricks or assembling structures.

MAIN COMPONENTS & DESIGN

BODY DESIGN

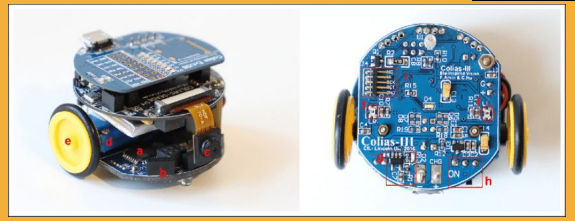
- Small and simple
- Low cost
- Design usually inspired by insects like ant, spiders
- The size maybe depends on task sometimes
- Manufacture in huge quantity despite small size



LOCOMOTION

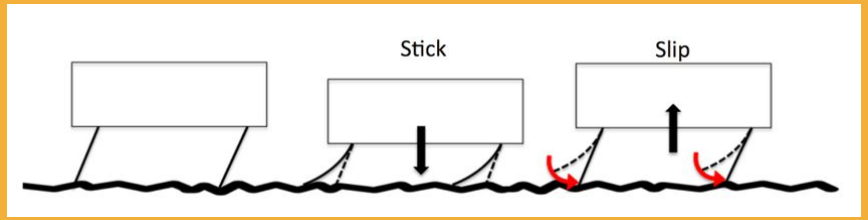
TRELLED

- Hybrid between wheeled and tracked
- More traction and stability when moving over rough or uneven terrain
- Ex: Jasmine



WHEELED

- Robot velocity: 25 cm/s
- Typically easy to design and control
- Ex: Khepera



SLIP STICK

- Robot velocity: 1 cm/s
- Needs Flat surface
- Inspired by the way snake moves
- Ex: I-Swarm

PROPULSION

Propulsion system	Description	Example
DC Motors	Simple, reliable, and efficient, and they can provide a wide range of speeds and torques.	Harvard RoboBees
Bidirectional Motors	a.k.a DC geared motors, are similar to DC motors but have a gearbox attached to the output shaft. This gearbox allows the motor to provide more torque at lower speeds.	Alice
Piezoelectric Polymers	Smart material that can generate motion in response to an electrical signal. These materials are lightweight, flexible, and can provide high-speed motion with low power consumption.	I-Swarm
Stepper motors	Motor that rotates in discrete steps, making them useful for precise motion control.	

NAVIGATION

- Navigate through sensors and behaviour.
- There is many type of sensors that being used such as accelerometer, IR sensor, wheel encoder, torque and etc.
- Every sensor has its own function to collected data.
- Ex: Accelerometer for movement accelaration
- For behaviour, there is some behaviour that being used to construct a navigation.

Behavior	Description	Example
Collective exploration	Navigation of the swarm of robots through the environment in order to explore it	Searching for objects, establishing a communication network, or monitoring the environment
Coordinated motion	Moving the swarm of robots in a formation	A line or flocking formation
Collective transport	Enabling the swarm of robots to move heavy or large objects together	Moving furniture or other heavy objects
Collective localization	Helping robots in the swarm find their position and orientation relative to each other via a local coordinate system	Establishing a local coordinate system throughout the swarm to determine relative positions

COMMUNICATION

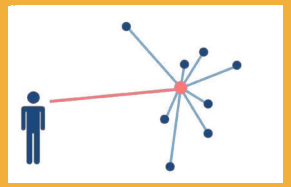
SWARMING ROBOT USUALLY COMMUNICATE THROUGH BLUETOOTH, WIRELESS LAN OR INFRARED. BELOW IS THE TYPE OF COMMUNICATION ARCHITECTURE THAT HAS BEEN APPLIED

1. CENTRALIZED CONTROL
2. HIERARCHICAL CONTROL
3. ENSEMBLE LEVEL CONTROL
4. BEHAVIORAL CONTROL

TAKE NOTE!!!

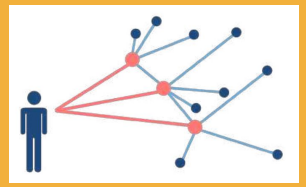
- COMMUNICATION RANGE SHOULD BE CONSIDERED
- LENGTH OF MESSAGE TOO
- TIME TAKEN TO SEND MESSAGE TO OTHERS
- INTERFERANCE

CENTRALIZED CONTROL



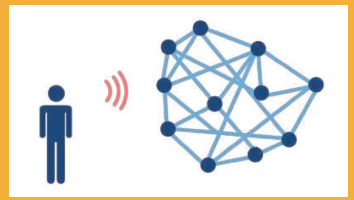
The commands go to the centralized controller, which, in turn, distributes instructions to each robot in the swarm.

HIERARCHICAL CONTROL



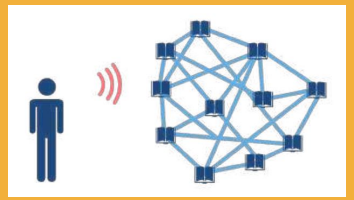
The commands go to (one or) several “squad leaders”, which, in turn, distribute instructions to the individual robots in their “squad".

ENSEMBLE-LEVEL CONTROL



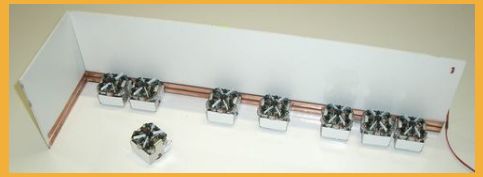
The commands are broadcast to the swarm as a single group, after which the individual robots make decisions on how to action that command.

BEHAVIORAL CONTROL



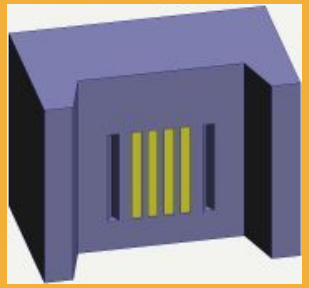
Each unit has a pre-programmed library of behaviors. The human commands the swarm to execute a certain behavior.

POWER MANAGEMENT



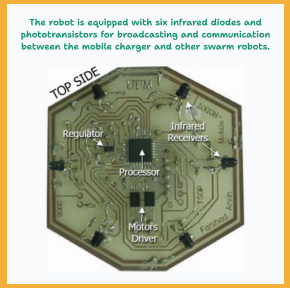
CHARGING STATION

- Only has charging facilities.
- Has Power and Ground contact
- Simple regulated voltage source



MAINTENANCE STATION

- Recharging, reprogramming and communication facilities.
- Simple regulated voltage source
- Power, Gnd, Clk, & Data contact
- USB or RS-232 communication with the host computer.



CHARGING ROBOT

- Portable charging robot will help to charging swarming robot when the robot power source is decreasing.
- Swarm robot will transmit signal to the robot when ot need to recharge.