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# Communication of Multi Mobile-Robots' Based On ZigBee Network

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**Abstract:** ***Robots can replace human working in some high-risk environment and scientific research Activities. With the rapid development of economic and technology, more and more service robots are widely used in a lot of machineries. How to effectively and reliably control the robots to serve human has become the focus of the study. The introduction of service robot wireless control system greatly improved travel efficiency and convenience for the disabled. It plays an important role not only to the operator but also to the caregiver. A novel wireless control system is designed in the paper. It can control the robot and feedback information in real time with ultrasonic obstacle avoidance function. The wireless monitoring hardware system for service robot is composed of upper PC workstation, MCU module, wireless communication module, ultrasonic sensor, wireless image transmission module, service robots and other parts. ultrasonic obstacle avoidance circuit used to obtain obstacles information sufficiently program to measure the distance between service robot and obstacles around .The wireless CMOS camera is chosen for the real-time image transmission Image contains a wealth of environmental information around the robot, which is equivalent to the function of its "eyes." The wireless receiver (EM250 Single-Chip ZigBee which is of 2.4GHz, IEEE 802.15.4-compliant transceiver).) is connected to the upper computer. The caregiver can monitor and control the robot in real time. It can also recognize and determine the initial target pose of robot .PC is the master of the system. Its role is to determine the next step of the motion and send commands based on the environmental information around the service robot. For solving the problem of the cooperation between multi-robots, a communication system based on the ZigBee network was designed. In the hardware of the robots, the ZigBee nodes are introduced. The multi-robots form a star network by the ZigBee nodes, and they keep communication with each other by the central node. The ZigBee network has many characteristics such as low cost, low power-consume, strong anti-jamming ability and real-time performance etc, it adapts to the application of intelligence. Experiments showed that the communication between the robots is reliable. This scheme is a good way for robots to complete complex task and improve working efficiency.***

**Keywords**: Robots, Zigbee, Transceiver, CMOS, MCU

## 1. Introduction

Communicating sensing to coordinate roles, i.e., to assign actions to each robot Communicating actions to coordinate roles primary objective of this project is to develop an embedded system, which is used to control multi robots through wireless and PC. This project is implemented ARM7-TDMI S based LPC 2148 developed board interfaced with zigbee and Personal Computer.

In this paper two robots are controlled by using our personal computer. A zigbee transiever will be attached to the PC and the two other will be attached to two robots individually. In this project there are two embedded systems based LPC2148 boards along with their robotic platforms. And one other embedded board is connected to pc through which we will control the other other two zigbee based robots. Whenever we want control the robot the commands are given from the Pc keyboard and these commands are encoded and transmitted through zigbee and the code is received by zigbee and robot will be controlled. Depending upon the command received by the zigbee those robots will decide which has to move.

## 2. Literature Survey

The Acorn RISC chip was first used in the revolutionary, but not terribly successful, Acorn Archimedes desktop computer. The low-power 32-bit processors proved far more valuable to the booming mobile device market. Interest in the ARM family was growing as more designers became interested in RISC. ARM's design was seen to match a definite need for low power consumption, low-cost RISC processors.

Since the early-Nineties, the success story of the ARM has grown slowly but steadily. The ARM has now become the standard processor for mobiles and now 98 percent of the more than one billion mobile phones sold each year use at least one ARM processor.

Today embedded systems are by far the largest market for processors: while a family may own one or two PCs, their car, mobile phones, and other devices may contain a total of dozens of embedded processors. ARM is the industry's leading provider of 32-bit embedded microprocessors, accounting for approximately 90 percent of all embedded 32-bit RISC processors.

ARM processors are used as the main CPU for most mobile phones, including those manufactured by Nokia, Sony Ericsson and Apple, many personal digital assistants and handhelds, like the Apple iPod and Nintendo DS as well as many other applications, including GPS, digital cameras, digital televisions, network devices and storage. Chip manufacturers use ARM designs in thousands of different ways, often embedding the ARM processor on a chip with lots of other components. In fact, today it is not uncommon for all the components of a computer to be on the one chip, this has an acronym, SOC, or System On a Chip. An example of an SOC is the new Apple iPad tablet computer. This one chip contains an ARM Cortex-A9 processor and an ARM Mali 50-Series graphics controller with all the electronics they need to make up a complete system.


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## 3. Design and Implementation

### ZigBee and XBee

ZigBee is a specification of the communication protocol low-power digital radios based on the IEEE 802.15.4 specification in 2003 and Zigbee alliance with a maximum range of 100 meters. IEEE 802.15.4 specification is the basis for the lower layers of the ZigBee MAC and PHY and determine the standard 2.4 GHz radio that is used in the world.

The ZigBee protocol is using same standard with the Bluetooth standard. Any manufacturer's device that fully supports the ZigBee standard can communicate with any other company's ZigBee device. So just as your Motorola Bluetooth headset can communicate with your Apple iPhone, a CentralLite ZigBee light switch can communicate with a Black & Decker door lock. Architecture ZigBee protocol shown in Fig 1 ZigBee is widely used in the market for ZigBee has many advantages, such as [7]:

- Reach 1 meter - 100 meter.
- ISM (Industrial, Scientific and Medical) radio bands: 2.4 GHz, 868 MHz and 915 MHz.
- Low power consumption.
- CSMA-CA channel access.
- Large networks (65,000 nodes)
- Highly secure (AES encryption)
- Network topology star, mesh and mutual support various applications.
- Interoperability across the world with other products
- Co-existence with other wireless media (eg, WLAN, Bluetooth, cellular).

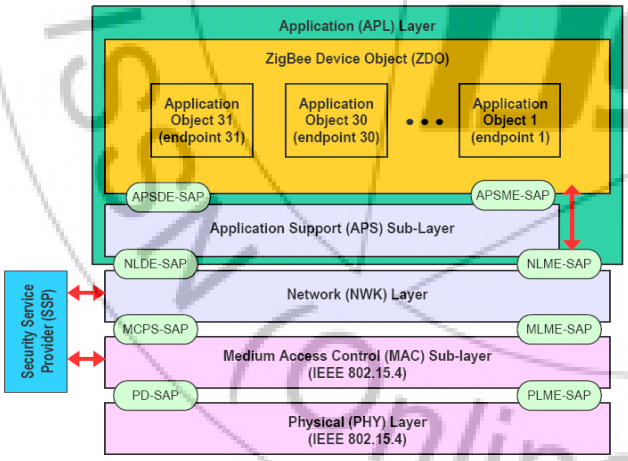


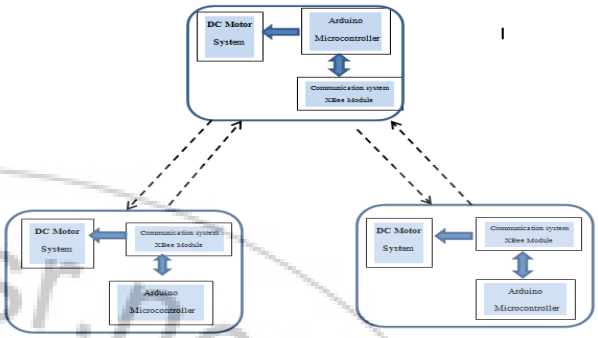

**Figure 1**: Architecture of Zigbee

The process of sending and receiving data on ZigBee. Using standard ZigBee network to transmit data specified by IEEE 802.15.4:

- Request data means the data transmission
- Data Confirm means the knowledge of the data request
- Data Indication means receiving data

## 4. System Design

The system is designed as shown in Figure 2.




The leader robot consists of an Arduino [8] microcontroller as the center of all the systems, and manages all activities of the input/output system. Sensor system which uses ultrasonic sensors functions as sensors obstacle in order that the robot can move well. Motion system using a DC motor driven with L298 Shield with maximum current 2A. Communication systems use Xbee Module with DFduino as connections between Xbee Shield and the Arduino microcontroller. This communication function for communication between leader robot and follower robots. As for the follower robots not have a sensor system. The movement of the follower robot just follows the leader robot by receiving commands via Xbee modules.

## 5. Methodologies

### A. User Interface

The robot will be controlled by remote server, which has the application design for this project. It will be connected with ZigBee transceiver, Video Receiver, Display terminal. This server will automatically acquiring the monitor data and store it into customized database at frequent interval of time. This project can be divided into two parts, i.e. Robot end and user interface (control) end. Robot has monitored and controlled by remote place. Robot has array of sensors for monitoring environmental status (Temperature, Humidity, Light Intensity). Since it started to move, it will check whether is there any obstacles in its path and if there is any obstacle it will detect the obstacle material, and the current environmental condition of the place where robot is situated and also the gripping force of the robot by means of PIR sensor. To design and build a wireless transmitter that works over the FM frequency and allows the transfer of all the data's over a certain distance to a FM tuner. From the user end we will get the data acquisition of monitoring parameters at the robotic end and the system will automatically stores the database of data acquired from other end at the frequent interval of time (in seconds). Robot's movements (Forward, Reverse, Left, Right) will be controlled via wireless medium. ZigBee-based Robot Localization and Control project uses wireless nodes to simultaneously localize and control the robot.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**B. Mobile Robot Base**

Mobile robot base is a platform that carries the load of the robot. Robot base design is depending on the application of the robot. If the robot move on the rough surface the material and size of the base must be suitable. In this project, the robot must be capable to carry microcontroller circuit, XBEE circuit, camera device, 6V battery holder and 2 pieces of 9V battery. The 6V servo motor is enough to carry this load.

**C. C Programming with CVAVR IDE**

To move the robot, it needs to be programmed. The C language is suitable for a robotic project because the users can see the structure of the robot operation. The programming includes initializing the PIC, configuring the LCD port, communicating with the wireless XBEE, controlling motor through driver control, and activating switch and buzzer. There are a lot of C compilers available but CVAVR IDE was chosen because it had been develop with the same manufacture with the AVR which is ATMEL. CVAVR Integrated Development Environment (IDE) is a free, integrated gcc-based toolset for the development of embedded applications employing AVR microcontrollers. The CVAVR IDE runs as a 32-bit application on Microsoft Windows, and includes several free software components for application development, hardware emulation and debugging. CVAVR IDE also serves as a single unified graphical user interface for additional Microchip and third-party software and hardware development tools.

**D. X-CTU Software for Zigbee setup**

X-CTU is a Windows-based application provided by Digi.This program was designed to interact with the firmware files found on Digi's RF products and to provide a simple-to-use graphical user interface to them. In this project the XBEE modules is chosen to be controlled with this software. X-CTU is designed to function with all Windows-based computers running Microsoft Windows 98 SE and above. Initially, the XBEE functions need to be set-up: PC setting, range test, terminal access using AT commands and modem configuration.

## 6. Results

This section discusses the results based on the development of hardware and software described in the previous section.

*Navigational Control*. The results of the mobile robot directional control is The motor can run in two modes which is normal and turbo. When in normal mode, the PWM speed was determined for 200 rpm whereas 255 rpm was set or turbo mode. The default speed is 200 rpm. The higher the speed the more the power required and the quicker the battery discharged.

## 7. Conclusion and Future Work

Based on the results, the objective of developing wireless mobile robot using Zigbee protocol has been achieved. Zigbee has been proven as a practical solution for low cost monitoring and controlling devices. The project demonstrated that implementing Zigbee network protocol 802.15.4 with microcontrollers ATMEGA8L can be done successfully. The wireless communication technologies are rapidly spreading to many new areas, including the automation and the importance of the use of wireless technologies in the data acquisition, building control, monitoring systems and automation of manufacturing processes will grow. Intelligent mobile robots and cooperative multi-agent robotic systems can be very efficient tools to speed up search and research operations in remote areas. These robots are also useful to do jobs in areas and in situations that are hazardous for human. They can go anywhere that is not reachable by humans and can go into gaps and move trough small holes that are impossible for humans and even trained dogs. As such, the scope of this project to demonstrate the successful wireless mobile robot navigation can be further improved. The next step is to build an autonomous robot, which is able to send the environmental status, the temperature condition, with smart obstacle avoidance system.

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