International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 4, pp: 67-70 www.ijaem.net ISSN: 2395-5252

Modern Agriculture Using Swarm Robots

Ravi Nandan[1], Lokesh S[2], Nikita Balappa Narasannavar[3], Pratyusha S A[4], Sampath Kumar S[5]
[1 2 3 4]Department of ECE, K S Institute of Technology, Bengaluru, India
[5]Assistant Professor, Dept. of ECE, K S Institute of Technology, Bengaluru, India
Corresponding author: Ravi Nandan

Date of Submission: 30-07-2020 Date of Acceptance: 09-08-2020

ABSTRACT—Robotics is expected to play a major role in the agricultural domain, and often multi-robot systems and collaborative approaches are mentioned as potential solutions to improve efficiency and system robustness. Among the multi-robot approaches, swarm robotics stresses aspects like flexibility, scalability and robustness in solving complex tasks, and is considered very relevant for precision farming and large-scale agricultural applications. However, swarm robotics research is still confined into the lab, and no application in the field is currently available. The objective of our project is to demonstrate the usage of this swarm intelligence concept in agriculture field. A distributed control system can let robots interact with other nearby robots, cooperating amongst themselves to accomplish their mission.Individual robots must work independently, only communicating with other nearby robots. The prototype of robots consists of Arduino Uno ATMEGA328P which is used as the control unit for both main robot and follower robot with a transceiver pair of NRF24L01 (2.4 GHz) to establish communication between them and complete agricultural tasks.

Index Terms— flexibility, scalability,robustness

I. INTRODUCTION

In nature, species like ants, birds and fish constantly develop entities, higher and more powerfull when they work together. Examples of those collective behaviors in nature include: flying patterns of birds to fly more efficiently, colonies build by ants, travel patterns of fish for safer travel, etc. The term “swarm” is used to refer “a large group of locally interacting individuals with common goals”. To coordinate large number of multi robots swarm robotics approach is employed. Field of artificial swarm intelligence is one of the emerging approaches. Some of agricultural applications of swarm robots are sowing seeds, harvesting, and storing grains in the warehouse. To reduce the work load of farmers and to increase their productivity swarm robotics has played an important role in the field of agriculture.Thecollactivebehaviour of organisms has inspired researches that were focused in applying the same behavioural pattern to robotics. Swarm robotics is the tecnological concept that allows a descentralized control system with multiple robots, in other words it allows every robot to take actions based on the behavior of the other robots without recieving commands from a central computer.Swarm robotics is an approach to the coordination of multiple robots as a system which consist of large numbers of mostly simple physical robots. It is supposed that a desired collective behavior emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behavior occurs.The research of swarm robotics is to study the design of robots, their physical body and their controlling behaviours. It is inspired but not limited by the emergent behaviour observed in social insects, called swarm intelligence. Relatively simple individual rules can produce a large set of complex swarm behaviours. A key-component is the communication between the members of the group that build a system of constant feedback. The swarm behaviour involves constant change of individuals in cooperation with others, as well as the behaviour of the whole group.Unlike distributed robotic systems in general, swarm robotics emphasizes a large number of robots, and promotes scalability, for instance by using only local communication. That local communication for example can be achieved by wireless transmission systems, like radio frequency or infrared.

II. PRINCIPLE

Karthik Narayanan, et al. [1] proposed a coding scheme designed for data compression in multi-robot systems. Huffman encoding for lossless data compression was used and here time and power optimization is obtained. The proposed method is implemented and tested on the Intel Edison platform

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 4, pp: 67-70 www.ijaem.net ISSN: 2395-5252

with custom robot chassis. In Huffman encoding a minor change in any bit of the encoded string would break the whole message.

Dario Albani, et al. [2] proposed a roadmap to bring swarm robotics to the field within the domain of weed control problems. This paper presents automatic detection and identification of weeds. A swarm of UAVs which will be recruited to monitor those areas in the field that have been identified as potentially containing weed patches, while weed less areas are quickly abandoned by the swarm. But this concept has limited coverage area.

Syed IrfanAliMeerza, et al. [3] proposed a method to direct the mobile robot toward a target and navigation through the environment without any prior knowledge about the environment. This paper introduces particle swarm optimization (PSO) with dynamic obstacle avoidance technique for robot path planning. Our proposed systems are simulated and tested in Processing IDE, for different environments. Computational simplicity is the feature of this system and it also requires less memory.

JhangJianJu, et al. [4] proposed self-assembly distributed control algorithm which aims to improve self-assembly efficiency of the swarm robot by lowering ineffectiveness of random navigational movement during self-assembly process and enabling dynamic local navigation of random movement according to the distance of seed robot and docking robot. In addition, this paper also studied and explored time efficiency of line-shape, arrow-shape, T-shape and star-shape morphology. This technique improves the efficiency of self-assembly.

Harish Verlekar, et al. [5] proposed a method based on the chain formation behavior of ants and division of labor in bees is emulated. Swarm robots are designed to emulate the ants, and form chains while foraging and the division of labor is used for preventing wastage of energy. For localization and navigation a computer vision based algorithm is used which is coupled with magnetometer sensor readings. Utilizing swarm robots approach we get Parallelism, Robustness and Scalability.

Dunwei Gong, et al. [6] introduced particle swarm optimization (PSO) with dynamic obstacle avoidance technique for robot path planning. Our proposed systems are simulated and tested in Processing IDE, for different environments. This paper proposes a PSO with dynamic collision avoidance technique for a multi-robot system. PSO is chosen due to its fast convergence capability and computational simplicity.

Jong-Hyun Lee1, et al. [7] proposed a method which analyzes a nature enthused supportive method to reduce the operating costs of the foraging swarm robots through simulation experiments. The method employs a behavioral model of honey bee swarm to improve the energy efficiency in collecting crops or minerals. The division of roles makes the complex social of honey bee operate efficiently. Foraging swarm robots consists of a crowd of robots to gather target objects based on a behavioral model. The robot mounts an infra-red sensor to look for the target objects (i.e., foods) or to avoid obstacles, and has GPS to figure out a location of the storehouse.

Senthil Kumar, et al [8] proposed a model to establish a communication among a group of robots using ZigBee and to communicate among the group of robots using ZigBee which perform a task allocated to each slave robot. Slave robots will send the status to master robot and master robot will give command to those robots. Zigbee module we will use to established communication. We make use of ZigBee module for performing different tasks and allocating work between them

.Qirong Tang, et al [9] proposed a mechanicalparticle swarm optimization method for single target searching of robots and for avoiding local traps and finding targets , dynamic neighborhood method is used. However, it cannot guarantee that the robot swarm can find all the targets unless the robots are big enough to identify the target . Besides these, improving the real robots localization accuracy or even liberating localization necessity is also a main concern.

Sanjay Sarma O V, et al [10] proposed a Graded particle swarm optimization . When it comes to the performance ranking GPSO algorithm outperformed both CPSO and PSO algorithms in terms of final average fitness and the average number of fitness evaluations. This algorithm also supports new search, exploration and mapping strategies in the fields of computational intelligence, swarm intelligence and swarm robotics.

III. PROPOSED SYSTEM BLOCK DIAGRAM

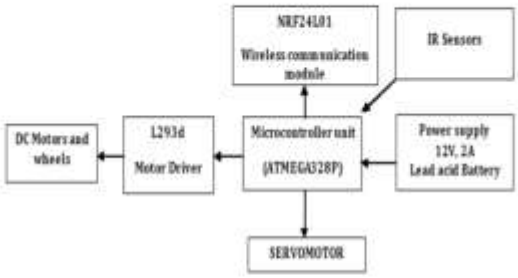

Fig: Block diagram of the swarm robotic system

The block diagram consists of microcontroller unit which is Arduino Nano, IR sensors, DC motors and its driver L293D, wheels,

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 4, pp: 67-70 www.ijaem.net ISSN: 2395-5252

servomotor, funnel and NRF24L01 wireless communication module.

The microcontroller ATmega328P has high performance, and is a low power CMOS 8 bit microcontroller. It has operating voltage of 1.8-5.5V with a temperature range of -40 to 85 degree Celsius and speed 0-20MHz.ATmega328P in 28 pin narrow dual in-line package (DIP-28N).It has a modified Harvard architecture 8-bit RISC processor core.

NRF24L01 is a single chip radio transceiver model used for the purpose of communication between the robots for the worldwide 2.4-2.5Ghz ISM band having the power supply range of 1.9-3.6v. Its output power, frequency channels and protocols setup as compared to others are easily programmable through a SPI interface. NRF24L01 consumes less current at a rate of 12.3mA in RX mode. Built-in power down and stand by modes makes power saving easily reliable.

Servomotor is a motor that controls the operations of angular position, acceleration and velocity. With the help of this servomotor and a funnel we are going to release the seeds in the soil. It is a High response, High precision positioning system. It provides accurate rotational angle and speed control. It is close loop system where it uses positive feedback system to control motion and final position of the shaft. Here, the device is controlled by feedback signal generated by comparing output signal and reference input signal.

DC motor is a device that converts direct current electrical energy into mechanical energy. Using this along with the driver system L293D we run the wheels of the robot. The speed of dc motor depends on the gear ratio and can be controlled over a wide range using either or variable supply voltage or by changing the strength of current in its field windings. It has operating speed of 1000 to 5000rpm, 60-75% efficiency rate, high starting torque and low no-load speeds.

An infrared sensor (IR sensor) is an electronic device that emits in order to sense some aspects of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. In our project we made use of three such sensors to detect the obstacles present in front, left and right of the robots. Some of the features of IR sensors are as follows. It has an operating voltage of 5V, with I/O pins 5V and 3.3V compliant. It has a range upto 20cm and a built-in ambient light sensor. It has supply current of 20mA.

IV. METHDOLOGY

Swarm robotics stands for communication within the robots which is inspired by the natural grouping system such as ants, honey bees, birds etc. It is a new approach to the coordination of the multi-robot systems which consists of more than one simple physical robot. It is supposed that a desired collective behavior emerges from the interaction between the robots and interaction of robot with the environment.

Step1: In our project we have used two robots where one robot is named as master robot and the other one as slave robot. We are making use of NRF24L01 communication module for the purpose of interaction between the two robots. The robots make use of controller called Arduino Nano. It is one type of Microcontroller board and it is designed by Arduino.cc which is built with a microcontroller like atmega328.

Step2: The master robot has one servomotor, two dc motors, three IR sensors, pump and a controller. The slave robot consists of NRF24L01 communication module, controller, dc motor, IR sensors, servomotor and pump.

Step3: The master robot sends the data through NRF24L01 module while it moves forward, while the slave robot starts moving forward when it receives the data from the master which means both the robots start moving at the same time.

Step4: If the master robot gets any obstacle in its way, it detects the obstacle with the help of IR sensors and it stops moving and sends the data to the slave robot (here it will send the different data than before). When the slave robot receives this data that an obstacle is present in front of the master robot, it also stops moving forward. At this time the master robot takes the deviation from the obstacle and starts moving forward. At this moment, it sends the data to the slave robot, so that the slave robot resumes its execution and moves forward. In this way the master robot keeps on sending data for every move.

Step5: In our project we have made use of such 3 IR sensors which are present at the front, right and left of the robot. All the three sensors detect obstacles in front of them. The IR sensor present at the front detects obstacle and makes the robot to stop. Further the right and the left IR sensor check if any obstacle is present in front of them and accordingly the robot turns right or left respectively. If the left sensor tells that obstacle is present in front of it, then the robot takes a right turn or vice versa.

Step6: The seed sowing operation is done by both the robots every 3 seconds accordingly taking into consideration the data trans-receiving with the help of servomotor and a funnel. The chemical pesticide is also sprayed continuously.

V. RESULT

In this project, we mainly demonstrated establishing communication between two robots (master and slave robot) and performed agriculture

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 4, pp: 67-70 www.ijaem.net ISSN: 2395-5252

applications such as seed sowing and chemical spraying. We analysed the outcome of our project with the help of software Arduino ide where we checked for different cases of robot movements, it's communication and it's reaction towards any obstacle in it's way. With the help of Arduino ide, the commands are given to the two robots to perform as per the situation and it provides solution the different cases and perform various agriculture application such as seed sowing and chemical spraying paralely. Hence we can say that theswarm robotics in the field of agriculture helps farmers to reduce burden of their work and get involved with new technologies. The figure below depicts how every robot looks in the swarm system.

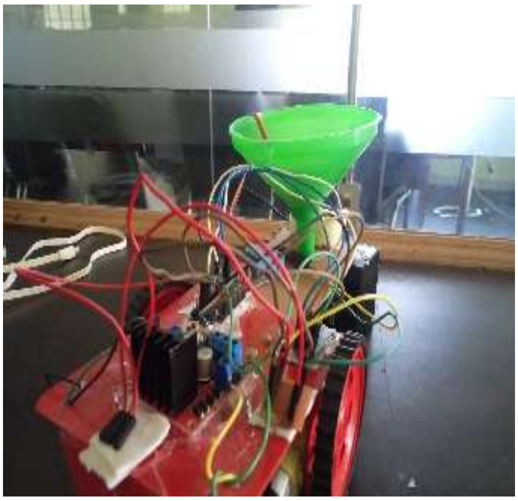

Fig: Model of a swarm robot

VI. CONCLUSION

Swarm robotics is new concept emerging in the technology.Inthe proposed system, inter communication between the two robots is established and performed some agriculture application such seed sowing and chemical spraying. In future we are willing to test our system in real world environment. The aim of our team is to incorporate efficient technology in the field of agriculture and reduce the workload of farmers.

REFERENCES

[1]. Karthik Narayanan, VinayakHonkote, Dibyendu Ghosh, Swamy Baldev (13 May 2019) "Energy Efficient Communication with Lossless Data Encoding for Swarm Robot Coordination" 2380-6923/19/$31.00 ©2019 IEEE DOI 10.1109/ VLSID.2019.00118

[2]. Dario Albani, JorisIjsselmuiden, Ramon Haken, Vito Trianni(2017) "Monitoring and mapping with robot swarms for agricultural applications" 978-1-5386-2939-0/17/$31.00 c 2017 IEEE

[3]. Syed Irfan Ali Meerza; MoinulIslam; Md. Mohiuddin Uzzal (23 May 2019) "Optimal Path Planning Algorithm for Swarm of Robots Using Particle Swarm Optimization Technique" 978-1-4673- 7523- 8/ 15/ $31.00 ©2015 IEEE

[4]. Jhang Jian Ju, Ge Yun Jian(2017) "A enhanced self-assembly morphology distributed control algorithm of swarm robots" 978-1-5386-1306-1/17/$31.00 ©2017 IEEE

[5]. Harish Verlekar, Kashyap Joshi (2017) "Ant & Bee Inspired foraging Swarm Robots using Computer Vision" 978-1-5386-2361-9/17/$31.00 ©2017 IEEE

[6]. Li Lu, Dunwei Gong (2008) "Robot Path Planning in Unknown Environments Using Particle Swarm Optimization" 978-0-7695-3304-9/08 $25.00 © 2008 IEEE DOI 10.1109/ICNC.2008.923

[7]. Jong-Hyun Lee1, Chang Wook Ahn1, and Jinung An2 (2013) "A Honey Bee Swarm-Inspired Cooperation Algorithm for Foraging Swarm Robots: An Empirical Analysis" IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM) Wollongong, Australia, July 9-12, 2013

[8]. Senthil Kumar Assistant Professor 2E.Sweetline Sylvia Student 3C.Srijayasri Student4G.Sharmila Student "Task Co-ordination And Control Between Swarm Of Robots For Assisting Farmers" International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE) Volume 6, Issue 3, March 2017

[9]. Qirong Tang, et al proposed a mechanical particle swarm optimization method for single target searching of robots and for avoiding local traps and finding targets, dynamic neighborhood method is used.

[10]. Sanjay Sarma O V, et al proposed a Graded particle swarm optimization. When it comes to the performance ranking GPSO algorithm outperformed both CPSO and PSO algorithms in terms of final average fitness and the average number of fitness evaluations.

International Journal of Advances in Engineering and Management
ISSN: 2395-5252

IJAEM

Volume: 02 Issue: 01 DOI: 10.35629/5252

www.ijaem.net
Email id: ijaem.paper@gmail.com