Swarm Robotics

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Abstract— Swarm Robotics is the study in which large numbers of simple robots are deployed to perform complex tasks in a simple way. These groups of robots form a swarm. Since these robot swarms can move to farther distances, it is important to have a pervasive networking environment for communications among robots, administrators, and mobile users. For this purpose, we propose to build a wireless mesh network as the wireless backbone within the areas of special interest. One or more robots can get connected with a nearby mesh router and access the remote server. Within each swarm, a self-organizing mobile ad hoc network is formed. So the major components in designing a swarm robot is Arduino UNO, RF Transmitter and Encoder module, L293D Motor driver circuit, DC motors. The applications are the swarms of robots of different sizes could be sent to different danger prone areas where workers can't reach safely, to detect the presence of life via infra-red sensors. On the other hand, swarm robotics can be suited to tasks that demand cheap designs, for instance mining or agricultural foraging tasks.

Keywords: Surveillance, Self-Organizing, Arduino-Uno, RF Transmitter, L293D Motor Driver, DC Motor & IR Sensor

I. Introduction

Robotics is the branch of Science that deals with the employment of Robots for different applications. Swarm Robotics is the study of a group of similar self-controlled tiny robots which perform complex tasks in simple way by following the "Divide and conquer" principle. The group of robots is assigned to a particular task. These robots share the work among them and accomplish the task collectively. This collective behavior of robots is inspired from social insects like ants, bees, birds and fish. As a group they can challenge any complex situation in easy fashion. Each robot in the swarm is autonomous by nature. Whenever, the task is allocated every robot finds out its own way to perform the task simpler. When the technique is found, these robots communicate and exercise that technique which is found simpler. Swarm robotics overcomes the disadvantage of centralized multi robot system. This is decentralized mode of communication. Since it is decentralized mode, this mode of communication costs low. Every individual robot has the knowledge of task to be performed. It is a connection less service and hence the circuit complexity is minimized. As a group, complex tasks can be made simpler and easier. So, swarm robotics finds its use in variety of applications like industries & surveillance.

II. Social insect motivation & inspiration

Social insects have been of great inspiration behind most of the latest technologies. Social insects include the ants, bees and fish. Swarm intelligence purely is inspired by this concept and this is the collective intelligence of the social insect colony. The social insects work together to find food and other resources to communicate this matter to others in their community. These social insects are capable of successfully navigating and acting in uncertain and unpredictable environments. These can't compete with other insects and even the larger animals for territory and food. Ants and other social insects do not have a particular leader, whenever an ant finds food, it will pass the information to the others and they together find the shortest path in getting the food. Similarly, the robots also follow the same concept. The collective decisions emerge from interactions among individuals which use local information. Social insects are concentrated mainly on the two factors in which one of them is the functional significance and the other one is the mechanisms which underlie decision-making. Swarm robotics also works just like these social insects do. The most interesting aspect of the swarm intelligence is that the group behavior is an emergent property and control is decentralized. This technique is productive because there are a group of robots which collectively perform tasks and finally finish them.

III. Centralized multi robot system

In the Centralized multi robot system, there exists one master system. This master system is connected to different slave systems in order to communicate the information about a particular task. The vital information is withheld with master. Master selects the device for particular task allocation. It also has the information of devices connected to it. The slave systems connected to master don't have prior knowledge regarding the tasks to be performed. Moreover, this Multi robot system is connection oriented network. This system is not robust as if the slave device malfunctions, it can't communicate with the master. So, the assigned task is not performed by the slave, which causes improper functioning of the system. It has only unidirectional communication i.e., for task allocation from master to slave devices. This is the major drawback in the centralized multi robot system. Due to connection of several devices to the master, this mode basically occupies large area. The position of device is fixed and is not portable to various places. This type of communication is seen in hospitals and industries. Any miscommunications among the devices lead to the entire failure of the system.

IV. KEY COMPONENTS

A. Arduino-Uno

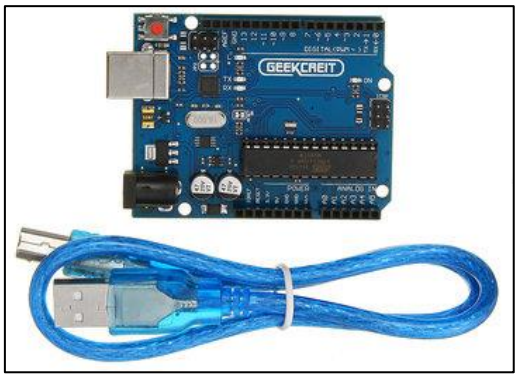

Fig. 1: Arduino-Uno

The ATmega328 Arduino is 8051 based MCU. It is a low power, high performance CMOS 8 bit MCU with 8KB of in-system programmable flash memory. The features are:

1) It is available in 40 pin DIP package
2) It has 256X8 internal RAM
3) It has 32 programmable input/output lines
4) It has 3 16 bit timer/counter modules

AVR microcontroller is developed by Atmel. Arduino is an open source hardware and software development platform. It has microcontroller boards for developing digital devices and interactive objects. It has flexibility to modify and design.

B. IR Sensor

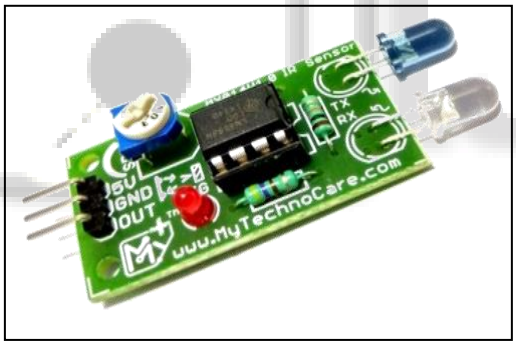

Fig. 2: IR sensor

Sensor provides information about the physical world. They contain transducer elements which convert energy from one form to another. The IR sensor emits light energy when current is supplied to it. This phenomenon is called Electro Luminescence. The IR sensor detects light with the help of photo diode. IR sensor detects an obstacle with the help of reflected IR light. The IR sensor is calibrated with the help of potentiometer on sensor.

C. RF Transmitter and Receiver

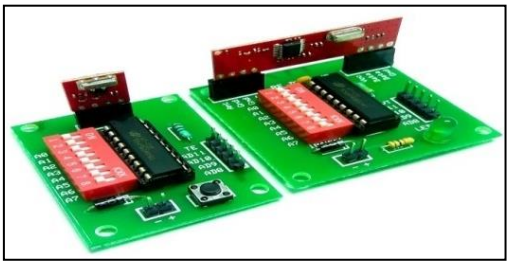

Fig. 3: RF Encoder & Decoder

RF Encoder is the combination of RF transmitter and antenna. The RF transmitter transmits serial data at a frequency of 34MHz. It has a crystal oscillator and it generates the frequency. The data pins accept the serial data from encoder and then transmit them through antenna.

RF Decoder is the combination of RF receiver and antenna. The IC used for decoder is HT12D. The RF receiver generates 434MHz frequency. It has 2 data output pins for both digital and analog data.

D. Motor drivers

Fig. 4: L293D Motor Driver

The motor drivers are required to make the motors move. The controllers are used to drive motor drivers. These motor runs with 9v supply. Arduino has only 5v. The MCU can't provide enough power required to drive motors. So, the motor drivers are used here. Motor drivers act as an interface between microcontroller and motor.

E. Motors

The motors convert electrical energy into mechanical energy. The types of motors are DC motors, Stepper motors and Servo motors. The DC motors are preferred because they have high torque, quick starting and stopping capability and variation of speed on the application of different voltages. The parts of DC motor include permanent magnet, commutator ring, brush and armature loop. The DC motor works on Fleming's left hand rule.

V. SCHEMATIC OF SWARM ROBOT

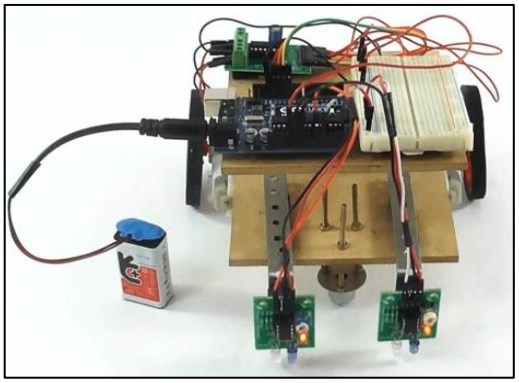

Fig. 5: Circuit Setup

The IR sensors present on either side of the robot detects black line. The black line is sensed when the analog value on the sensor is less than 600 volts. Whenever the IR sensor senses the black line it sends the information the Arduino

board which is connected to the DC motor. The DC motor makes the wheels of robot move in forward, backward, left and right direction. The RF transmitter records these motions of the robot and through RF communication it transfers data to another robot in order to locate the path quicker. The RF receiver is connected to Arduino board which makes the other robot move with the help of DC motors.

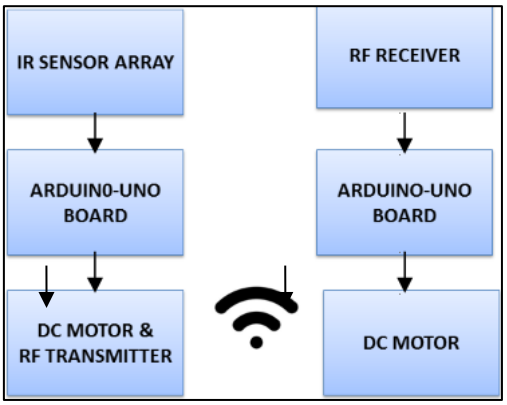

Fig. 6: Block Diagram of Swarm Robot

A. *Line Detection*

Usually these line follower robots are autonomous robots that mean these robots automatically follow the line. Either black line on white surface or white line on black surface until the line exists. These robots are used in many industrial works such as carrying heavy tasks which are a bit risky to humans and radioactive products transportation inside the factory will be very risky for us so at that situation these robots can be employed. Not only for these transportation tasks these robots can be used in hospitals for monitoring patient and informing to doctor but also at hotels as food servers and order takers.

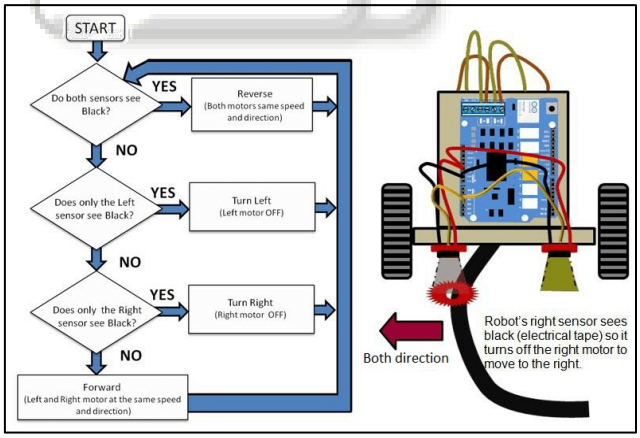

Fig. 7: Flow chart for Line detection

As mentioned in the flow chart if the robot detects black line it moves. If the right IR sensor detects black line, it takes right turn. If the left IR sensor detects black line, it takes left turn. These motions of the robot are communicated to other robot using RF transmitter and receiver modules.

VI. RESULTS

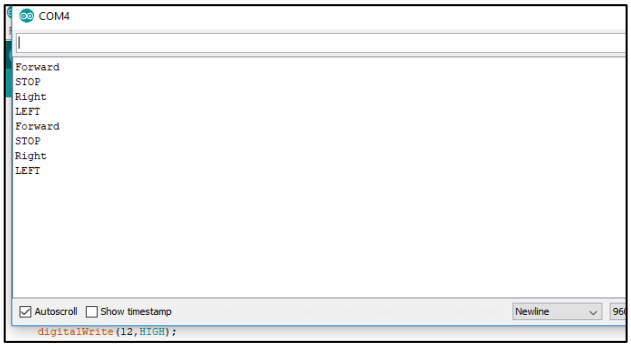

Fig. 8: Final Motions of robot

Directions of the robot can be record by using left and right sensor values. If the value on both the sensors is greater than 600, then the motion is forward. If the value of right sensor is less than 600 and the value of left sensor is greater than 600, then the robot takes right turn. If the value of right sensor is greater than 600 and the value of left sensor is less than 600, then the robot takes left turn. If the value on both then sensors is less than 600, the robots stop.

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