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Swarm Robots for Warehouse Management

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***Abstract*: Swarm robotics is a new approach to the coordination of multirobot systems which consist of large numbers of mostly simple physical robots. In this paper, we will discuss this emerging filed, Swarm Robots. This filed has many applications. We will also discuss these applications in detail. Swarm robotics is an approach to collective robotics that takes inspiration from the self-organized behaviors of social animals. Through simple rules and local interactions, swarm robotics aims at designing robust, scalable, and flexible collective behaviors for the coordination of large numbers of robots. In this paper, we analyze the literature from the point of view of swarm engineering: we focus mainly on ideas and concepts that contribute to the advancement of swarm robotics as an engineering field and that could be relevant to tackle real-world applications. Swarm engineering is an emerging discipline that aims at defining systematic and well-founded procedures for modeling, designing, realizing, verifying, validating, operating, and maintaining a swarm robotics system. We propose two taxonomies: in the first taxonomy, we classify works that deal with design and analysis methods; in the second taxonomy, we classify works according to the collective behavior studied. We conclude with a discussion of the current limits of swarm robotics as an engineering discipline and with suggestions for future research directions.**

***Keywords*: Robot, Intelligence, Swarm, Applications.**

1. Introduction

Swarm robotics is a new approach to the coordination of multirobot systems which consist of large numbers of mostly simple physical robots. The desired collective behaviour 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 behaviour occurs. Individuals within the group interact by exchanging locally available information such that the problem (global objective) is solved more efficient than it would be done by a single individual. Problem-solving behaviour that emerges from such interactions is called swarm intelligence [1]-[5]. Swarm robotics is the application of swarm intelligence techniques to the analysis of activities in which the agents are physical robotic devices that can effect changes in their environments based on intelligent decision-making from various input. The goal of this approach is to study the design of robots such that a desired collective behaviour emerges from the inter-robot interactions and the interactions of the robots with the environment, inspired but not limited by the emergent behaviour observed in social insects. The paper is organized in the following manner.

2. Literature survey

Dudek et al. (1993) chose swarm size, communication range, communication topology, communication bandwidth, swarm reconfigurability and swarm unit processing ability to classify the literature. Cao et al. (1997) used: group architecture, resource conflicts, origins of cooperation, learning, and geometric problems. Iocchi et al. (2001) adopted a hierarchical taxonomy: in the first level they considered aware versus unaware cooperation. The aware category is divided into strongly coordinated, weakly coordinated and not-coordinated systems. Works related to strongly coordinated systems are divided into strongly centralized, weakly centralized and distributed. A separate section is dedicated to applications of multi-robot systems. Gazi and Fidan (2007) chose to divide the literature into mathematical models, swarm coordination and control, and design approaches. Bayindir and ¸Sahin (2007) classified the literature according to five taxonomies: modeling, behavior design, communication, analytical studies and problems.

3. Robot Design

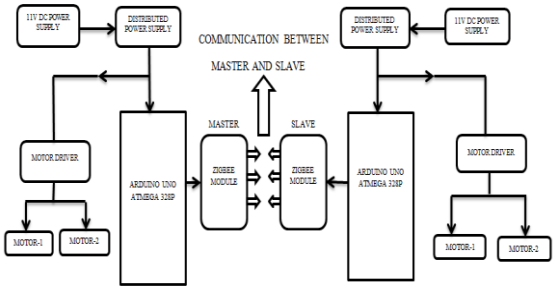

Fig. 1. Block diagram

A. Arduino Uno

Arduino/genuino uno is a microcontroller board based on the atmega328p (datasheet). It has 14 digital input/output pins (of

which 6 can be used as pwm outputs), 6 analog inputs, a 16 mhz quartz crystal, a usb connection, a power jack, an icsp header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a usb cable or power it with a ac-to-dc adapter or battery to get started. You can tinker with your uno without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

"Uno" means one in italian and was chosen to mark the release of arduino software (ide) 1.0. The uno board and version 1.0 of arduino software (ide) were the reference versions of arduino, now evolved to newer releases. The uno board is the first in a series of usb arduino boards, and the reference model for the arduino platform; for an extensive list of current, past or outdated boards see the arduino index of boards.

Table 1
Specifications

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
LED_BUILTIN	13
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Fig. 2. Arduino Uno

B. Zigbee

ZigBee is a wireless technology developed as an open global standard to address the unique needs of low-cost, low-power, wireless sensor networks. The standard takes full advantage of the IEEE 802.15.4 physical radio specification and operates in unlicensed bands worldwide at the following frequencies: 2.400–2.484 GHz, 902-928 MHz and 868.0–868.6 MHz.

1. The power levels (down from 5v to 3.3v) to power the zigbee module.
2. The communication lines (TX, RX, DIN and DOUT) to the appropriate voltages.

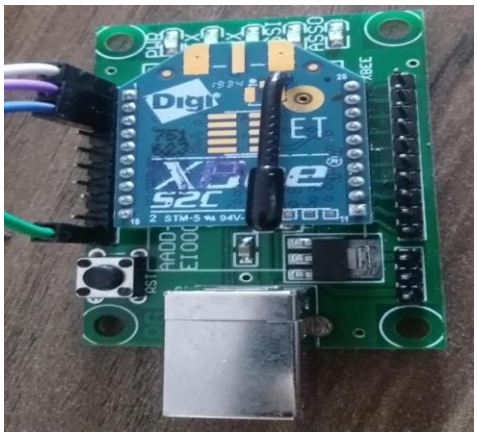

Fig. 3. Zigbee module

The Zigbee module acts as both transmitter and receiver. The Rx and Tx pins of ZIGBEE are connected to Tx and Rx of 8051 microcontroller respectively. The data's from microcontroller is serially transmitted to Zigbee module via UART port. Then Zigbee transmits the data to another Zigbee. The data's from Zigbee transmitted from Dout pin. The Zigbee from other side receives the data via Din pin.

ZigBee module. The €1 coin, shown for size reference, is about 23 mm in diameter. ZigBee is a specification for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio. The technology defined by the ZigBee specification is intended to be simpler and less expensive than other WPANs, such as Bluetooth. ZigBee is targeted at radio-frequency (RF) applications that require a low data rate, long battery life, and secure networking.

C. Motor Driver

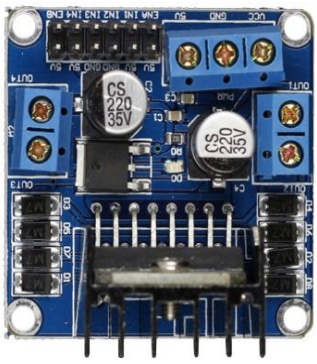

Fig. 4. Motor driver

The L298N is an integrated monolithic circuit in a 15- lead

Multiwatt and PowerSO20 packages. It is a high voltage, high current dual full-bridge driver de-signed to accept standard TTL logic level sand drive inductive loads such as relays, solenoids, DC and stepping motors. Two enable inputs are provided to enable or disable the device independently of the in-put signals. The emitters of the lower transistors of each bridge are connected together rand the corresponding external terminal can be used for the connection of an external sensing resistor. An additional Supply input is provided so that the logic works at a lower voltage.

D. DC Motor

A DC motor in simple words is a device that converts direct current (electrical energy) into mechanical energy. It's of vital importance for the industry today.

A DC motor is designed to run on DC electric power. Two examples of pure DC designs are Michael Faraday's homo-polar motor (which is uncommon), and the ball bearing motor, which is (so far) a novelty.

By far the most common DC motor types are the brushed and brushless types, which use internal and external commutation respectively to create an oscillating AC current from the DC source—so they are not purely DC machines in a strict sense.

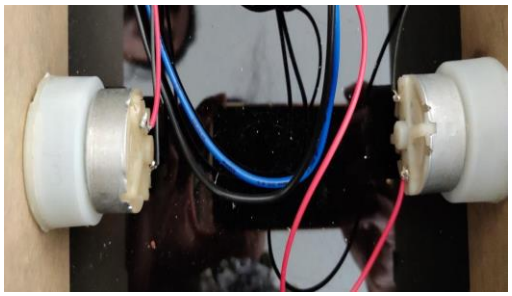

Fig. 5. DC motor

4. Project Working

Arduino UNO is considered as the heart of the total robot which consist of the microcontroller ATMEGA328P.

Path following master and slave robot consists of Arduino Uno, Zigbee, motors, motor driver, battery for power supply and power distribution board for distributing the power supply.

To this board, all the remaining hardware components are connected so as to control them.

A battery is connected to the power distribution board as it distributes the power to remaining all the hardware components.

Two motor drivers are connected to the different digital (4, 5, 6, 7) pins in the Arduino to control the motors as per the instruction.

A Zigbee module which is powered using V_{cc} is connected to digital pins 0, 1 which acts as a transmission and reception pins used to operate the robot in wireless.

We give a path to the master robot and it follows the path to the destination and when it gives the same path to the slave as it need to follow the same path at simultaneously.

We give commands to the master only and then it sends the commands to the slave.

Thus, master and slave reach the same destination while we give commands only to the master.

5. Flow Chart

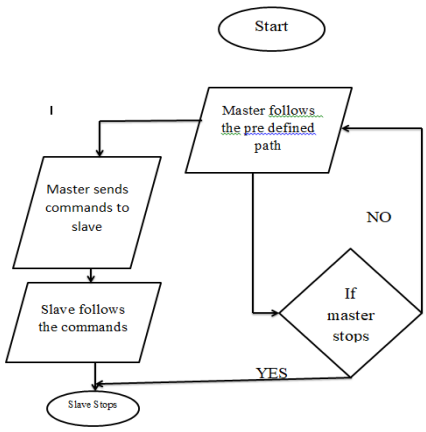

Fig. 6. Flowchart

6. Result

Fig. 7. Final view of the project

In the above figure 7, we are seeing the two robots which one of them are master while the other acting as a slave. In the figure the robot which is following the other is called as a slave where the followed robot is called master.

Master gave commands to the slave when it is started to the destination and the slave follows the commands to reach the destination.

7. Conclusion

The main aim behind this project is to operate one of the robot without any human commands.

It is a new approach to the coordination of multi robot systems which consist of large number of mostly simply

physical robots. Master and slave robot design, technology and applications are developed, enhanced and growing day by day.

Master and slave robots may one day be developed by the thousands of slaves to monitor and sense the environment, inspect machinery, or even perform medical procedures inside the human body.

8. Future Scope

With the emerging technologies in robotics this project may extend to several applications such as wars, military.

- The Arduino used can be replaced by powerful regulatory circuits which are more efficient than Arduino Uno.
- The components used in our project are confined to a particular distance. This range can be increased by adapting new technologies.
- An obstacle detector can be added so that, slave always follows the master without any Collison.
- This project can be extended as a maze solver and to get the shortest path between two points using certain algorithms.

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