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CONFIGURATION OF WIRELESS SENSOR NETWORK FOR ITS APPLICATIONS IN CONSTRUCTION SITES.

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ABSTRACT

Civil engineering construction site is a-risky area, where several accidents and unwanted incidents occur, but most of the construction sites lack important safety measures monitoring and warning system to provide safety to the workers. To overcome this nowadays-wireless sensor networks arebeing configured at the sites. The structure of system being installed, its topology, and wireless sensor nodesarchitecture,hardware design, system performance test and the architecture of information fusion are presented in this paper. This paper introduces a wireless sensor network system which is platform designed for the protection and safety of workers employed in the building sites, exposed to harmful physical agents. The network configuration comprised of a standard ZigBee technology, or a more versatile ad-hoc set-up for large infrastructure, which narrows the transmission bandwidth and decreasesthe frequency of the carriers.

Keywords: CivilEngineering construction, safety Monitoring, Wireless Sensor Networks, Information Fusion

I. INTRODUCTION

With the immense development and innovation of the construction industry in past decades, operations at a construction sites have become more tough and dynamic because of increasednumber of resources and man labourinvolved. As a result, an effective resource management system has become a very important requirement for the success of construction project. Management at construction sites could benefit could result in improved situation awareness, productivity assessment, waste reduction and safety and accident prevention. Research into construction resources tracking and automated data collection (ADC) has been upgraded along with the growing power of information technologies in recent years. In this paper, the purpose is to evaluate the technical feasibility of applying emerging wireless network technologies for resources tracking at building construction sites. Based on available localization methods and wirelesscommunication technologies, ZigBee-based system and the received signal strength indicator (RSSI) method has been identified as the most promising for solving on-site resources tracking problems in Wireless Sensor Network at construction sites. This whole paper is presented as follows. Firstly, some basic localization principles used for wireless positioning and the assessment of wireless network technologies, such as Wi-Fi, Bluetooth, Ultra-Wideband (UWB), and ZigBee are analysed. Using those technologies and methodologies the feasibility of WSN for resources tracking at building

construction sites are then evaluated. For tracking the workers and construction resources location, two different localization methods are used at the construction site for determining node positioning-

1) finding distance between the node i.e. literation

2) finding angle between the nodesi.e. angulation.

II. LOCALIZATION PRINCIPLES USED FOR TRACKING

For locating an object in wireless networks, four different Localization principles are commonly used: angle of arrival (AOA), RSSI, time of arrival (TOA), and time difference of arrival (TDOA).

In AOA, minimum two base stations are required to locate the mobile unit (MU). The direction of the transmitted signal is measured using Directional antennas or antenna arrays. The location of the MU can then be estimated by the intersection of the two angled directional lines. AOA is capable of locating the object by using only two stations. The accuracy of this approach is limited by signal shadowing, or by multipath reflections yielding misleading directions. Another disadvantage of AOA is that it's quite expensive as it requires investment of infrastructure, such as directional antennas or antenna arrays.

Positioning or tracking with RSSI is based on equations of propagation loss. A base station and a mobile unit distance can be estimated by calculating the attenuation of the emitted signal strength being received. presently most of indoor positioning systems are based on RSSI, because it is convenient to be implemented and usually requires software modifications without extending existing infrastructure. On the downside, due to high nonlinear features of the radio signal strength in indoor environments or built-up areas, the strength is severely susceptible to environmental conditions. In a TOA system, the time-of-flight of a signal traveling between a mobile unit and a specific base station is measured for calculating the distance. Once the transmission radii are measured, the location of the mobile unit can be determined using geometrical triangulation methods (intersection of three distance circles). TOA solutions provide accurate positioning given the availability of extremely precise time-keeping devices. GPS with atomic clocks is one of the most famous and successful application of TOA. Similar to TOA, TDOA measures the time-difference of arrival of the signal transmitted from two base stations (Fig. 1d). However, both TOA and TDOA demand accurate source clocks and clock synchronization. In addition, multipath fading and shadowing degrade the accuracy of TOA and TDOA measurements significantly.

III. Wi-Fi

Localization based on Wi-Fi has been seen as a cost-effective solution for indoor environments. RSSI is widely adopted, and the accuracy of typical Wi-Fi positioning systems is approximately 3 - 30 m, with an update rate in the range of a few seconds. The most well-known solution by far is the RADAR system developed by Microsoft and the commercial software-based Ekahau system. GPS and magnetic orientation sensors are implemented to track user's outdoor location and viewpoint. For indoor enclosed environments where GPS becomes unavailable, their ongoing research investigates applicability of WLAN for dynamic user tracking.

IV. BLUETOOTH TECHNOLOGY

The Bluetooth technology is originally designed as a short-range wireless connectivity solution for personal, portable, and handheld electronic devices. The Bluetooth radio also operates on the 2.4 GHz ISM band. Notably, Bluetooth employs a fast, frequency-hopping spread spectrum (FHSS) technology to avoid the interference in the ISM band and ensure the reliability of data communication. With extensive applications of Bluetooth for wireless data communication in hand-held devices and wireless computing, researchers also have drawn on Bluetooth for local positioning. Similar to Wi-Fi, Bluetooth can provide several meters of localization accuracy based on the popular RSSI methodology. Strong multipath interference is identified as one of the key factors that affect positioning accuracy.

V. SENSOR NODE ARCHITECTURE

Wireless Sensor Nodes have found wide applications in various Physical and Environmental applications.
The main components of sensor nodes are:

i) Sensors, which detects the physical activities

Ii) Microcontroller

Iii) Antenna

IV) External memory

V) Power source

VI) Energy harvester

VI. ZigBee USED FOR RESOURCE TRACKING

ZigBee is a standard, which is recognized globally for its use in Wireless Network technology. It can access the remote unit, monitor it and can be used for its control applications.
The technologies offered by ZigBee are cheaper than any other wireless Networks such as Wi-Fi, Bluetooth etc. Since power consumption of ZigBee is very less because of which also it is used in construction sites as it gives the sensor a longer battery life.
For resource tracking and monitoring in construction sites, ZigBee based Wireless sensor network are applied with Ultrasound and TOA for localization purpose.

When the ZigBee based wireless network is used on-site, its nodes are divided in to two parts-static nodes and mobile nodes.
Static nodes are scattered at the site and constitute a adhoc network for monitoring emission of dust, noise and vibrations. Mobile nodes are attached resources to be tracked such as labour, tools etc.

V. RECEIVED SIGNAL STRENGHT INDICATOR(RSSI)

The localization principles such as TOA, TDOA etc. are used at the sites but the accuracy of these principles suffer because of shadowing or blockage caused due to surrounding settings or construction materials,

equipment at the site. This is overcome by using RSSI principle at the construction or demolition sites. RSSI with the aid of signal propagation models estimated the distance between the two ZigBee nodes. It then determines the range in relation to three different nodes to calculate the location of tracking node by use of triangulation algorithm.

VI. PHYSICAL SENSORS

Exact measurement of dust is nearly impossible as it keeps on variating at construction sites and depends on factors such as rain, wind, humidity etc. Dust Sensor gives the indication of dust concentration in environment and hence useful for improving air quality at construction sites.

Vibration sensors such as accelerometer are use at the construction sites. They are installed within the ground with the help of metal lances and screws.

VII: ENERGY HARVESTER

Sensor Nodes are not auto rechargeable. So all the components in WSN are chosen such that they consume less power. When used continuously the battery discharges and also it becomes very difficult to provide power supply to recharge batteries of sensors at construction sites.as a result Energy harvester is used in the WSN that converts energy available from the environment such as solar light, wind Energy, Acoustic Noise, thermal energy etc. to electrical energy. This Electrical energy is then used by battery for its recharging thus making network more reliable and avoids nodes failure.

VIII. CONCLUSION AND FUTURE WORK

This Paper presents a design of a Wireless Sensor Network for which continuously monitors and controls the harmful emissions of dust, noise from construction and demolition sites thus providing safety to the workers and nearby residents at the site. It gives the detailed overview of hardware architecture of Wireless Network used at construction site. For the future implementation a limit can be set for the emission of dust, noise, vibrations at the site based on the previous experiences and accordingly a series of experiments on real construction and destruction sites can be performed. If the emission exceeds the set limit, check and analyse the working of WSN, Sensor Nodes and the action taken by authorities. With the development and improvement of ZigBee based wireless sensor network and localization principle, the proposed system can be used to track the resources such as labour, material, tools at the construction sites and the exact position of node of interests

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