DESIGN AND IMPLEMENTATION OF SWARM ROBOTS

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Abstract: Swarm robots require some sort of communication mechanism among the robots. Basically speaking, two different approaches for communication can be used – line-of-sight communication and non-line-of-sight communication. In the literature, under the line-of-sight approach, three different communication methodologies have been identified – infra red, colour and touch. The non-line of sight approach includes high frequency radio waves, ultra sound waves, and pheromone.

In this research work, both line of site and non-line of site approach are using. Swarm of RF (non-line of sight approach) and IR (line of sight approach) connected robots are used. Firstly, present a RF robot platform having four IR sensing systems developed specifically for swarm robotic studies. Its infrared-based short-range sensing system has been described capable of measuring the range to obstacles and detecting other robots. Each robot consists of four IR sensors and one RF module (Receiver and Transmitter). So RF module also connected at each Robot.

Keywords: IR, RF, Transmitter, Infrared, line of sight, Non line of sight

1. INTRODUCTION

Swarm robotics studies how to design groups of robots that work without any external infrastructure or any form of centralized control. In a swarm of robots, the collective behaviour of robots derives from the local interactions between robots and robots and the environment in which they operate. The design of robot swarms is guided by the principles of swarm intelligence. These principles support the development of fault-tolerant, scalable and flexible systems. Swarm robotics appears to be a promising approach when it is necessary to perform several tasks simultaneously, when high redundancy is desired and when there is no single point of failure and when it is technically impossible to implement the required infrastructure. to control robots in a centralized environment way. Examples of activities that could be profitably managed by swarm robotics are mine clearance, search and rescue, planetary or underwater exploration and surveillance. Therefore, Swarm robotics represents a new and good approach to the coordination of a large number of robots that draws inspiration from the impressive coordination skills of social insects such as bees, ants and termites etc. It examines how a large number of robots can interact to create collectively intelligent systems without centralized coordination and achieve robustness, flexibility and scalability at the system level and provide best results.

2. COMPONENTS USED IN SWARM ROBOTS

Controller/Processor

This is the main part of master robot. This is used for receiving the serial communication commands and operating as the commands. This also used for transmitting signals to slave robots using RF transmitter. The controller/processor decides the working mode also that means how many slave robots or master robot work together.

Motors

Motors are the main part of robot for motion. Robot move from one place to another place with the help of motors. There are various types of motors which can be used in swarm robots like DC motor, stepper motor, servo motor, DC brushless motor etc. Here we are using Bipolar DC motors

Motor Driver IC

Motor drive IC is used for driving the motors because a controller/processor cannot drive a motor directly due to insufficiently value of current. Here L293D IC is used for driving the motors. L293D is a typical motor or motor control circuit that allows the DC motor to work in both directions. L293D is a 16-pin integrated circuit that can simultaneously control two DC motors in all directions. This means that two DC motors can be controlled with a single L293D integrated circuit. Integrated circuit (IC) of the H-Bridge motor controller.

RF transmitter module is used for transmitting the RF signal to the RF receivers connected with slave robots. This RF module consists of RF transmitter IC and encoder IC. In general, the designer of wireless systems has two main constraints: it must operate at a certain distance and transfer a certain amount of information into a data transmission speed. The RF modules have very small dimensions and a wide operating voltage range, from 3 V to 12 V. Basically, the RF modules are 433 MHz RF transmitter and receiver modules. The transmitter does not consume power when it emits a logical zero while completely removing the carrier frequency, thus consuming considerably less energy in battery operation. When the logic is sent, the conveyor is completely on at about 4.5 mA with a 3 volt supply.

RF Receiver Module

RF receiver module is used for receiving the RF signal from the RF transmitter connected with master robot. This RF receiver module consists of RF receiver IC and decoder IC.

Serial Communication Device

If serial communication is used then, for communicating with master robot, there are various types of serial communication mechanism like Bluetooth control, IoT control, Wi-Fi control etc. The role of serial communication is to control the master robot for the purpose of operation and mode of Master and slave robots.

3. WORKING OF SWARM ROBOT

In swarm robotics each robot has to perform these two basic working steps simultaneously without engaged in a single loop -

(i) Perform the job provided
(ii) Communicate with other robots

All the robots have to work according these two basic steps. Robots perform their job at the same time they communicate with other robots for new or changing job challenge. Swarm Robotics can be used with Artificial Intelligence and Internet of Things also.

In this work, the steps of algorithm of each robot movement are given as:
Among all robots, one robot is master robot which controls other robots. Motion of each slave robot depends on master robot signal and status about target. That is if there is no obstacle in front of master robot it will provide the signal to the slaves robots if all the slaves also don't have any obstacle in front of them then they will communicate the signal to master robots and if everything is clear and no hurdle in front of everyone then master robot will communicate to motor to forward and this process will be continuous. If any obstacle comes in between in front of any slave or master robot then master robot stops the motor by signalling. If there is a target for swarm robots then master robot will be justified it and controlled the direction of motion of each slave robot. Master robot sends the signal continuously to other robots using RF transmitter and receive the status of other robots using RF receiver.

The robots can move in forward and backward direction detecting objects using four IR (three in font side, one is in back side) sensors connected front and back of each robot. The slave robots start moving towards target in control of master robot. If there is any object detection or any other robot detection, it is avoided using IR sensors. When master robot and other robot reach the target location or complete the task, they are ready for new target. Finally, the process can be finished or repeated.

4. ROBOT to ROBOT COMMUNICATION ALGORITHM

Now the question arises how one robot communicate with other robots. That means if one robot has any signal like collision or target signal, how other robots will be notified by it. For this problem, we are using RF transceivers (transmitter + receiver) which are used for communicating signals from one robot to others or vice-versa. So, for communicating robots with each other we are using non line of site algorithm.

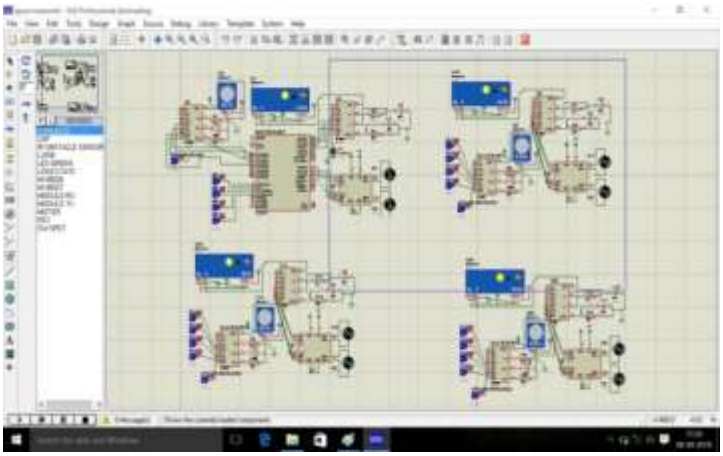

Fig. 1 Simulation of swarm robot

5. CONCLUSIONS AND FUTURE SCOPE

Theme of this work is to control different slave robots without adding micro-controllers to slave robots. Only one micro-controller is used with master robot. This is also about the behavioural control of multi homogenous robots and way they communicate each other for their synchronization in doing a particular task. Despites of the lot of research in this field there is still lots of improvement should be done for its full-fledged implementation in real world. In our daily life some regular problems arises like : traffic jam , lifting different types of heavy things, and in garment sectors sometimes workers carry loads and heavy machines. Swarm robots can give solution of above problems by communicating with each other.
So in this way this work is helpful in reducing hardware, software, programming and cost in swarm robotics and can control large number of slave robots with master robot in swarm robotics.

There is a large and wide scope of swarm robotics in various fields like army, medical, manpower, space missions and it can be work as servant in future. Swarm Robotics can be implemented in industries for heavy material handing requirements using a group of robots as well as these robots can be used individually. But whenever they need as a group they combine together. All of these examples can be implement using single microcontroller in master robot.

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