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Wireless Sensor Network for Real Time Health Control and Tracking of Pilgrims

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ABSTRACT: *Advances in wireless communications have motivated the development of Wireless Sensor Networks (WSNs) for low-cost and easy-deployable physical and environmental monitoring. WSN (Wireless Sensor Networks) composed from a large number of small, low data rate and inexpensive node that communicate in order to sense or control a physical phenomenon. WSN have a lot of applications like disaster management, health, military and security, and enormously attracted the community of researchers and has fueled the interest in sensor networks during the past few years. Sensors are typically capable of wireless communication and able to solve several problems in numerous domains. India is known about its varied heritage. It is a multi-religious country, in which there are so many holy areas. Kumbh Mela, Amaranath Yatra, Pandharpur Vari such different events are conducted every year in respective state. Millions of pilgrims participate in such events in that elderly people visiting the pilgrimage is noteworthy, the respective authorities of the holy areas were facing a lot of problems related to the health of pilgrims and their position in the area of pilgrimage. Numerous existing applications using RFID are focused just on the identification of pilgrims and listing their information. Others focus only on the localization of pilgrims lost. At this moment, none of these applications treat health monitoring of pilgrims in real time. It is in this context, we propose a hybrid architecture based sensor networks using BSN and able to locate lost pilgrims consists of portable wireless sensor units with BSN carried by pilgrims and a fixed wireless network infrastructure capable of gathering, processing, and routing information on locations and time stamps of the pilgrims. This letter focuses on the design, implementation of a real time pilgrim tracking and health monitoring system.*

Keywords: *Body Sensors, GPS, Pilgrims Tracking, Pilgrimage, WSN*

I. INTRODUCTION

Sacred site festivals in India, called *melas*, are a vital part of the pilgrimage tradition of Hinduism. Celebrating a mythological event in the life of a deity or an auspicious astrological period, the melas attract enormous numbers of pilgrims from all over the country.Kumbh Mela, Amaranath Yatra, Pandharpur Vari such different events are conducted every year in respective state. Millions of pilgrims participate in such events in that elderly people visiting the pilgrimage is noteworthy. Such events have unique characteristics with regards to the people who attend it (pilgrims), the place they meet in, and the rituals they perform. Such a setup poses a real challenge to the authorities in managing the crowd, and tracking/identifying People. What makes it even more challenging is that all pilgrims move at the same times and to the same places. While such events are a unique spiritual experience for all pilgrims, it poses major challenges of all sorts to the authorities responsible for facilitating this annual event. The following are some of the common difficulties faced by the pilgrims and the authorities alike: Identification of pilgrims (lost, dead, or injured), Medical emergencies, Guiding lost pilgrims to their respective camps, Congestion management.

Many people die every year because of the poor organization of crowded events. Many people get stampede due to overcrowding and mismanagement. Overcrowding can be contained, and hence catastrophes can be prevented, by efficient crowd management using modern technology [3]. Most of the crowded events are usually religious in nature and often involve simultaneous movement of very large groups of people. The respective au**t**horities of the holy areas were facing many problems. But they are unable to provide those facilities in a full fledge manner. However, providing a solution to solve the problems completely is impossible. For such a scenario, there is a need for a robust tracking system for pilgrims. Passive and active RFID systems have been tested in the past with limited success [6]. Other approaches such as image-based tracking systems are not suitable for a large crowd as in this application. Thus, the idea of using wireless sensor network (WSN) for tracking pilgrims was initiated [5]. As the elderly people participating in such events health related issues of them arises. Those have health problems may arise in severe situations, especially in large crowds and congestion, causing death in some cases. Even before efforts in health services by local and international authorities, unfortunately, it is difficult to monitor and intervene in time to save lives. Numerous existing applications using RFID are focused just on the identification of pilgrims and listing their information. Others focus only on the localization of pilgrims lost.

At this moment, none of these applications treat health monitoring of pilgrims in real time. It is in this context, we propose a hybrid architecture based sensor networks using BSN and able to monitor health status and locate lost pilgrims consists of portable wireless sensor units with BSN carried by pilgrims and a fixed wireless network infrastructure capable of gathering, processing, and routing information on locations and time stamps of the pilgrims. This letter focuses on the design, implementation of a real time pilgrim tracking and health monitoring system. The letter is organized as follows: Section II describes the literature survey. Section III describes the system design. Section IV describes the proposed design of the mobile units and the WSN. Some concluding remarks are discussed in Section V.

II. RELATED WORK

As we are well-known about KUMBH MELA –Missing pilgrim's history, in the yesteryears, pilgrimage authorities use conventional measures in dealing with the missing pilgrim's situation, where multilingual guards and mobilized scouts are placed to help pilgrims finding their way back. Even a lost pilgrims' centre was established to further improves the situation. Guards and scouts are not placed in every corner of pilgrimage area and there are possibilities where pilgrims might get lost in secluded places and cannot be found. The solution can be addressed by offering specific framework to accommodate the needs in technology deprived places and densely populated areas.

One of the most widely recognized is the tracking via RFID chips. Nowadays, we could see a lot of embedded RFID chips placed in our belongings and because of its relatively small size, it has been used quite extensively. In order to have a system that suits events such as Hajj, Yamin etal. [4] proposed to track people using the RFID and wireless technologies. It used a database to store data and entities of each person. Conversely, installing sensor networks for sensing and reading the chips would have some serious economic considerations especially for events that happen irregularly [3]. Another approach is by having object recognition where a picture, usually landmark, is taken, using a built-in camera in any common mobile phone, to identify their location based on the picture they taken [7].

Another approach is by implementing a low cost object tracking system using GPS and GPRS [1].The system allows a user to view the present and the past positions recorded of a target object on Google Maps through the Internet. In contrast, although it is cheaper to use wireless network technologies in mass usage, it is expensive to be use if we consider the period of time it will be used, with the amount of money we have to pay. However, in pilgrimage situation where the pilgrims will only be there for maximum of around a month, getting Internet services from ISPs might be troublesome and therefore might results in inability to use the localization service. Now a day mobile phones are easily available with this facilities but the issue is its network/ range [2]. It may get lost or weakened inside the buildings or in some region.[14] Lists a project build by the use of WSN; they made WSN Stations as emergency fixed stations. These stations are spread around the holy mosque to support local rescues and aid the retrieval of missing pilgrims. Each station has a button switch to press if the pilgrims get lost or if they need to request services. The last work is focused on the problems of missing people and helping those in need of urgent medical services with absence of any health control.

As reported in the related works, numerous existing applications using RFID are focused just on the identification of pilgrims and listing their information. Others focus only on the localization of pilgrims lost. At this moment, none of these applications treat health monitoring of pilgrims in real time. It is in this context, we propose a hybrid architecture based sensor networks using WSN and able to monitor health status and locate lost pilgrims.

III. SYSTEM DESIGN

Wireless sensor neworks

Micro-electromechanical systems, embedded technology, sensor technology and wireless communication technology has become more sophisticated and progressive, to promote wireless sensor networks (WSN) generation and development, WSN become the current research in the field of IT hot, and has been widely used in many fields. Actually, this technology is omnipresent in application that requires communication with their components to transmit relevant quantities or values like light, temperature, humidity and more. A WSN, sensor nodes are organized into fields "sensor fields" (fig.1). Each of these nodes has the ability to collect data and transfer them to the gateway node (called "sink" in English or sink) via a multihop architecture. Well then transmits this data via the Internet or satellite to the central computer "Task Manager" to analyze and make these decisions. Their applications are mainly related to conduct surveillance and remote control of the events of sensory (or physical) several different such as temperature, pressure, light, sound. These

devices (motes or sensors) are able to capture and collect information sensitized in the environment monitoring, and then you send it wirelessly from one sensor to another in cooperation with each other to a the base station (sink), which is a computer that collects information from wireless sensors scattered, processed and analyzed. Due to their importance, sensors are used in many domains like military, rescue and ambulance, in nuclear reactors conducts a periodic surveillance, transport (plane and car) VANETs (Vehicle Ad hoc Networks), animal control, natural disasters (earthquakes and volcanoes) for the purpose of surveillance.

BODY SENSOR NETWORKS (BSN)

BSN is a special Body Area network (BAN) which considered as a technology that emerges as the natural byproduct of existing sensor network technology and biomedical engineering fig.2. Body Sensor Networks are a specific and medical application of wireless sensor networks intended to operate in a pervasive manner for on-body applications [12] [8]. Using this technology, it is possible to obtain measurements of heart rate, oxygen saturation, pressure, and temperature, with small, non-invasive sensors; we expect that, over time, an increasing array of sensors with sophisticated capabilities will become available. Practically, BSNs for healthcare monitoring appears in several network applications operating in a variety of different environments including a hospital operating room, an elderly health clinic or a personal home setting and also in special area in hajj environment. Each of these environments varies substantially from one to another. Because of this, BSN framework must be adaptable and distributed to accommodate for such different settings. Due to this, we must appropriately structure the network in terms of number of sensors, and select relevant features in the BSN. Several benefits of the use of BSN can be exploited to monitor and control persons in real time and in their position.

IV. PROPOSED ARCHITECTURE

The sensor network developed for the pilgrim tracking system consists of mobile units as well as fixed units. The number of mobile units to be monitored is significantly large compared to the fixed units. Thus, the WSN for this application has similarity to the ZebraNet [9] designed for habitat monitoring. It makes use of opportunistic, ad-hoc, and short-range wireless communications to disseminate data. In our application, each pilgrim carries a mobile unit that includes a GPS receiver, body sensor and an IEEE802.16.4/ ZigBee radio to communicate with the network of fixed units. The fixed sensor units consist of hardware and software to communicate with the mobile units carried by pilgrims to make queries and to receive location and UID information. Further, these fixed units communicate with each other to route the collected data to the tracking and monitoring station via gateway nodes. The gateway nodes are part of a commercial high data rate network, such as a high speed packet access (HSPA) or any other 3.5G network. The server can receive large volume of data via this high data rate network. The location information of a pilgrim carrying the mobile unit along with the time stamp and UID are transmitted to the nearest fixed sensors periodically, or in response to a query originating from the monitoring station.

The subsections to follow elaborate on the mobile and fixed unit design, sensor network configurations, and protocols involved in the WSN based tracking system.

Mobile Sensor Units

The BSN architecture of the pilgrim health control system is designed in a hierarchical tree. The main component here is the Pilgrim equipped by Body Sensors considered as mobile sensor fig.3.

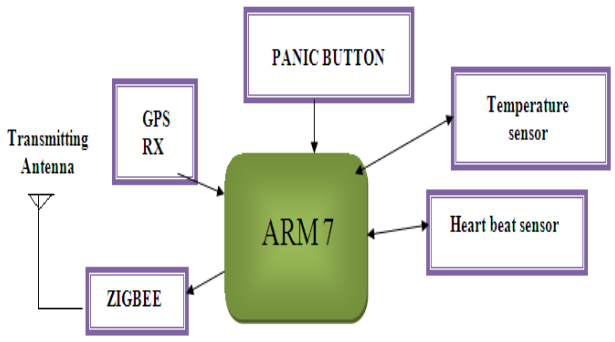

Fig. 3 Mobile Units

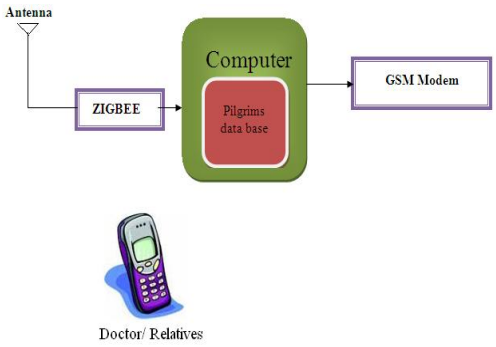

Fig .4 Control Room / Fixed Unit

Murals and fixed sensors in several placement of the area of the pilgrimage are used to achieve data to the centers. Those centers transmit valid request to base stations. The pilgrimage area is subdivided to several zones. Each zone contains a computer center that collects periodically measurement achieved by mural sensors. Taking

in consideration the WSN range and dimensions of the pilgrimage those sensors are fixed and deployed to cover all area of the pilgrimage, and referenced to absolute bi-dimensional reference. The system constantly tracking location and monitor important body parameters like temperature, heartbeat, ECG and would compare it against a predetermined value set and if these values cross a particular limit it would automatically displaying emergency message to control room and then control room automatically informing to doctor and to relatives of the patient via a SMS. In such case the GPS will track location of pilgrim hence pilgrim will get a very quick medical help and also would save time and energy of the relatives who would not be with them at that time [13]. Temperature, ECG and Heart Beat pulse signals are measured from the temperature, ECG and heart beat sensors and are processed by a built-in ARM processor. The processed data are then transmitted by Zigbee wirelessly. Embedded C is used for programming the ARM processor. Using GSM modem message is transmitted to the programmed mobile number to the doctor in charge when the measured temperature exceeds the allowable value or if the pulse measured is abnormal. The Body sensors send emergency message when exceeding a threshold of critical measurements by avoiding sending regular or periodic data, which causes more consumption of energy. In this mobile unit we are providing panic button for any emergency arise with pilgrims like missing, health related issues.

Fixed Sensor Units

The WSN is based on a set of fixed wireless nodes. Each fixed wireless node consists of a UHF high gain antenna, RF transceiver, microcontroller, battery and Ethernet for interfacing to the server via internet (TCP/IP connection) fig.4.Whenever there is a need to locate a pilgrim, the fixed units broadcast his/her unique UID. Each mobile unit checks whether this UID matches its own. If there is a match, the mobile unit sends an acknowledgement while others remain silent. Subsequent protocol ensures that the appropriate location information is sent to the fixed node which in turn sends it to the server. To keep the overall software managing the system simple, we did not consider any data encryption at this stage since only UID (known only to authorized officers at the central server), time stamp, and location information are sent across the network. Control room storing the data of each pilgrim which includes: pilgrim ID, health parameter, relatives' phone numbers, and pilgrim location history. Whenever missing pilgrim situation arise server send query to track location of pilgrim and get its location as well as his health status.

Node Configuration in the WSN

All nodes in the fixed WSN are made identical to keep the deployment, configuration and reconfiguration process simple. Under the proposed configuration, the different nodes are classified either as sensing only, sensing and routing, or gateways. Sensing-only nodes receive queries from the network; collect data from the

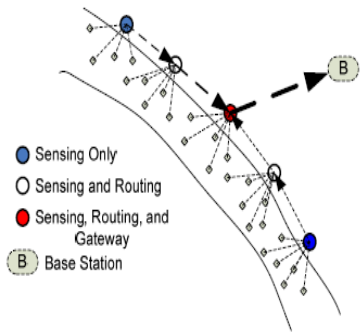

Fig. 5 Sensor configurations and data routing

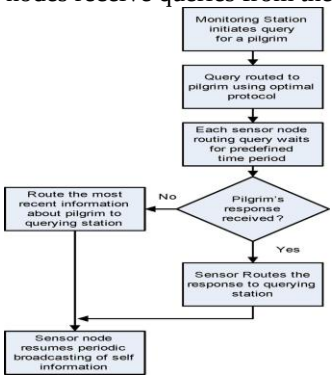

Fig. 6 Flow of commands for querying a pilgrim

mobile units in the vicinity, then send the data to nearby sensors. In addition to sensing, some nodes function also as routers. Moreover, few strategically placed nodes are selected to communicate with the public communication networks. Fig.5 shows a typical scenario where the mobile units and fixed sensors of different configurations communicating to each other. The minimization of energy consumptions highly relies on the processing and communication requirements of the protocols and algorithms at various layers of the WSN. The flow of commands in a typical query for a given pilgrim is outlined in Fig.6. Consideration of the elements at all layers with a cross layer design approach is vital to the overall efficiency of the network. At the PHY and MAC layer levels, the duty cycle of the nodes (the ratio of ON to OFF periods) is reduced by using modified carrier-sense multiple access (CSMA) protocol [10]. The history of location information is retained and used in subsequent computations for increased energy efficiency and reduced computational load. Moreover, the use of previous location information minimizes latency in responding to future queries. Another aspect is the efficient

in-network processing of data. This includes data encryption and compression. Even though we did not consider encryption at this stage, a joint data compression and encryption scheme can be used to achieve high security and good energy efficiency [11]. The benchmark standard for such implementation is the IEEE 802.15.4/ZigBee protocol suite for low bit rate communications.

V. CONCLUSION

Tracking and monitoring individuals in crowded and dense surroundings is already a difficult issue. Despite the ever improving technologies in the modern world, it has not been able to solve the most basic issue in any crowded events, such as the Kumbh Mela, Amaranath Yatra, Pandharpur Vari pilgrimage. The use of better and more advanced frameworks might not be the panacea in overcoming the problem, but it will surely offers a help in aiding the problem. This letter describes the design and implementation of a system for tracking and monitoring pilgrims. The system consists of mobile units having body sensor carried by pilgrims and a fixed wireless sensor network. Based on some preset parameters, the WSN communicates periodically location and health information of pilgrims to a central server. The communication between mobile units and the WSN relies on the IEEE802.15.4/Zigbee protocol. The presented work were control the health of patients and locate the lost pilgrims in order to intervene in time to save lives and guide the lost pilgrims to their camps.

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