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Cultivation in Agriculture using Swarm Technology in Robotics (CASTRO)

Shilpa Hiremath[1], Nitish Kumar K[2], Prajwal D[3], Rajshekar N[4], Rakshith A[5]

[1]Asst Professor, Department of Electronics and Communication Engineering
[2345]Student, Department of Electronics and Communication Engineering
BMS Institute of Technology and Management, Bangalore, India

Abstract: The Multi Robot System is based on Interactive Robotics. The multi-robot system is a novel way to connect a large number of robots and has emerged as the use of mass particles in many robotic systems. Many robotic systems are more flexible and tolerant than single-functional robots. Seeking food together is one of the most important tasks in the study of the interaction of many robots. Some form of direct or indirect communication has been used to generate collaboration and improve performance. Swarm robotics is a new research area inspired by biological systems such as ants or bee colonies. It features a system with many small robots with simple control mechanisms capable of achieving complex interaction behavior at the locust level such as merging, pattern formation and joint movement. However, further research is needed to use swarm robotics in practice. Within the scope of our knowledge there are currently no swarm robotic applications for real-life problems. Current research often solves specific tasks in laboratory-controlled environments. In this paper we examine the existing functions of robotic robots and their applications and analyze their potential to solve real health problems.

Keywords: Master-slave, Seeding, Swarm Robots, WIFI, Zigbee.

1. Introduction

A robot is a real or active agent, usually an electromechanical machine controlled by a computer or an electronic system, and thus able to perform tasks on its own. The Robotic Industries Association defines a robot as follows "A robot is a reprogrammable, multifunctional manipulator designed to move material, parts, tools or specialized devices through variable programmed motions for the performance of a variety of tasks" Since a single robot launch can't accomplish the satisfaction of man because of the increasing demand for work, many scientists are developed multi robots to perform complex tasks, either homogeneous or heterogeneous forms. In similar forms, researchers often use a group of independent robots troubleshooting using a distributed method. These robots are commonly referred to as a swarm robot. There is a mysterious interaction that exists in crowds of ants, bees, and other social insects. External human observer, simultaneously looking at each individual the simplicity and complexity of the group, failing to understand the nature of cooperation. In carrying out local order tasks, robots must have a special ability to walking in their space, interacting with other robots, observing and processing details of their locations. The swarm shares information about the environment and the individual agents interacts with each other, therefore a distinction between the sensing and the communication network is made. Due to no central coordination within their task execution, their cooperative behaviour becomes an essential part in swarm research. The effectiveness of the coordination among the individual agents of swarm can be achieved using information sharing.

In this project, the experimental multi robot system will be designed to demonstrate swarm-intelligent for aging behavior under specific design constraints in order to investigate a limited subset of system characteristics.

The design constraints are as follows:

- Direct communication
- Centralized control
- Behaviour-based control

These attributes depend on a number of system parameters, the following three are investigated here:

- number of robots
- item distribution.

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1.2 Problem Statement

- In single robot application, very less tasks done in more span of time, and the efficiency is less in single robot application compared to swarm robotics, modularity cannot be achieved with single robot.
- If any problem occurs in a robot all function will get affected by that because single robot is used to perform a multiple task.

2. Literature Survey

In Paper [1] three methods of integration are introduced, which are used here to calculate the distance between robots. Depending on the method, each robot identifies its nearest set of contacts. After that, to gains integration, the visual acuity of interaction between preset members is modeled using viscoelastic mesh. In Paper [2] they faced the challenge of robots searching multiple rocks at the same time. The efficiency of the swarm and the field of artificial energy is finally built, the new extension enables the formation of bio-inspired particles first given the robotic mechanical properties that reduce the cost of control and is already above the normal range of application algorithm. In Paper [3] they prepare to analyze the title of the supervisor and follower in the form of a graph and use the proportion of the proposed graph to re-assign membership. They take each robot as a node and look at both communication and purpose delays, i.e., testing in an unknown location, such as a boundary weight. They then used the Laplacian matrix to split the graph over and over again to increase group division. Imitation results confirm the effectiveness of the proposed method. In Paper [4] they have specified the complexity of agriculture. It is a review of the problem of wheelbarrow movement in agriculture and provides detailed map presentation, landscaping and navigation planning, as well as the application of the WMR navigation problem solution in agricultural engineering, prioritizing research guide to solve problems in precise navigation in agricultural areas. In Paper [5] they have studied swarm robotics technology, which is applied on cleaning process here the swarm robots cover the given ground in an optimized way. And starts the cleaning process where the contamination is widely spread and starts to decontaminate. the accuracy and speed of this process is measured by constant and strong contamination spread at different distribution times

3. Methodology

3.1 Proposed System:

In this proposed, the experimental multi robot system will be designed to demonstrate swarm-intelligent foraging behavior under specific design constraints in order to investigate a limited subset of system characteristics. Proposed system must satisfy following requirements: First, be capable of automating whole order picking and placing operations. Along with that our system consist of vacuum and Mopping module for cleaning purpose. The following features are implemented in the proposed system:

- Activate master robot through WIFI module.
- Master robot will perform one specific task (Sweeping, Mopping, Pick & Place).
- Master robot will send commands to slave robot using Zigbee module.
- Slave robot will perform the tasks according to the command given by the master robot.

3.2 Working Principle:

In our project, there are three robots, one is master and other two are slave robots. The master robot can control the activities of the two slaves. The master robot is controlled remotely by using laptop through Zigbee module. Once the master is activated, it will do the function which has been hardcoded and simultaneously sends the command to the slave robots. The slave is selected will cover three different areas. And here, the starting of functions can be controlled by user and only master is under user control. Slaves are under master, when we give instruction for cleaning, the master will send commands to initialize the working of slaves, when they start working, they will cover a predefined area and after finish they stop working. Here we are using IR Sensors to detect any obstacle and remove it from path of cleaning, Once the robot detects the object through IR sensor, it tries to pick and place the object aside and continues its workflow. Ultrasonic sensors are used to measure and maintain the accurate distance between the robots and other obstacles like wall. When the obstacle like wall is detected by the ultrasonic sensor, the robot takes the predefined path.

3.3 System Design:

For MASTER:

First the main robot, Slave Robot1 and Robot 2 are programmed. Master Robot, Slave Robot 1 and Robot 2 are having Zigbee Transceiver module for sending and receiving of data. The master robot has digging tools and IR sensors to avoid obstacle selection of Both Robots, Zigbee send the command the same is received by both robots through Zigbee connected to both the robots and are ready for receiving the data command, Main

Control station again send the data command for direction, the data command is received by both robots, DC motors of Robot 1 and Robot 2 will be move according to the data of received.

By user input, Master robot send the selection of Robots 1, Zigbee send the command the same is received by robots1 and is ready for receiving the data command. Master robot gets initialized, and it starts digging function robot movement and sensor data monitoring gets initialized along with obstacle detection. After digging function is completed command will be sent to slave to do its operations. Figure 1 shows the flowchart of master robot subsystem operation steps.

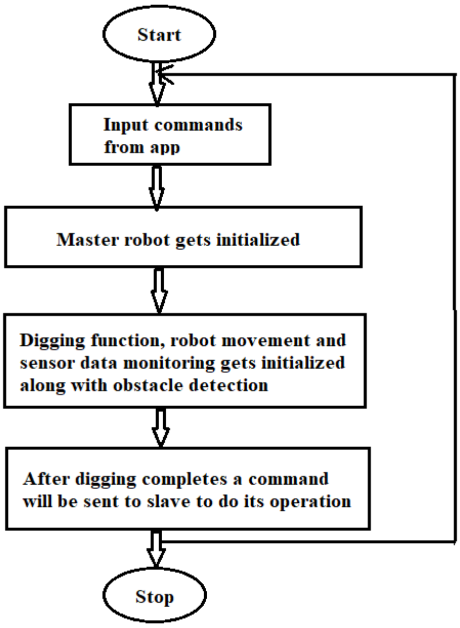

Fig. 1 Flowchart of master robot subsystem

For SLAVE:

Figure 2 describes the flow diagram of slave robot subsystem operation steps. Once, it receives input command from the master, slave robot 1 gets initialized it performs seeding function, robot movement and sensor data monitoring get initialized with obstacle detection after seeding is completed a command will be given to robot 2 to do its operation.

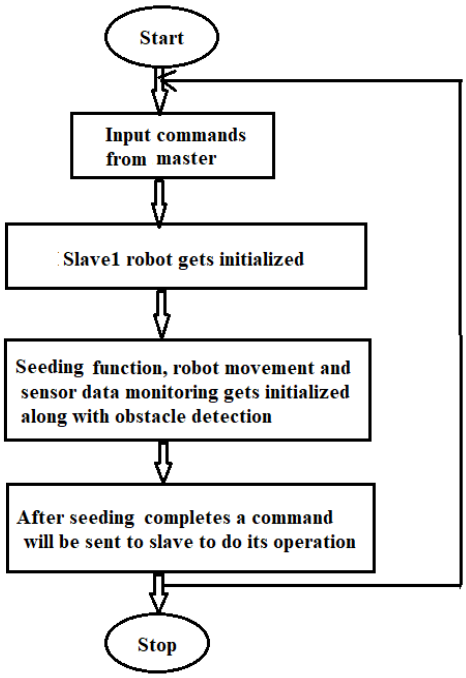

Fig. 2 Flowchart of slave robot subsystem

4 Hardware and Software Requirements:

4.1 Hardware components:

- The various components used are raspberry pi as processor in master robot.
- Dc motors are used for movements and to run the tools like funnel for seeding and digging tools.
- Zigbee is used as a communication device between the master and slave.
- We use a 12-v power supply for turning the device on.
- A power divider is used to divide power into 5v and 12v.
- We use H-bridge motor drivers to run motors.

The slave robot has similar hardware but we have used Arduino as microcontroller.

4.2 Software Requirements:

We have used the microprocessor raspberry-pi for the master and for the controlling and commands we have used the **python 3.5** to code in **python IDE** in the raspberry pi OS that is available, and have used Arduino-uno for the slave and for the controlling and commands we have used the **processing** language which is very similar to C to code, have used **Arduino IDE** that is available.

The important concept we have followed is the concept of xor function to control the movement of dc motors i.e. only when one of the inputs is 1/high it rotates in clockwise (01) or anticlockwise (10) direction, if not the motor doesn't run. And for communication between the robots make sure to set the same baud rate in all of the robots and set the parameters in the functions that will be called with correct parameter names.

5 Results and Outcomes

We have designed a master slave swarm robot which performs various agriculture activities like digging, seeding, levelling the field.

The below figure 3 shows the pictures of master robot developed:

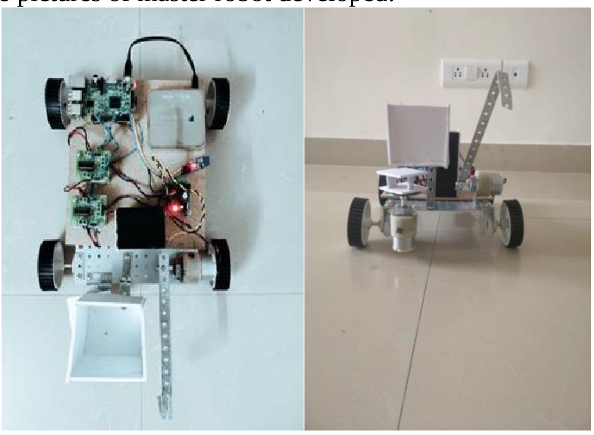

Fig. 3 Top View and Front View of Master Robot

Once the master robot is initiated it starts moving in a predefined path. As it moves it performs the digging operation and after that it performs the seeding function after this it sends the signal to the slave robot to start the seeding operation and moves forward. This process is continuing until the complete field is covered.

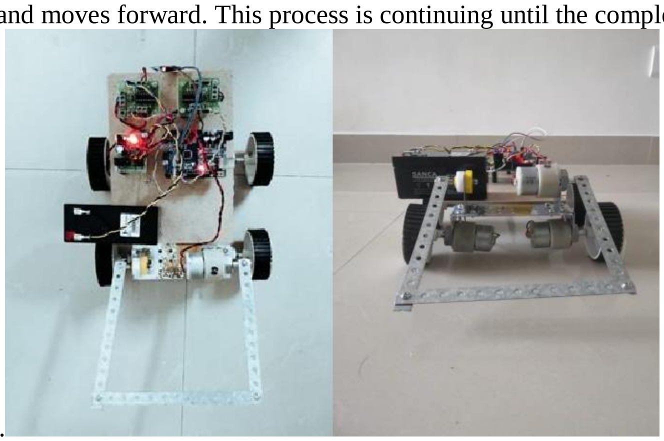

Fig. 4 Top View and Back view of Slave Robot

Once the slave robot receives the commands from the master robot it starts to perform the levelling operation figure 4 shows the images of slave robot. After the complete field is covered, we get a message from the master to our telegram app (Twilio) stating the work is completed as in figure 5.

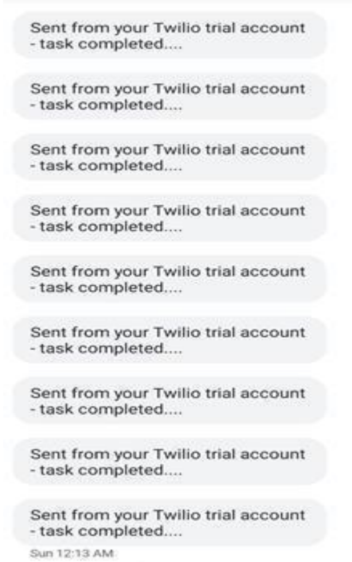

Fig. 5 image of message received in telegram app

6 Conclusion

Since the world’s population has crossed almost 8 billion people, the need for the food and amount of land that is used for crop agriculture have to be increased, however the latter requirement will not be easy and possible in the long run as we’ll eventually run out of fertile land. So, it’s high time that technology needs to be implemented in the cultivation field for increase in both the output and efficiency. Hence, we have tried to implement the concept of swarm technology through robotics which itself is inspired from nature like swarm of bees or colony of ants. To conclude, this idea portrays creating multiple robots that work in coordination with a single robot having all the controls and command, and N number of slave robot’s following those commands by monitoring the progress and also performing various other tasks along with it. For the proper way of commercializing this idea, the communications between these robots in real time have to be monitored carefully and keep improving as the technology grows.

7 Scope in Future:

7.1 Tomorrow's Time:

This application can be easily customized under a variety of conditions such as different types of fields or agricultural needs and we can customize it by adding new features when we need it. Reuse is also possible if required in this application. Gives us flexibility.

7.2 Software Scope:

Extension: Written code text can be used as a basis for any future features as well, it can help kicking start those. We can improve the security of the code by creating public and private cases and perhaps use an algorithm that can reduce gaps between communications and help organize the entire robots' journey from start to finish.

Reconfiguration: Updates are also possible if required in this application, whenever required or in near future. Reusable software reduces the cost of designing, coding and testing by reducing effort of several designs. Reducing the complexity of the code also makes it easier to understand, which increases the chances that the code is correct. We can follow both types of reuses. Sharing newly written in-project code and re-use of pre-written code for new projects, which helps the project grow.

Simplicity: The process is understandable if someone other than the path creator can understand the code (and the creator later). We have used a method, small and compact, that helps to achieve this.

Cost effectiveness: Its costs are below budget and are made over a period of time. It is desirable to pursue a low-cost plan on the condition that it meets all the requirements. The scope of this document is to set out the requirements, clearly identifying the information the user needs, the source of information and the expected outcomes of the system.

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