SHARING OF COMPASS SENSOR DATA OVER NETWORK IN WIRELESS SENSOR NETWORKS

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Abstract- Wireless Sensor Networks are very popular and applicable new technology in many fields in recent years. Data can be collected interactively with the environment using Wireless Sensor Networks, these data can be collectively evaluated and when needed, changes can be made on the environment, based on the data. In most of the applications implemented nowadays, similar sensors are available on many devices close to each other. When the sensor data are needed in another device and no sensor is available on the device, the device cannot receive the sensor data. With this study, sending of information of the compass sensor from any device to the target device over Zigbee technology has been achieved.

Keywords- Wireless Sensor Networks, Zigbee, Sensor Nodes, Compass, Common Use of Sensors, Detection of Direction

I. INTRODUCTION

Wireless Sensor Networks consist of sensor nodes containing basic processors, low power consuming antennas and various detectors. As the sensor nodes do not require a wired communication infrastructure, they can be created without harming the environment and in a cheap manner[1] ([1]. The sensor nodes are capable of data storing and processing with the hardware and software they possess. The fact that they can communicate with each other enables them to cooperate not only in exchanging data but also in performing of complicated transactions.

That the communication means have a low power consumption allows for a longer life span for the sensor nodes. The fact that the nodes are programmable after they are installed provides big advantages. The wireless Sensor Nodes are very convenient in using in industrial and environmental applications thanks to the low costs and flexibility in use[2].

Wireless Sensor Networks are a very popular technology used for communication between machines lately.

Depending on the application too, in the Wireless Sensor Networks, it is aimed that data of a temperature detector in an environment with many sensors close to each other, as the ambient temperature would be the same all around, will be utilised by the other devices available in the network. Thus, the general cost and the power consumption could be minimised.

For this purpose, in order for use in communication between machines (M2M) sensor nodes containing compass sensors have been designed. Direction data (the angle to the magnetic North) can be determined with a compass sensor. The magnitudes measured by the sensors are generally used for the explanation of the relation between a value they have taken as a reference. For instance, the accelerometer measures the force applied on it. When it is fixed, the gravitational acceleration value falls on it as the reference value.

The compass sensor however, allows us to take the angle information that is created by the sensor with reference to the magnetic field of the Earth. Compasses are used for direction finding and operate taking the magnetic field of the Earth as reference. The compass always measures the angle between itself and the magnetic field of the Earth.

The electronic compass sensors make this measurement for each value of the axis, thus every angle that compass sensor makes with the magnetic field is always known. In worldwide applications in all transport and architecture compasses (Magnetometers) are used for direction finding. In this study, HMC5883L compass sensor has been used. This sensor generally provides the adequate resolution, power consumption and accuracy. In this study, instead of using many compasses in all of the devices, a compass has been installed in one node only. The other devices can retrieve the present information from this sensor when needed or the data on the compass sensor can be regularly collected in the central (base) station and broadcast to the other sensor nodes.

II. COMPASS

A fixed magnetic field line is generated on the Earth due to the magnetic field of the Earth. When there is nothing around to be taken as reference (Buildings,

mountains etc.) and as there is nothing to be taken as reference in similar looking areas (Oceans, air, forests etc.), reliable direction finding is almost impossible. In such cases where direction finding is necessary, the magnetic field of the Earth of which the direction is always constant is used. These magnetic field lines are available all over the Earth and are used for safe direction finding reference. In the old days, direction finding issues used to be worked out in mechanical compasses. As a result of the progresses in MEMS technology in time, direction finding can accurately and definitely be made by virtue of the electronic compasses. Electronic compasses are sensors which can be easily integrated into electronic circuits, which can measure angle values up to 3 axes and with low power consumption.

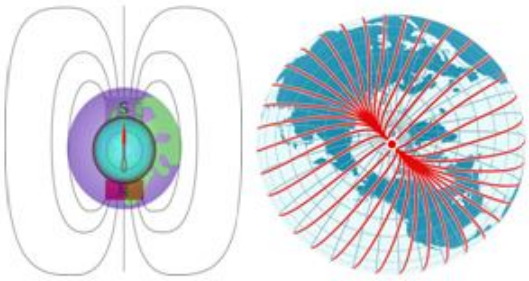


Figure1. Magnetic Pole

As seen in Figure 1, the magnetic pole is fixed in whole of the Earth and the mechanical and electronic compasses gives the value of the angle calculated with this magnetic field as output data. Compasses are used efficiently by sailors, airmen, soldiers, miners, architects etc. The resolution of the compass can be determined depending on how accurately we wish to measure distance between the magnetic poles (N-S). The higher the resolution is the more definite the direction finding would be possible. The frequencies of the compasses however, are about how many measurements will be made in second. As the frequency increases the power consumption increases as well. The compasses should be kept away from magnetic field propagating objects regardless of being an electronic or mechanical compass. These objects act as the magnetic pole of the Earth and make the compass give false directions. When working on electronic compasses, it is important to prevent the compasses being affected by the magnetic field. Also, when the genetic fluids are put in metal cases, in order to make sure that the sensor nodes make accurate measurements, necessary comparing should be made with an electronic compass.

III. DESIGN OF SENSOR NODES AND COORDINATOR NODE

Nowadays, where smart environment projects are rapidly growing, development of monitoring and control systems containing a single communication protocol is gaining more and more importance. The fact that Zigbee has become prominent with its features; such as ease of installation, cost, and expandability and low power consumption conduces toward different application to be developed with this technology. The constituents constituting sensor nodes are given in Figure 2. Small devices possessing detection, calculation and communication abilities are used for the creation of self-installed, unplanned (Ad-Hoc) networks to observe the environment and interact with the physical Earth. Each one of the nodes that form the Wireless Sensor networks however, are called sensor nodes or mote based upon the small sizes.

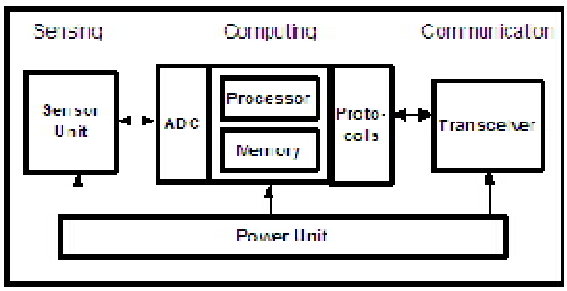


Figure 2. Constituents of Sensor Nodes

A sensor node is comprised of 4 kinds of components. These are; the processor, memory unit, power source, sensor and/or access assembly and finally the communication sub-system (Radio). In this study as well, Zigbee[3] technology has been utilised in order to transfer data wirelessly due to low power consumption and its supremacy over other technologies.

Zigbee Personal Area Networks, is a standard suitable for high level communication protocols based on IEEE 802.15.4 [4,5] with low power consumption. Zigbee is defined as a cluster of wireless communication protocols with short rage and low transfer speed. Zigbee is basically aimed to be used at low data transfer rates in applications where low-cost and long battery life features could be housed.

As the processor, MSP430G2553 processor has been used. The MSP430 processors are microcontrollers produced by Texas Instruments Inc. in architecture of 16-Bit RISC and well known world-wide by its low power consumption. It pulls 0.1 µA current in sleeping mode and it can wake up from its sleeping mode in just under 1 µs. This way, it can give the same reaction, when interrupt or similar options are used, as most of the processors that are not in sleep mode. It also has hardware I2C, SPI, UART. It can communicate with other sensors and computers by means of these communication interfaces.

The features of the HMC5883L compass sensors are given below:

- Measuring of the angle with the magnetic field in all 3 axes.
- Ability to take measurements in 12 bit resolution.

- Being able to be connected in parallel with many sensors with an I2C interface.
- 160 Hz measuring speed.
- Low power consumption: 100µA measuring mode , 2 µA sleeping mode
- Operations in the range of -40ºC and +125 ºC

With these features of the sensor, it is possible to be used in all applications carried out with sensor nodes. Given in Figure 3 is the circuit for sensor and the microcontroller of the sensor nodes.

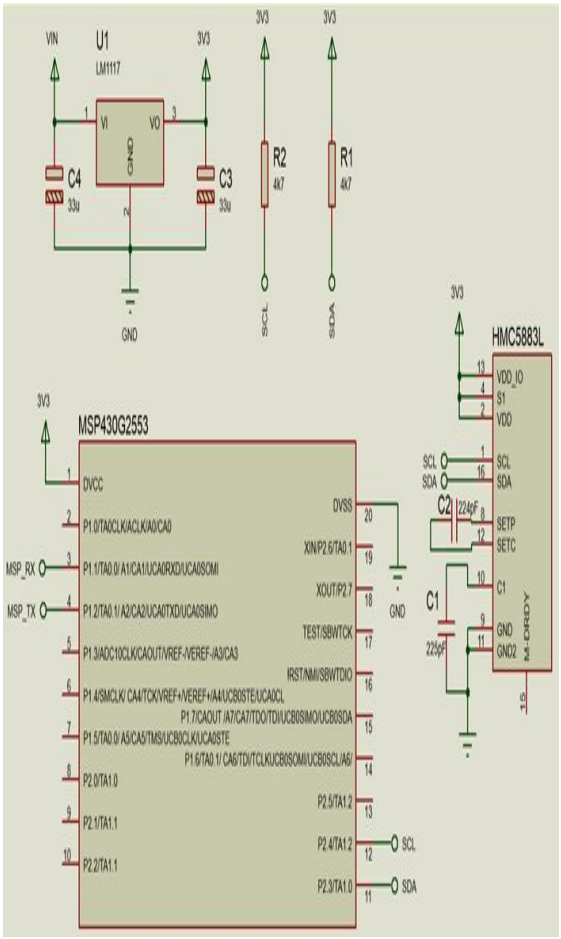


Figure 3. Microcontroller and Sensor Circuits

The sensor nodes forward the information they detect in cooperation, to the central node. Here, it is extremely important that this information is sent to faraway stations. In this regard, central nodes have been developed in order for the information coming from the sensor nodes to the faraway stations.

Therefore, the information shall become monitorable and controllable from a faraway station. The information sent to far away stations will be saved in the database and this information will be reachable upon request. In addition to this, in coordinator node however, SIM900 GSM/GPRS module has been used. This way communication with the server or a mobile phone can be established. In Figure 4, given is the circuit drawing for SIM900 GSM/GPRS Module.

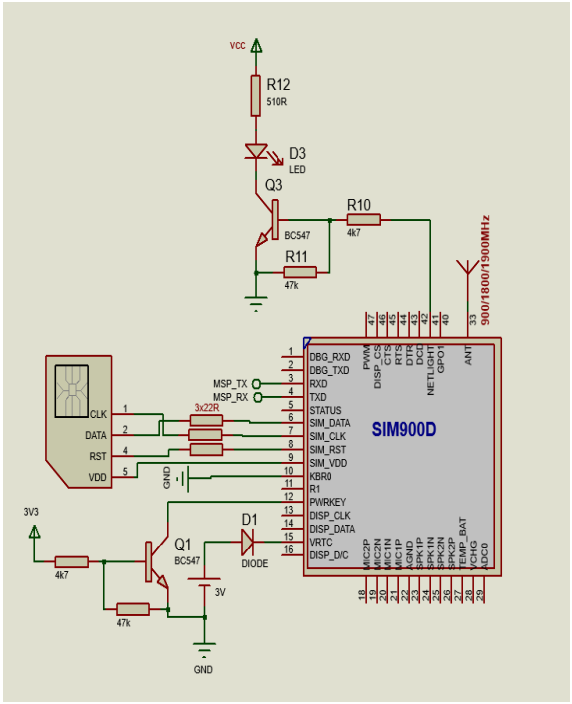


Figure 4. Circuit drawing for SIM900 GSM/GPRS Module

In the study conducted, it has been aimed to determine only one of the nodes available in a physical environment and let other nodes be informed about this information. With this application, sharing of sensor data available in only one place through whole network has been aimed.

IV. MONITORING OF ENVIRONMENT DATA

A general operation of a Wireless Sensor Network is shown in Figure 5.

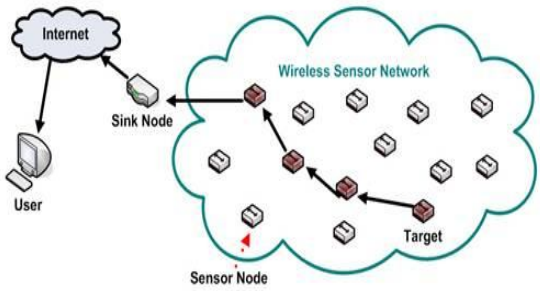


Figure 5. Sample of a Wireless Sensor Network

In an environment where sensor nodes have been placed, information of direction can be monitored. This information comes from the environment node. If the value that arrives is different to the one specified by the user, then it is understood that there is a problem in the environment and the user is notified with an SMS/call. This way, sudden changes that might occur in the environment can be instantly identified and taking precautions will be lot easier.

The values detected by the sensor nodes in the network are received by the coordinating device. The coordinating device transiently sends the data to the

Server by means of the Module SIM900. By virtue of the software that can be implemented on the computers, concluding of graphical statistics and triggering of instant warning systems can be performed. The instant behaviours of the systems can be remotely monitored by virtue of the web-based coded software and remote monitoring features; also the control of the devices can be accomplished.

CONCLUSIONS

Wireless sensors are convenient to be used in many military, civilian and environmental applications due to low costs and flexibility of use. The traditional systems used for indoor applications contain a wired infrastructure and a centralised control unit. The wired infrastructure causes installation expenses. Break down of the central control unit and the damaging of the cables will bring the whole system down. For all of these reasons, the most convenient and the cheapest solution is the Wireless Sensor Networks. In this study, sensor nodes and coordinator nodes have been designed. A compass sensor was integrated into the sensor node and the information received by this sensor was wirelessly sent to the central unit. This system could be used in applications where direction information is needed. Also, in case direction change, informing by means of SMS or calls are initiated and monitoring and control of the user is being eased.

ACKNOWLEDGEMENTS

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