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Implementation of Heterogeneous Network for Industrial Applications

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Abstract

In this paper, i am going to implement a heterogeneous network for industrial applications. In general, A wireless remote controller in which providing a wireless sensing solution for industries to operate essential industrial appliances, ranging from simple lightings to sophisticated electronic devices. A wireless protocol based on wireless token ring protocol (WTRP) has been modified, yielding wireless controller area network (WCAN) data centric communications, which is then proposed to be applied in managing concurrency control of industrial appliances. WCAN is an adaptation of its wired cousin, controller area network (CAN) protocol which has not being properly defined.

The wireless controller communicates with the standalone server which in turn communicates with the rest of sensing nodes through CAN system. Each node will be receiving command from the Standalone server and based on the message identifier, either executing the command or discarding it. WCAN has been chosen to become the backbone network of the system as it offers an alternative solution when industrial mobile stations under certain constraints should continue to use CAN protocol as frame exchange protocol. This project is implemented in three sections. First node runs as data acquisition node to which sensors are connected and another one is responsible controlling machines and appliances.

Communications between two nodes are accomplished through High Speed CAN communication. Sensors connected are temperature, level and MEMS. Third node is the Master Node collects all necessary data from node 1 and controls industrial appliances through node 2. The communication between master node with node 1 2 is through wireless CAN protocol.

Keywords: Accelerometer, CAN, Temperature Sensor Level Sensor, PICMicrocontroller, ZigBee

I. INTRODUCTION

CAN (controller area network) is a vehicle bus standard designed to allow microcontrollers and devices to communicate with each other within a vehicle without a host computer [3].

CAN bus is a message-based protocol, designed specifically for automotive applications but now also used in other areas such as industrial automation and medical equipment. CAN bus was originally invented in 1983 by Robert Bosch GmbH. The protocol was officially released in 1986 at the Society of Automotive Engineers (SAE) congress in Detroit, Michigan. Previously, sensor networks consisted of small number of sensor nodes that were wired to a central processing station. However, nowadays, the focus is more on wireless, distributed, sensing nodes. A typical smart sensor network is made up of nodes that have different functions. Some nodes will only transmit data, some will receive data, and some may have multiple functions [1].

A typical smart sensor node is made up of both digital and analog components, which allow the sensor data to be captured, transformed, analyzed, and transmitted to other nodes in the system. There are various methods for communication between these distributed nodes like RF(Radio Frequency, Bluetooth and other various wireless method. But by Applying the CAN protocol to a smart sensor network is a natural progression from existing sensor networks. It will prove itself efficient and economic media for communication.

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The CAN bus provides an ideal platform for nterconnecting nodes and allows each node to communicate with any other node.

A networked system which requires fast and robust communication and where data should maintain high integrity, Controller Area Network protocol (CAN) can be used for the communication between nodes, as CAN protocol was optimized for systems that need to transmit and receive relatively small amounts of information reliably to any or all other nodes on the network.

The CAN protocol is robust and uses sophisticated error checking and handling, which allows errors and failures to occur without shutting the entire system down which is useful in the motor control node[1]. The error containment also allows sensor nodes to be added to or removed from the system while the network is in operation. The objective of this paper is to design a CAN based networked industry monitor and control using two sensor nodes.

II.RELATED WORK

Heterogeneous wireless network:

A Heterogeneous wireless network (HWN) is a special case of a Heterogeneous network (HetNet). Whereas a HetNet may consist of a network of computers or devices with different capabilities in terms of operating systems, hardware, protocols, etc., a HWN is a wireless network which consists of devices using different underlying radio access technology.

There are several problems still to be solved in heterogeneous wireless networks such as:

- Determining the theoretical capacity of HWNs
- Interoperability of technology
- Handover
- Mobility
- Quality of Service / Quality of Experience
- Interference between RATs

There are several benefits to a HWN as opposed to a traditional homogeneous wireless network including increased reliability, improved spectrum efficiency, and increased coverage. Reliability is improved because when one particular RAT within the HWN fails, it may still be possible to maintain a connection by falling back to another RAT. Spectrum efficiency is improved by making use of RATs which may have few users through the use of load balancing across RATs and coverage may be improved because different RATs may fill holes in coverage that any one of the single networks alone would not be able to fill.

Wireless networks characteristics

Attending to current architectural trends in next generation networks [12], wireless networks are mainly devoted to providing network connectivity services (i.e., bearer services) that may be characterized by a given quality of service (QoS) profile. Then, end user service provisioning is supported by means of specialized service platforms (e.g., IP multimedia subsystem [IMS]) that become accessible to the users via those bearer services. Accordingly the wireless network provides network layer connectivity (e.g., IP connectivity) to external networks and service platforms via some type of network gateway (NG).

In addition, this NG can allocate mechanisms to dynamically acquire operator policies related to QoS and accounting, and enforce them on a packet-by-packet basis for each mobile user. On the other side, a RAT-specific radio link protocol stack would be used in the air interface. This radio protocol stack can be entirely allocated in base stations (BSs) or distributed in a hierarchical manner between BSs and some type of radio controllers. The radio link protocol stack comprises physical, medium access control, and radio link control layers.

Through this radio protocol stack, data transfer in the radio interface can be managed, attending to each mobile user's specific needs while simultaneously pursuing an efficient usage of radio resources by means of appropriate radio resource management (RRM) mechanisms. Hence, BSs and NGs constitute the two key elements within the data plane functions (i.e., those functions that are executed directly on the flow of data packets). Additionally, the data plane between BSs and NGs can also comprise mobility anchoring functions in charge of receiving data destined for a given mobile and redirecting the data (usually through tunneling) to the mobile's serving BS.

Controll Area Network

Controll Area Network (CAN) was initially created by German automotive system supplier Robert Bosch in the mid-1980s for automotive applications as a method for enabling robust serial communication. The protocol was officially released in 1986 at the Society of Automotive Engineers (SAE) congress in Detroit, Michigan.

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The first CAN controller chips, produced by Intel and Philips, came on the market in 1987. Bosch published the CAN 2.0 specification in 1991.

CAN is a serial communications protocol which efficiently supports distributed real-time control with a very high level of security. Its domain of application ranges from high speed networks to low cost multiplex wiring. In automotive electronics, engine control units, sensors, anti-skid-systems etc. are connected using CAN with bitrates up to 1 Mbit/s. At the same time it is cost effective to build into vehicle body electronics e.g. lamp clusters, electric windows etc. The goal was to make automobiles more reliable, safe and fuel-efficient while decreasing wiring harness weight and complexity.

Disadvantages of Existing System:

- Lack of Intelligence in the detection systems.
- Way of monitoring people to be manual
- Time delay
- Not accurate

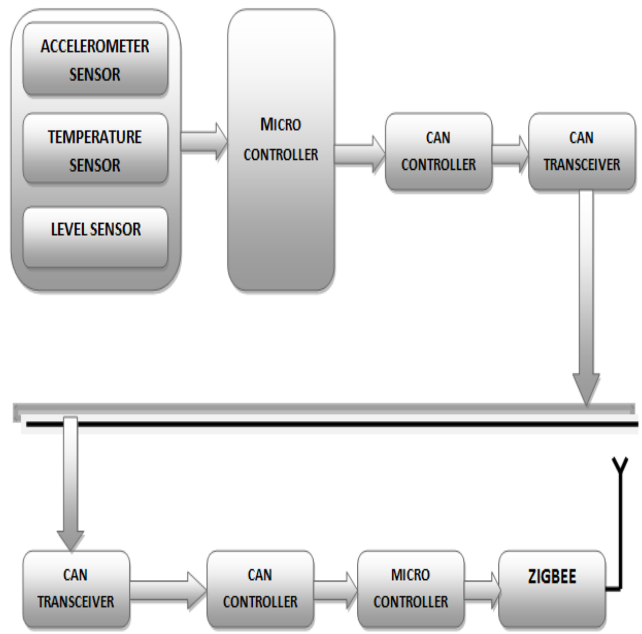
Advantages of Proposed System:

- For easy access the server maintains a database for each node, and hence each node will have a unique id for addressing it.
- Wireless technologies used for information transferring.
- Accurate
- Intelligent system

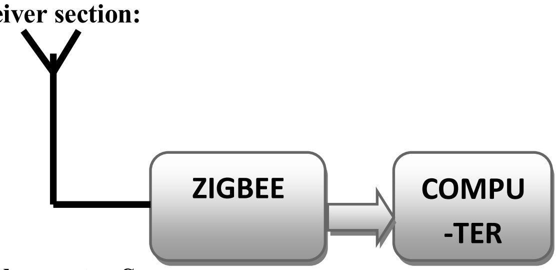
III.PROPOSED SYSTEM DESIGN

Block Diagram

Transmitter section:



Receiver section:



Accelerometer Sensor

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.The ADXL335 is available in a small, low profile, 4 mm × 4 mm × 1.45. Shown in

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Fig. Accelerometer

Temperature Sensor

The LM35 is an integrated circuit sensor that can be used to measure temperature with an electrical output proportional to the temperature (in oC) .The LM35 - An Integrated Circuit Temperature Sensor. They use the fact as temperature increases, and the voltage across a diode increases at a known rate. (Technically, this is actually the voltage drop between the base and emitter - the Vbe - of a transistor. By precisely amplifying the voltage change, it is asy to generate an analog signal that is directly proportional to temperature. You can measure temperature more accurately than a using a thermistor. Shown in fig .

Level sensor

Level sensors detect the level of substances that flow, including liquids, slurries, granular materials, and powders. Fluids and fluidized solids flow to become essentially level in their containers (or other physical boundaries) because of gravity whereas most bulk solids pile at an angle of repose to a peak. The substance to be measured can be inside a container or can be in its natural form (e.g., a river or a lake). The level measurement can be either continuous or point values. Continuous level sensors measure level within a specified range and determine the exact amount of substance in a certain place, while point-level sensors only indicate whether the substance is above or below the sensing point. Generally the latter detect levels that are excessively high or low. There are many physical and application variables that affect the selection of the optimal level monitoring method for industrial and commercial processes.

The selection criteria include the physical: phase (liquid, solid or slurry), temperature, pressure or vacuum, chemistry, dielectric constant of medium, density (specific gravity) of medium, agitation (action), acoustical or electrical noise, vibration, mechanical shock, tank or bin size and shape. Also important are the application constraints: price, accuracy, appearance, response rate, ease of calibration or programming, physical size and mounting of the instrument, monitoring or control of continuous or discrete (point) levels. In short, level sensors are one of the very important sensors and play very important role in variety of consumer/ industrial applications. As with other type of sensors, level sensors are available or can be designed using variety of sensing principles. Selection of an appropriate type of sensor suiting to the application requirement is very important.

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Micro controller (LPC2148)

The LPC2141/42/44/46/48 microcontrollers are based on a 16-bit/32-bit ARM7TDMI-S CPU with real-time emulation and embedded trace support, that combine the microcontroller with embedded high-speed flash memory ranging from 32 kB to 512 kB. A 128-bit wide memory interface and unique accelerator architecture enable 32-bit code execution at the maximum clock rate. For critical code size applications, the alternative 16-bit Thumb mode reduces code by more than 30 % with minimal performance penalty. Due to their tiny size and low power consumption, LPC2141/42/44/46/48 are ideal for applications where miniaturization is a key requirement, such as access control and point-of-sale.

Features

- 16-bit/32-bit ARM7TDMI-S microcontroller in a tiny LQFP64 package.
- 8 kB to 40 kB of on-chip static RAM and 32 kB to 512 kB of on-chip flash memory. 128-bit wide interface/accelerator enables high-speed 60 MHz operation.
- In-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader software. Single flash sector or full chip erase in 400 ms and programming of 256 in 1 ms

Can controller (MCP2515)

The MCP2515 is a stand-alone CAN controller developed to simplify applications that require interfacing with a CAN bus. A simple block diagram of the MCP2515 is shown in Figure. The device consists of three main blocks:

1. The CAN module, which includes the CAN protocol engine, masks, filters, transmit and receive buffers.
2. The control logic and registers that are used to configure the device and its operation.
3. The SPI protocol block. An example system implementation using the device is shown in Figure

.

Technology

CAN is a multi-master broadcast serial bus standard used for connecting electronic control units (ECUs). Each node is able to send and receive messages, but not simultaneously. A message primarily consists of an ID (identifier), which represents the priority of the message, and up to eight data bytes. It is transmitted serially onto the bus. This signal pattern is encoded in non-return-to-zero (NRZ) and is sensed by all nodes. The devices that are connected by a CAN network are typically sensors, actuators, and other control devices. These devices are not connected directly to the bus, but through a host processor and a CAN controller.

If the bus is free, any node may begin to transmit. If two or more nodes begin sending messages at the same time, the message with the more dominant ID (which has more dominant bits, i.e., zeroes) will overwrite other nodes' less dominant IDs, so that eventually (after this arbitration on the ID.) only the dominant message remains and is received by all nodes. This mechanism is referred to as priority based bus arbitration. Messages with numerically smaller values of IDs have higher priority and are transmitted first.

Can transceiver MCP2551

The MCP2551 is a high-speed CAN, fault-tolerant device that serves as the interface between a CAN protocol controller and the physical bus. The MCP2551 provides differential transmit and receive capability for the CAN protocol controller and is fully compatible with the ISO-11898 standard, including 24V requirements. It will operate at speeds of up to 1 Mb/s. typically; each node in a CAN system must have a device to convert the digital signals generated by a CAN controller to signals suitable for transmission over the bus cabling (differential output). It also provides a buffer between the CAN controller and the high-voltage spikes that can be generated on the CAN bus by outside sources (EMI, ESD, electrical transients, etc.).

Zigbee

The field of wireless communications has been in existence since the first humans learned to communicate. In early days of civilization humans would transmit notices of important events, such as enemy invasions or royal births, through the sounding of horns or the lighting of fires. While simple messages could be effectively transmitted in this manner, in order to communicate over long distances the manpower expense was great, since watchtowers had to be built within sight of each other and continually manned, and the number of messages was small. It was not until the 1800’s that wireless communications became what we know it as today. Now we are able to use radio frequencies to communicate information over long distances (think of the Cassini mission to Saturn), we can send voice or video at rates of more than hundreds of megabits per second, and the associated technology

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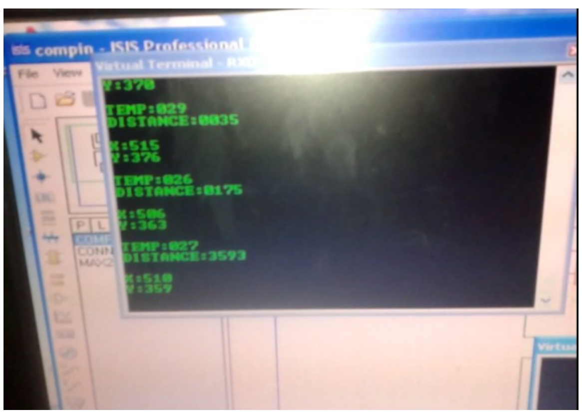
has become so inexpensive that many people are able to afford a mobile phone in order to be in constant contact with others.

ZigBee is an established set of specifications for wireless personal area networking (WPAN), i.e. Digital radio connections between computers and related devices. WPAN Low Rate or ZigBee provides specifications for devices that have low data rates, consume very low power and are thus characterized by long battery life. ZigBee makes possible completely networked homes where all devices are able to communicate and be controlled by a single unit. The ZigBee Alliance, the standards body which defines ZigBee, also publishes application.

Profiles that allow multiple OEM vendors to create interoperable products. The current list of application profiles either published or in the works are:

- Home Automation
- ZigBee Smart Energy
- Telecommunication Applications
- Personal Home

IV.RESULT



CONCLUSION

CAN based industry and home automation have been designed with transmitter nodes and receiver node. The transmitter nodes are designed as sensor nodes and the receiver node as the control node with display, which accepts messages from the sensor nodes and uses the information etc. The small size of the CAN transceiver IC and the micro controller with integrated CAN solution reduces the size and cost of the node considerably. With the use of high speed CAN transceiver the data is transmitted and received in faster rates with high level of integrity. The processing time associated is also small. Industry monitoring is an important class of sensor network applications with enormous potential benefits for the industrials. CAN based smart sensor network for industry monitoring and control has been designed with two transmitter nodes and one receiver node.

The transmitter nodes are designed as sensor nodes and the receiver node as the motor control node with display which accepts messages from the sensor nodes and uses the information to switch on and off the fan, there by controlling the concentration of air contaminant gases. CAN communication between the two sensor nodes and the motor control node has been implemented through the CAN physical layer standard ISO 11898-2, which defines CAN bus as two wire differential bus. Because the protocol is message based, any node can send a message to any other node. This gives tremendous flexibility to the system designer. The small size of the CAN transceiver IC and the microcontroller with integrated CAN solution reduces the size and cost of the node considerably. With the use of high speed CAN transceiver the data is transmitted and received in faster rates with high level of integrity. The processing time associated is also small.

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