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AUTOMATED FARMING AND INSECT CONTROL USING SWARMBOTS

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Abstract

Swarm robotics is a new idea to the co- ordination and communication of robots, that are autonomous, capable of local communication and operates based on some sense of biological inspiration such as ants, bees, termites. This robotic technology is been inspired from natural systems in an environment composed of many individuals that coordinate among themselves to perform a certain task or work towards a common goal. Incorporating this robotic technology in the process of farming is one of the major breakthrough in this generation of robotics. Our project aims at applying this in the process of ploughing, drilling, seeding, application of fertilizer/water and monitoring the crops throughout its growth period. It uses a simple and efficient communication protocol for fast exchange of data.

Index terms: *Swarm, Parallelism, Image processing.*

1. Introduction

In order to overcome the problem we are proposing a model of swarm robots. Swarm robotics is a branch of multi-robot systems that are derived from biological species such as ants and schools of fish. The term "swarm" is used to refer "a large group of locally communicating individuals with common goals to perform a task".[1] Swarm robotics systems are characterized by distributed sensing, ease of communication capabilities, parallelism in executing a task, reliability, improved performance and fault tolerance. Ant colony can be viewed as an example – a single ant will have limited sensing capabilities and it depends only on local manual method of ploughing and application of fertilizer is done by this autonomous system, which yields high crop productivity.

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2. SWARMBOTS IN AGRICULTURE

Agriculture forms the major backbone of our country. There are many technological advancements information, but by working together the ant is able to perform rather complex, construction and transportation tasks.

Swarm robots are basically a group of robots which co-ordinate and communicate among themselves to achieve a particular task which is farming in our scenerio.[2]The unique selling proposition of our project is reducing power consumption; since mostly farming is carried out during day time, solar panels can be kept on top of swarm robots and solar energy can be harnessed for farming processes.

Due to increasing prices of groceries and staple crops, we plan to introduce a autonomous system where swarm robots will solve the major problem of unavailability of work-force, reduce waste wastage, increase production of crops and constantly monitor the crops throughout its growth period. This proposed system provides a solution for optimum seed spacing, helps in efficient utilization of water, and application of fertilizer is done by this autonomous system. This system will be able to achieve a very high productivity.[3] Traditional method of farming does not ensure the optimum spacing of seeds, which results in inefficient utilization of seeds. There is also a problem of proper management of water or lack of it. In traditional method of farming, ploughing using tractor and application of fertilizer is been done manually. Excess fertilizer usage not only makes the plant dependent on artificial fertilizer but also erodes the land quality, polluted ground water and in case of surface runoff, pollutes the nearby water bodies. This proposed system provides a solution for optimum seed spacing, helps in efficient utilization of water happening in agriculture, but still there are a few setbacks. The migration of people to cities, farmers find it difficult to get daily workers and the increased labour wages had made farming a bane to the farmers.[4] Due to increasing population, the farmers are also under pressure to feed more people. In order to solve the above problems, we are proposing a model based on swarm robots. These swarmbots does the following operations autonomously viz.,ploughing, drilling, spraying, seeding and insect control. A quad copter attached with camera is used to constantly monitor the crops throughout its growth period through image processing technique.

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3. DYNAMIC STRUCTURE

The swarmbots performing these activities in farming consists of Arduino Atmega 328 mounted on the top forms the heart of the robot system. The hardware part comprises of Arduino, Zigbee for long distance communication, ultrasonic sensor for obstacle detection. Since mostly farming is performed during daytime, solar panel is used to reduce power consumption.

4. HARDWARE IMPLEMENTATION

4.1. Ploughing mechanism

The first and foremost step in farming is ploughing. This process is done in order to lose the soil and create a path or tracks on the farm land to sow the seed uniformly.[5] The structure and size of the plough tool depends on various constraints such as the type of soil to be ploughed and the type of crops as shown in the fig.1.

Figure 1. Plough tool

4.2. *Drilling mechanism*:

The setup consists mainly a drill and a to and fro rotatory to linear converter. According to the controller it drills in to the soil beneath the setup and seeds are put in the drilled pits. [6][7] The drill bit is designed in such a way that it covers the pit when the bit rotated in anticlockwise direction using a flap, as shown in the fig. 2

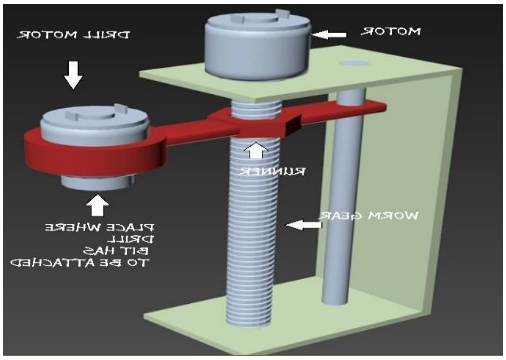

Fig.2. Drill pit

4.3. Sprayer mechanism:

This apparatus is used both for irrigation and spraying fertilizers. When water is to be sprayed, tank is filled with water and when used for fertilizers, tank is filled with fertilizers.

Fig.3. Water/Fertilizer Sprayer

Based on the amount of water required for that particular crop suitable irrigation methods are adopted. Our bot adopt the drip irrigation for the irrigation process. The water required for the irrigation is stored in a tank and is mounted onto the bot. The frequency of drop of the water is controlled using water pump. The water from the container flows to the field through the nozzle provided for irrigation uniformly. The same irrigation tool can be used for fertilizing by replacing the water with fertilizer, as shown in the fig. 3.

4.4. Insect Control

A quad copter fixed with camera is employed to monitor the crops throughout its growth period using image processing. It visualizes the leaves, takes photographs and detects the condition of the leaves viz., whether it is healthy or needs treatment.[8] Based on the detection, the quad copter sprays the pesticides on the affected plants and leaves the healthy crops undisturbed as shown in the fig. 4 and fig. 5

Fig.4 Healthy Leaves

Fig.5. Unhealthy leaves

5. HIGH LEVEL DESIGN

In fig. 6, shows the swarmbots dispersed in the agricultural field and the co-ordination between them by wireless communication.

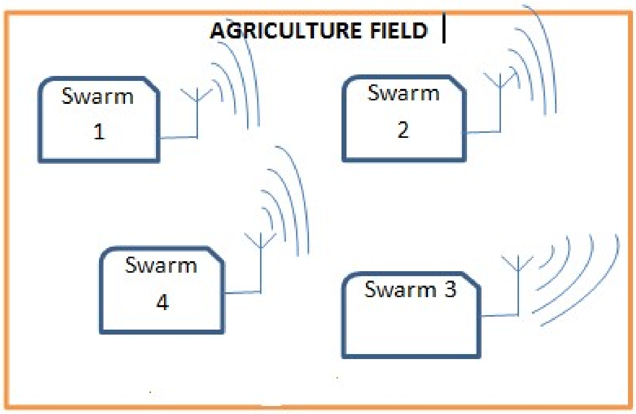

Fig. 6. Higher Level Design

6. EXISTING TECHNOLOGIES

IOWA inventor David Dorhout is working on a swarm of robots that could revolutionize agriculture[9]. The prototype **"Prospero"** is a swarm of autonomous microplanters as shown in the fig.7.

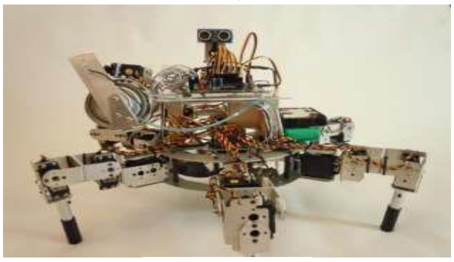

Fig.7. Prospero

7. IMPLEMENTATION

Our major priority has been to apply this immense potential of distributed, coordinated systems to revolutionize farming. We believe in the distant future farming will be completely overtaken by robotic systems. [10]

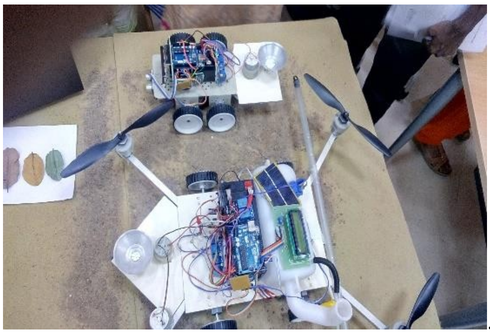

Fig. 8. Hardware Reallization

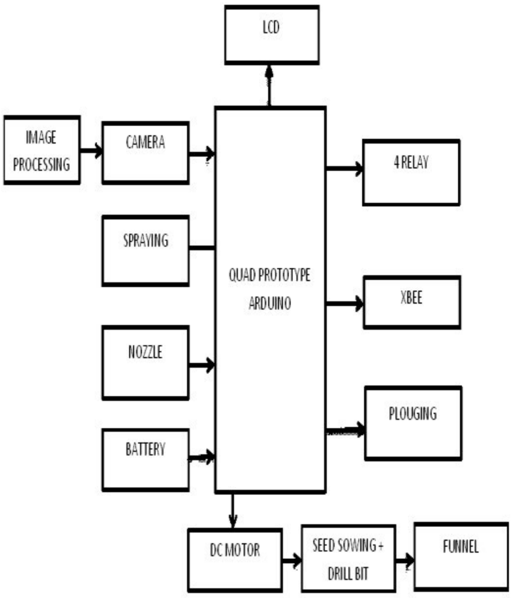

Fig. 9 Block Diagram

There are four mechanism employed by the robot. At first, the ploughing mechanism is initialized. After a few seconds of delay, the drilling mechanism is enabled and the drill bit drills the soil. The seeds from the chamber are dropped into the drilled pits. A leveler is employed to cover the soil[11][12]. Once the seeding mechanism is over, the spraying mechanism is started. The tank mounted on the top of the bot can be filled with either water/fertilizer according to the requirements as shown in the fig.8. And Fig. 9 shows the overall block diagram.

8. WORKING OF ROBOT

Step 1: It consists of several devices featuring different sets of peripherals targeted for various applications.

Step 2: Swarm robots to be activated are powered on and they are positioned in respective areas.

Step 3: Command is given to the robots through wireless module (Zigbee module)

Step 4: On reception, ploughing mechanism is first enabled. Here the soil is loosened and tracks are formed with the specially designed plough tool.

Step 5: After the completion of ploughing, the drilling mechanism is enabled.

Step 6 :This setup consist mainly a drill and a to and fro rotatory to linear converter.

Step 7: According to the controller it drills into the soil.

Step 8: The water is sprayed to the entire field with

the flow control achieved with the help of water pump immersed in water.

Step 9: Seeding mechanism is enabled.

Step 10: The seeds present in the seed container flows out uniformly through the channel. The seeds are dropped as and when the bot moves over entire field.

Step 11: Seeding mechanism is terminated.

Step 12: Solar panel is used as a source of power supply. The power from solar panel is stored in the battery and used for the

Step 13: After the cultivation is completed, the bots continuously monitor the crops throughout its growth period.

Step 14: Image processing technique is employed to monitor the crops. The camera attached in the quad copter captures the leaf's sample and is processed. The features such as texture and colour features are extracted for identifying and classifying such as healthy or diseased leaf sample.

Step 15: Based on this detection, the pesticide is sprayed to the infected plant and the healthy plant is undisturbed.

Step16: All the mechanisms are completed successfully.

9. ADVANTAGES OF SWARMBOTS

9.1. Comparing with a single robot

Single robot is vulnerable especially when a small broken part of the robot may affect the whole system and it's difficult to predict what will happen. Under certain conditions, the failure of a single bot does not affect the whole system; the given task is distributed among the bots.

9.2. Parallelism

If the tasks are distributed, then by using parallelism, groups can make tasks to be performed more efficiently. This indicates that the swarm can perform the tasks involving multiple targets distributed in a vast range in the environment.

9.3 Scalability

The interaction in the swarm is local, allowing the individuals to join or quit the task at any time without interrupting the whole swarm.

9.4. Distributed Sensing

The range of sensing of a multi robots is wider than the range of a single robot.

9.5 Benefits Of Our System

9.5.1 Conservation of energy resources.

Since most of the farming is done in daylight, solar panel is used and thus reduces power consumption.

9.5.2. Optimum seed spacing

The bot ensures seed spacing and thus reduces the wastage of seeds.

9.5.3 Wastage of fertilizer and water is minimum.

Since the fertilizer/water is sprayed only in the particular region of the plant, the wastage of water and fertilizer is minimum.

9.5.4 Controls the application of herbicides

Since the seed is dropped only in the place specified, it controls the growth of weeds thus reducing herbicide application.

10. CONCLUSION

Thus swarm robotics has been one of the cutting edge technologies of the present and has the potential to replace all the existing robotic systems or those systems which still require a lot of manpower; hence change the course of the future. Even though our paper stresses on application of the prototype in a controlled environment, it can be easily extended to larger operating environments. Its simplicity and cost effectiveness have been its major weapons. Limited hardware use makes it easy to handle and maintenance free. A simple communication protocol enables the system to function without any technical

problems and also provides real time solutions. In a broader sense Swarm system intelligence and architecture can be configured and programmed to suit any modern day system environment. However, there is an increased need for research and development of Swarm Intelligence based systems which alter the course of how robots are understood by the common man.

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