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Zigbee based Hierarchical Network for Supervisory Industrial Process Control

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Abstract*—Zigbee based hierarchical networks for supervisory industrial process control is a highly advanced technique to automate the industry in object management, material movement, plant demand and warehouse supply can be effectively facilitated in an efficient, accurate and intelligent way. It is a useful concept in today's competitive industry and marketplace, the companies require advanced technology to improve process effectiveness, comply with environmental guidelines, and meet corporate financial goals. Traditionally, industrial automation systems are realized through wired communications. However, the wired systems require expensive communication cables to be installed and regularly maintained, and thus, they are not widely implemented in industrial plants because of their high cost. Therefore, there is a need for cost-effective wireless automation systems that enable significant savings and reduce air-pollutant emissions by optimizing the management of industrial systems.*

Keywords*— Zigbee, plant, warehouse, object management, object handling.*

I. INTRODUCTION

ZigBee is a specification for a suite of high level communication protocols using tiny, low-power digital radios based on an IEEE 802 standard for personal area networks. ZigBee has a defined rate of 250 Kbit/s best suited for periodic or irregular data or a single signal transmission from a sensor or input device. The ZigBee standard provides network, security, and application support ser-vices operating on top of the IEEE 802.15.4. The standard is aiming to be a low-cost, low-power solution for systems consisting of unsupervised groups of devices in houses, factories and offices.

A. Existing Technology

Traditionally, industrial automation systems are realized through wired communications. However, the wired systems require expensive communication cables to be installed and regularly maintained, and thus, they are not widely implemented in industrial plants because of their high cost. Therefore, there is an urgent need for cost-effective wireless automation systems that enable significant savings and reduce air-pollutant emissions by optimizing the management of industrial systems.

B. Need for Zigbee

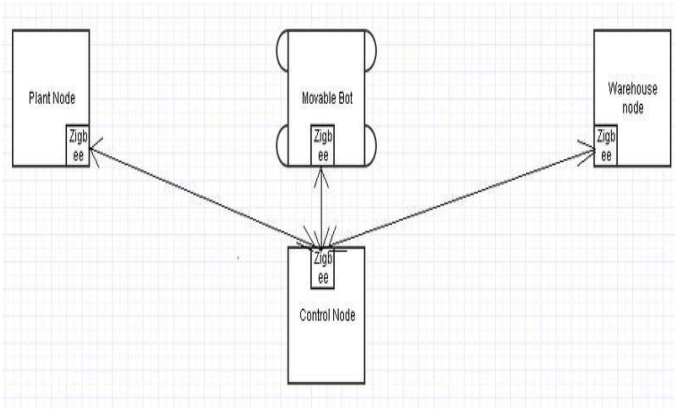
There are a multitude of standards that address mid to high data rates for voice, PC LANs, video, etc. However, up till now there hasn't been a wireless network standard that meets the unique needs of sensors and control devices. Sensors and controls don't need high bandwidth but they do need low latency and very low energy consumption for long battery lives and for large device arrays. There are a multitude of proprietary wireless systems manufactured today to solve a multitude of problems that also don't require high data rates but do require low cost and very low current drain. These proprietary systems were designed because there were no standards that met their requirements. These legacy systems are creating significant interoperability problems with each other and with newer technologies.

C. Proposed System

We recommend the use of zigbees in industrial nodal communication for where different nodes will operate together to facilitate object handling and management. There can be multiple nodes, one at warehouse, one at plant and one on the transport vehicle. All of them will be connected using a zigbee network wherein the speed of data transmission will be very high therefore the controlling signals will be sent and received immediately. Microcontroller AVR can be used at the warehouse which along with a computer will keep track of and will provide the objects to the locomotive vehicle.

II. ARCHITECTURE

The figure below shows the rendition of the proposed architecture wherein the nodes will be connected using zigbees in a wireless manner so that industrial object handling can be carried out.



Recommended schematic of the object- handling system

In the method there will be a warehouse in which materials required for the plant will be present. There will be a mechanism which will place or drop the desired materials on the locomotive vehicle. For communication between

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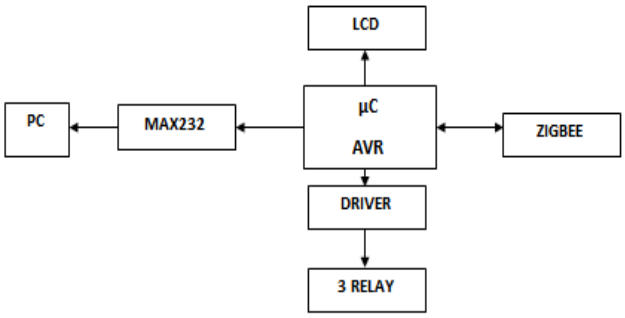
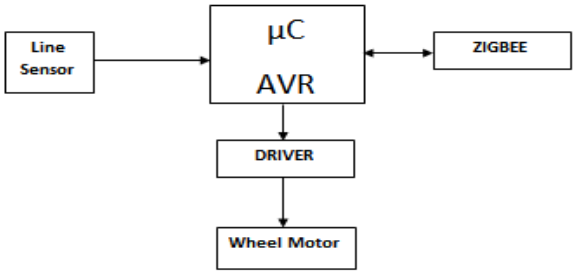
locomotive vehicle, warehouse and plant we recommend the use of zigbee communication protocol.

We also propose designs for all industrial nodes so that communication using zigbee can be facilitated.



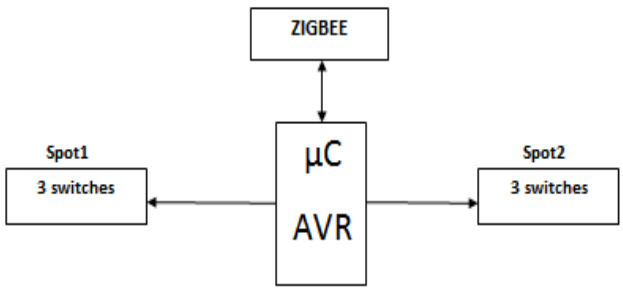
Recommended schematic of the warehouse node

As shown above, we recommend microcontroller AVR processor at the warehouse node which is compatible with zigbee, consumes less power and with the help of MAX -232 can provide serial data about the availability of objects or materials to the computer.



Recommended schematic of the locomotive vehicle

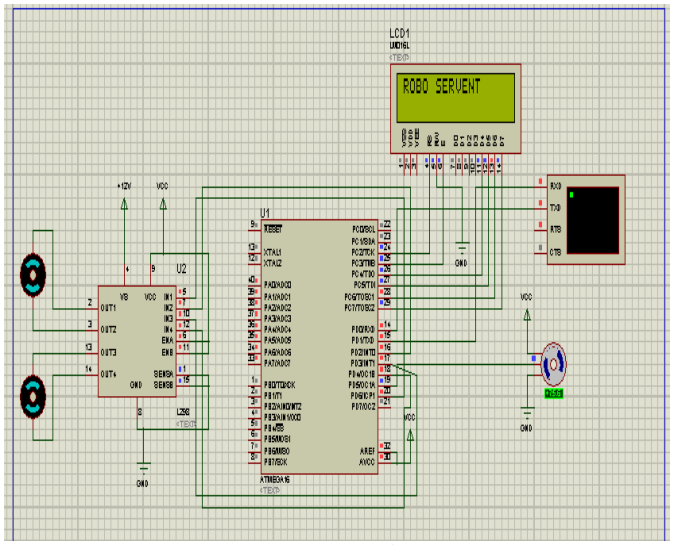
Also, for faster object management with high accuracy we recommend line follower sensors on the locomotive vehicle and that the fixed nodes be connected using physically painted lines. Microcontrollers with in-built programs or with interrupts can be used for driving the locomotive.



Recommended schematic of the plant node

III. TROUBLESHOOTING OF ROBOT

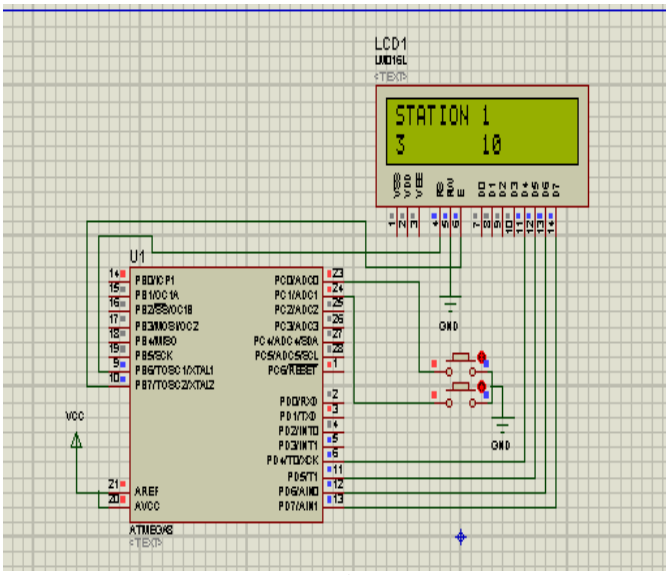
For testing of Robot circuit we are using LCD on Robot which shows different reading and messages. Firstly when power supply is on LCD will display ROBO SERVENT .After getting request from station 1 it will display station 1 and if get request from station 2 then display station 2 and DC motors starts and robot goes towards required station. After reaching the station and detecting the object servo motor starts and goes down. Then flapper takes the component and goes to the assembly point. After reaching the assembly point servo motor goes up and objects are placed at required assembly point.



Troubleshooting of robot

IV. TROUBLESHOOTING OF ASSEMBLY POINT

We are using LCD to check how many objects remaining. Two IR sensors are of two assembly points. We put the maximum object count 10.



Troubleshooting of assembly point

Then in the process at the assembly point when the object count is reduced to 3 then signal is send to Robot for to borrow the objects from warehouse. LCD display shows the total count and present count of objects remained at the assembly point. In proteus we use two switches instead of IR sensors.

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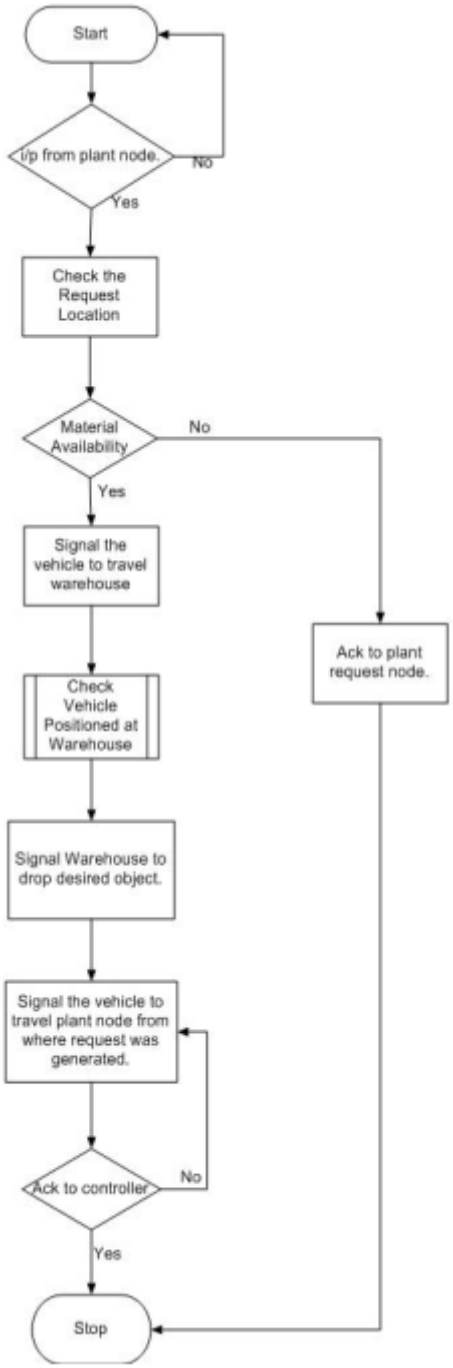
V. IMPLEMENTATION



VI. ADVANTAGES

There arises a legitimate question that why Bluetooth shouldn't be used instead of zigbee. But it should be noted that Bluetooth has many different modes and states depending upon your latency and power requirements such as sniff, park, hold, active, etc. ZigBee/IEEE 802.15.4 has active (transmit/receive) or sleep mode. Application software needs to focus on the application, not on which power mode is optimum for each aspect of operation.

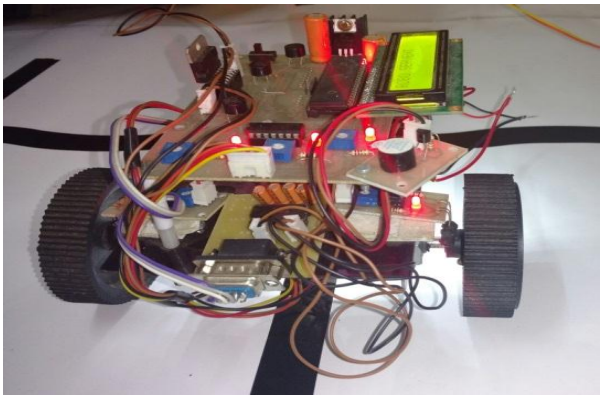
Low cost to the users means low device cost, low installation cost and low maintenance. ZigBee devices allow batteries to last up to years using primary cells (low cost) without any chargers (low cost and easy installation). ZigBee's simplicity allows for inherent configuration and redundancy of network devices provides low maintenance.

The recommended system is low cost and secure. Reliability and speed of operation is high. There is scope for flexibility and extendibility. Power consumption is low. Also, it can be global with use of unlicensed radio bands. Also integrated intelligence for network set-up and message routing can be provided.

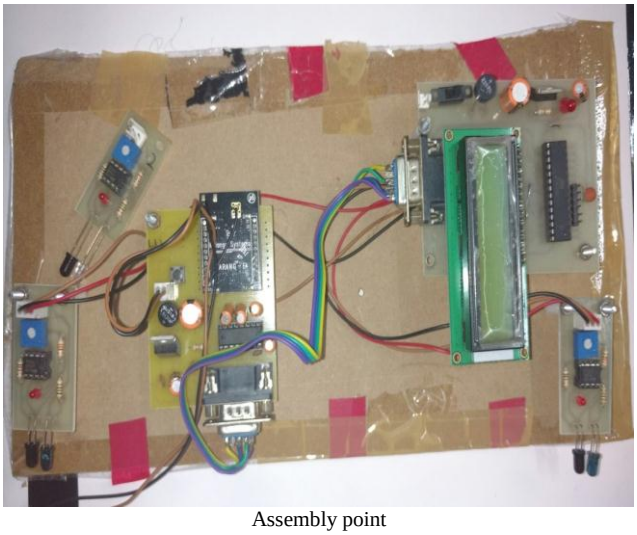
VII. APPLICATIONS

Zigbee technology is programmed in a chip form and is used in many devices to function automatically .For controlling and monitoring a whole factory unit while sitting in one cabin is possible by using Zigbee technology. It centralizes all the units in one place and enables the remote monitoring. In a similar way, a home can be centralized by increasing the security aspect. Many small equipment's are coming with embedded Zigbee technology chips and really works like a miracle.

The proposed system can be useful in chemical and pharmaceutical industries, automobile industries, food canning industry, bottling plants, packing industries, advanced libraries for managing books etc. Also, it can be useful for bringing objects in a home designed for Alzheimer patients.



VIII. PICTURE OF DEVELOPED SYSTEM



Assembly point

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IX. Future Scope

In future we can design the robot with a camera for further supervisory purpose. The present device can be enhanced to perform a wider range of applications such as accident rescue robot. More assembly points can be interfaced and more components can be provided.Enhancement of security can be facilitated by adding advanced encryption techniques on signals.

X. Conclusion

For this project we have designed a system that provides the industrial process automation and supervisory process control. The higher authority can monitor the data stored in the excel sheet for further supervision such as the timings for the request and the service provided are stored hence malfunctioning are detected.

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