The Design and Implementation of Remote Personel Monitoring System in Military Zones

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***Abstract*— Nowadays, despite there are many advanced technological applications to maintain the security of buildings, premises or regions, human intervention is necessary when considering both economical facts and the effectiveness of the systems especially for the security of military zones. In the presented work, a highly secure system has been designed. With the system to be implemented, the location, postures (lying, standing, sitting, and etc.), health conditions (body temperature, heart rate, and etc.), and environment conditions of the guard officers can be monitored remotely so that the key personal can be warned to take required steps in emergency at once. The system consists of three basic devices. First, an originally designed portable Wireless Sensor Node (WSN), which detects the desired parameters and transfers them to a Wireless Central Unit (WCU) by a secure radio frequency communication, is placed on the guards. The WCU collects all information to the center coming from wireless sensor nodes. Finally, a Central Monitoring Unit (CMU), in which all information from the WCU is monitored visually and evaluated, has been designed and implemented.**

Keywords*— *Remote Monitoring, Wireless Sensor Networks, Security, Telemedicine

I. INTRODUCTION

Maintaining the security by shifting of guards in restricted sites especially in military zones cannot be fulfilled appropriately in some circumstances. The most encountered unfavorable incidents in the night shifts are sleeping of guards in the duty area and leaving the duty area without permission of the authorized people. Another problem caused by adversary engagements is to have a case of deactivated guards. The proper duty shifting is a vital requirement in some circumstances that include a high risk of adversary penetrations into battlefields and safeguard areas.

Normally, the shift guards are checked in round-robin styles within certain intervals by wireless radio, telephone or patrols. Hence, between intervals most guards out of scope especially in large military zones. In the meantime, there is a risk of penetrations when guards are deactivated in some way. Therefore, the guards must be monitored constantly with automated systems along with the essential alarm policies must be established to avoid such threatening conditions.

In this study, we have developed a low-cost mobile system, which monitors the position (lying, sitting, and standing), health parameters, and sleep/awake conditions of the guards. When an unexpected incidence occurs, required defense techniques can be activated so that the security weakness can be avoided by operating alarm procedures.

II. RELATED WORKS

In literature, there are several studies pertaining to remote monitoring systems especially in medical and military applications. We have summarized some crucial studies of them below.

Shnayder and et.al developed a remote monitoring system called Code Blue in which the health parameters are monitored by a set of sensors. The system consists of three units. The heart rate and oxygen level in the blood of the patients are measured by a finger-wearable pulse oximeter sensor. The cardiograph is obtained from another sensor on ECG board and an EMG sensor is employed to determine the location and position of the patient[1].

Milenkovic A. and et.al used WPAN (Wireless Personal Area Network) and WBAN (Wireless Body Area Network) to transfer the vital data of the patient to a hospital periodically during emergency transport. The sending instantaneous data can be used in both proper interventions for the patient in the ambulance and arranging required settings in the hospital for quick diagnostics and recoveries [2].

Baker C. and et.al have implemented a study to determine the health conditions of the patient by the help of data obtained from the WSN (Wireless Sensor Network) nodes located in

their houses or on their bodies. The nodes located on the bodies of the individuals denote the sleep/awake modes and sleep positions of them. The health parameters as heart rates and ECG can be remotely monitored by means of sensors that are located on the shirts of the patients [3].

In another study, a real-time based health monitoring system using WSN communication infrastructure has been designed and implemented to trace the movements and location of people indoors. The system uses Monte Carlo localization algorithms, an accelerometer and an indoor map data to determine the step counts, location, and motions of the individuals [4].

Sevin A., Bayılmış C., and et.al has been implemented an Emergency Discovery and Saving System using WSN nodes to propose a solution for man overboard situations. In maritime industry, falling overboard into the sea is a crucial problem that can only be minimized by real-time based location detection systems. In man overboard cases, the location of the victim is illuminated when the incidence occurred in the dark [5].

In another study, a web-based application has been developed to monitor health parameters of individuals using WBAN technologies. The system designed maintains many real-time monitoring facilities especially for elderly people and patients. The sensors attached to particular part of their body measure some parameters such as heart rate, blood pressure and body temperature. The data is recorded constantly into a database and responsible people for the patients can monitor and evaluate the conditions through several interfaces on desktop or mobile platforms [6].

Ersoy C., and Alemdar H., has reviewed many health service applications using WSN's. They classified the topic into three subtitles as location detection, activity detection, and medical status monitoring [7].

Çetin G. et.al have implemented a health monitoring system in which body temperature and heart rate measurements are used by employing WBANs on elderly people who has chronical illness or has special requirement that has to be traced closely. The data obtained from individuals are presented on web-based interfaces [8]. Kırbaş, İ., et.al have implemented another monitoring system using WSNs for incubation control. It is not only a monitoring system also includes ambiance control facilities such as ambiance temperature and humidity control along with blood oxidation level. The system has been configured for premature infants whose vital health parameters monitored and the data obtained from the incubation environment can be accessed by locally or remotely [9].

Kaçar S., et.al has implemented a web interface on which the data acquired from sensor nodes are presented by the help of Matlab program and ASP.NET technologies [10]. Another example of health monitoring system has been designed and implemented based on WSNs to trace the location and health conditions of survivors in the case of disasters. To determine the locations an adaptive algorithm, in which both the signal strength from the sensors and the attenuation level of electromagnetic signals from reference nodes are considered, has been designed [11].

In a paper, many military applications that employ WSN communication techniques have been presented to be used for detection and monitoring of threats. In that paper, several techniques to maintain border security using WSN communication have been categorized as GPS-based, acoustic-based, RF-based, visual-based systems [12].

III. Presentation of The Developed System

In this study, we have developed a security and monitoring system using WSNs to be used for military purposes in a specified region. The basic system architecture is given in Fig.1 in which the system incorporates three fundamental components: WSNs, a WCU (Wireless Central Unit), and a CMU (Central Monitoring Unit). The personnel data is sensed and measured by WSNs on military personnel and it is transferred to CMU followed by WCU. CMU processes the data accordingly and visualize the data to be observed by authorized personnel.

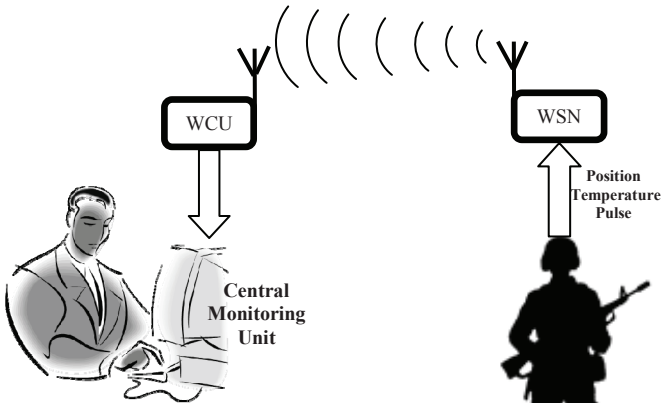

Fig. 1. System architecture

A. Wireless Sensor Node and Wireless Central Unit

A novel mobile wireless node and a wireless central unit (base station) have been designed and implemented to obtain required personal data. While there is no difference between wireless sensor node and wireless central unit in terms of hardware, the software of each unit is distinct. The nodes have been designed in a unique way that they can be used in other WSNs on request. In addition, they differ from the similar counterparts when cost, data rate, and energy consumption parameters are considered. In Fig. 2, the basic components of the designed WSN and WCU are illustrated.

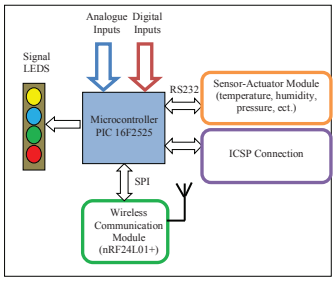

Fig. 2. The designed WCU and WSN

The signals obtained from sensors can be applied to analog/digital inputs of the WCU or WSNs directly, or they can also be transferred to a microcontroller via RS232 connection once they are processed by signal conditioners. The microcontroller inside WCU/WSNs drives the status indicators and is connected the wireless communication module by its SPI serial interface. It receives and interprets the messages coming from wireless medium and it sends out the data in packages when its turn is reached. ICSP (In-Circuit Serial Programming) technology enables microcontroller debugging facilities by means of direct connection between nodes and a computer. Fig. 3 demonstrates implemented hardware circuit of designed a WSN or WCU.

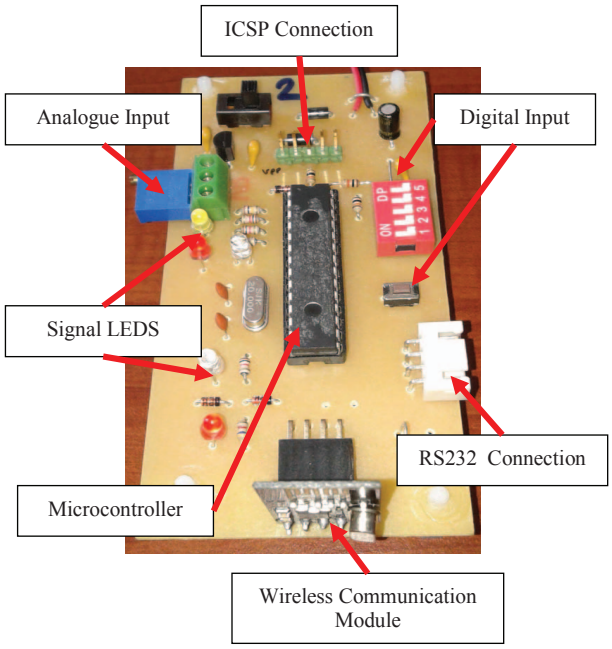

Fig. 3. Hardware of the designed WCU and WSN

The circuit parameters of designed nodes are given in Table-1.

TABLE I. CIRCUIT PARAMETERS OF THE DESIGNED NODES

Parameter	Value
Standby mode current	16.62 mA
Current at 0 dBm transmitting power	34.18 mA
Current at -18 dBm transmitting power	29.88 mA
Listening mode current	30.65 mA
Avarage battery life	580 mAh
Data rate	1 Mbit/s
Data package size	256 bit
Standby mode current for processor	8.32 mA
Sleep mode current for processor	11 µA

The advantages/features of designed nodes can be listed as followings:

- Support for distinct MACs (CSMA, FDMA, TDMA, CDMA, etc.)
- Convenient for both academic and experimental studies
- Debugging facilities and package tracing
- No need to use commercial software and interfaces
- Coding availability in several development environment (PIC C, HI-TECH C, mikroPascal, mikroC, mikroBasic, ProtonBasic, PICBasic, CCS C, C18, etc.)
- Running and testing data security and encryption algorithm options on the nodes
- By means of multi-channel support and burst mode data transfer, it meet the medical signals transfers requirements for high-density mobile WBAN nodes
- Availability for direct connection to computers and sensor boards through RS232 connection

B. *Central Monitoring Unit and User Interface*

The Central Monitoring Unit (CMU) of the designed system is a PC having necessary hardware and software features. The status (as awake, sleeping), physical movements (as falling, walking), locations and medical data (as heart rate, body temperature) of the security guards can be monitored by the help of user interface running on CMU. The user interface incorporates many diverse coding technologies such as HTML5, Javascript, Jquery, CSS, ASP.Net. Google Maps APIs have been employed to locate the individuals on the map.

The user interface developed can be seen in Fig. 4. As seen, it is consisted of two separate panes. On the right-pane, the locations of the individuals are monitored on a map; on the left-pane, the obtained data from the individuals is illustrated in special formats as a table in which the names, outdoor temperature and humidity, date, body movement status are demonstrated. ***Status*** title represents the body movement status as falling, standing still and walking by means of a set of images consistent with results acquired from the algorithm developed. Similarly, the body movements of the personals are represented dynamically in the map on the right-pane as GIF images. When clicked on a chart icon under the ***Actions*** title, temperature and humidity data obtained from an individual is shown in a graph and associated personal data is also presented as seen in Fig. 4.

IV. CONCLUSIONS

The system designed not only allows personal monitoring in military and public zones, also in civil guarded areas and indoor division. Thus, the system can also be used in or adapted to private security companies, which are particularly promising business nowadays. Note that these companies need to monitor their guards in real-time manner.

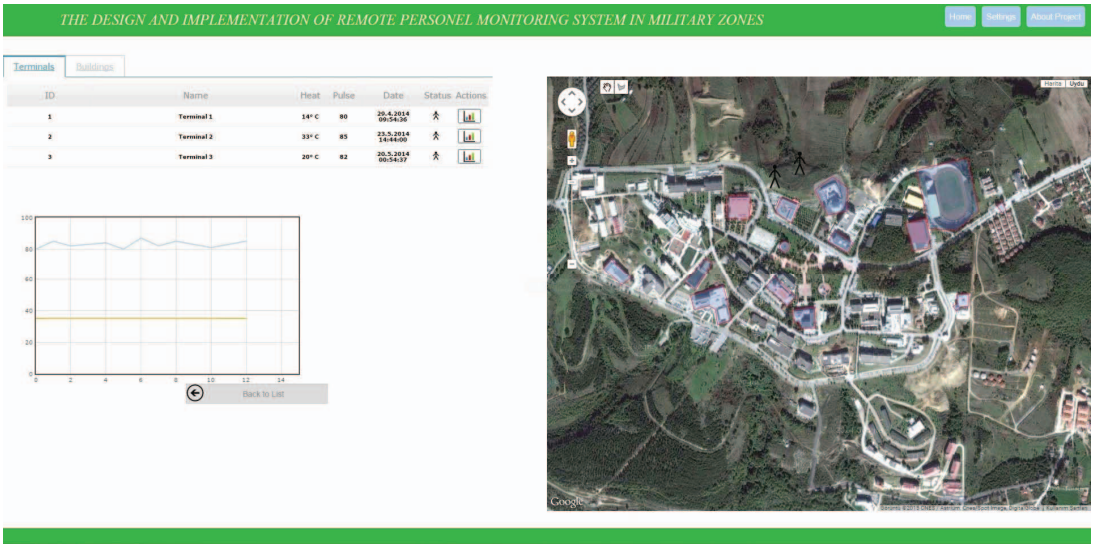

Fig. 4. The developed user interface

The security guards performing their shift duties can be monitored constantly by the system designed. Thus, any inconvenient incidence can be spotted immediately to diminish severe casualties and injuries. In addition, any adversary engagements into the protected territories or deactivation of any guard mostly because of violating security policies can be detected in real-time and required precautions can be taken immediately.

The system designed has some capabilities as listed below: (i) monitoring vital health functions of the guards in military and civil regions, (ii) an ability for authorized people to monitor their personals, (iii) alarm policies for shifting guards or soldiers leaving shifting area, (iv) locating of personals in a predetermined region, (v) prompt intervention opportunity for shifting personals when vital health parameters are out of limits, (vi) immediate intervention when adversary intrusions are detected because of deactivated personals (vii) restricting and monitoring security regions, (viii) monitoring objects in security areas, (ix) employing in coast guard services with minor configurations.

ACKNOWLEDGMENT

This research work was supported by the Ministry of Science, Industry and Technology of Turkey under the contract SANTEZ 0200.STZ.2013-1 and Research Fund of the Sakarya University, Project Number: 2013-09-10-001.

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Proceedings of the 2015 Twelve International Conference on Electronics Computer and Computation (ICECCO)

http://www.icecco.org

EDITED BY

Selim Guvercin

Meirambek Zhaparov

Aigerim Sagandykova

INTERNATIONAL CONFERENCE

SEPTEMBER 27-30, 2015

ALMATY, KAZAKHSTAN

ISBN: 978-1-5090-0199-6

CONTENTS

2015 Twelve International Conference on Electronics Computer and Computation (ICECCO)

Date 27-30 Sept. 2015

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Publication Year: 2015, Page(s):1 - 4