An Inexpensive Ant Robot: Basic Concept and Implementation

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Abstract: Imitating animal behaviors is one of the research projects in robotics. This paper presents basic concepts and implementation of ant robots. Our ant robots refer to the robots that are designed and built by imitating ants' behaviors. ant robot is 5x5x6 cm^3. A special feature of our ant robot is low cost, we spend under 30 $US for this project.

Keywords: ant robot, behavior control, low cost robot, robotics

1. Introduction

Field of robotics has been mingled with the biology by importing the ideas and the functions of animals in animal kingdom. Some examples of this theme is presented in [1-4]. In this paper, we present low cost ants' colony. Our ant robot has been designed for using on desktop factory. We have imitating the social behavior of ants, which is corporation behavior among the group. The basic framework in this paper is discussed in the next section.

2. Basic framework

Our ant robots are in a wheeled mobile structure. The structure of an ant leg with its exoskeleton piece and joints are not mimic. The reason is that the operation is on smooth surface or desktop platform —not on uneven terrain. In addition, the wheeled design is much relatively easy than the legged counterpart. Figure 1 shows ant robots building by the authors.

Figure 1. Inexpensive ant robots.

In functioning design, ant robots are designed to work in colony. Each ants equipped with sensors for regulating movement and communication among the agents. If an ant can find food, it will send signal to the other ant for helping it carry food to the nest. Information about location of food, the nest, and each ant coordinates must be known. Figure 2 shows autonomous agents cooperate during carrying food to their nest.

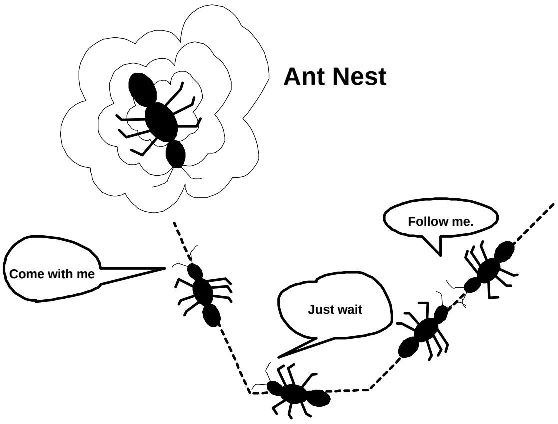

Figure 2. Agents during operation tasks.

3. Hardware Description

Block diagram of basic hardware is shown in Figure 3. Four units need to be implemented, which are sensors for sensing signals, a microcontroller for control feature, a driver and actuators for movement, and a gripper for carrying food.

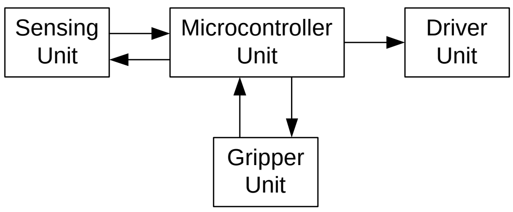

Figure 3. Block diagram of basic hardware units for an ant robot.

For sensing unit, we have 7 sensors for an ant robot, which uses for sensors to detect barriers and collision avoidance, and the other two for catching function of the gripper. The 38kHz infrared pulse signal is used for communication with modulation to protect the communication signal from the background noise. Locations of the sensors are shown in Fig. 4.

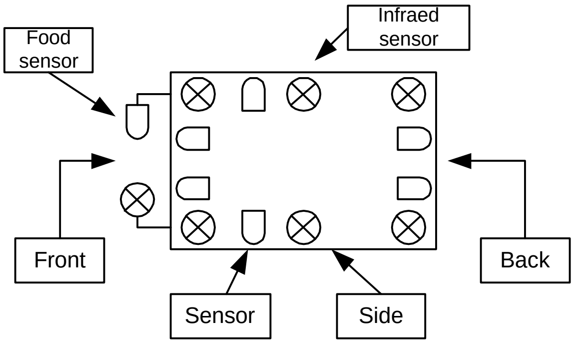

Figure. 4 Locations of sensors on the robot.

For control unit, we use a microcontroller, MCS51 89C2051, written in Assembly language. Flow charts for ant functions need to be constructed to guide the program before implementing to the chip in the conceptual designing phase. For example, Fig. 5 shows a flowchart for operational tasks of the robot.

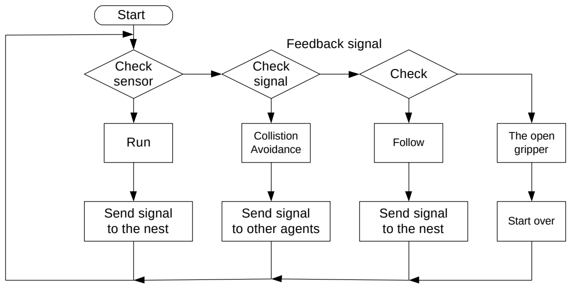

Figure. 5 An example of the flowchart for operational tasks.

We use IC7805 as a voltage regulator for transforming 9 Volts of the voltages into 5 volts. The IC L293D is also used as a motor's driver. The designer can used IC L293DD instead for more current supplied to the load. A block diagram for overall control unit is shown in Fig. 6.

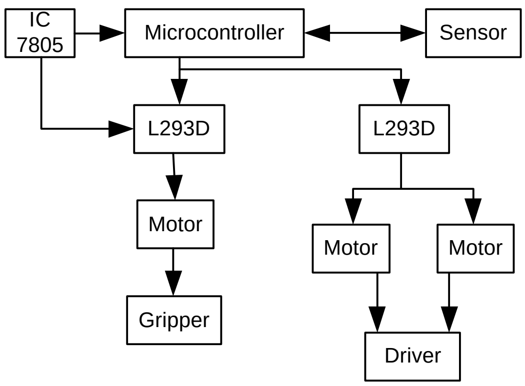

Figure. 6 A block diagram for the overall control unit.

For gripper unit, a DC motor is used for opening or closing the gripper. The working limit of the gripper is set around 45 to 90 degree measured from the middle line inside the Gripping space. Figure. 7 shows the mechanism of the gripper.

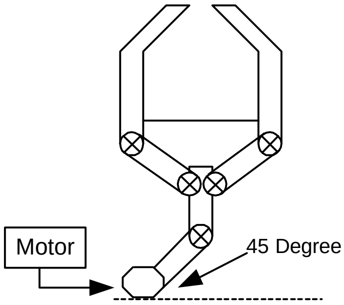

Figure 7 Mechanism of the gripper.

4. Experimental Results

The experimental results show the effectiveness of the design and implementation. Figure 8 shows the route recording of the robots' travelling path during the operation. We use the old fashion recording by attaching pencils with ant robots. Satisfactory result is achieved. However, the more intelligent tasks need to be extended for future research.

5. Conclusion

From our experiences, the following observations are given:

1. The behavior control paradigm needs to be adapted for different applications. Such paradigm should design a task into subtasks.
2. Before designing the communication among the robots, the designer needs to check and debug all software and hardware for regulation tasks. The movement function must be fully available upon receiving the communication signal from the other agents.
3. Intelligent functions such as path remembering or path optimization should be added.
4. Tools or gripper located at the ants' heads should be designed to provide more flexibility in order to be versatile.

6. Acknowledgment

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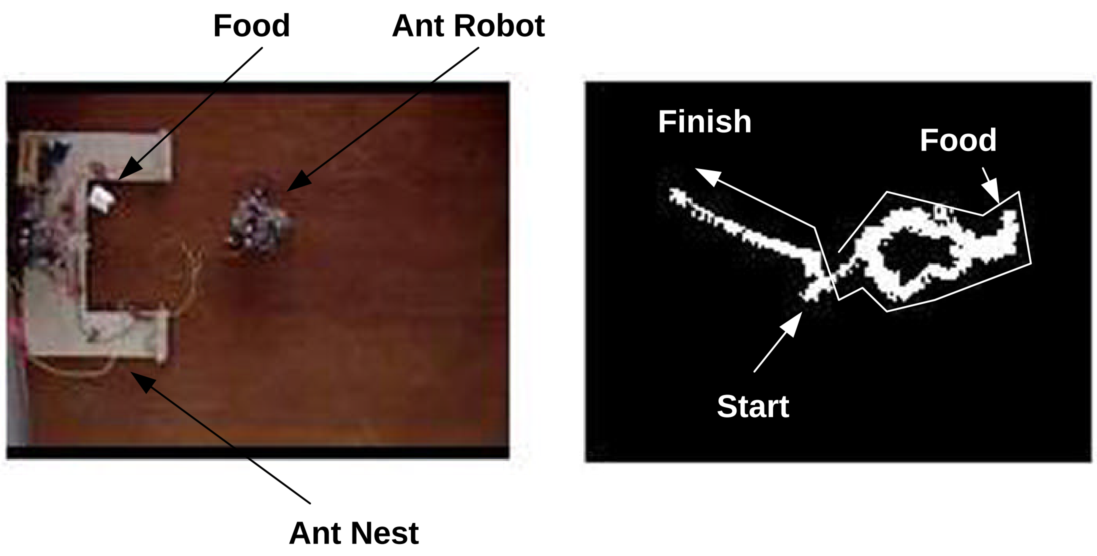

Figure 8. Route recording of the robot's traveling path.