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Intelligent Hospital Monitoring System using Internet of Things

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ABSTRACT

In the context of Internet of Things (IoT), the research goal is a more efficient GUI development approach that does not require program code to be written. To enable end-users with little or no programming experience to participate in the GUI development process, this research eliminate the need for programming by introducing a new development approach. The development of applications for end-user devices, i.e. devices through which the end-user directly interacts with systems. The complexity of such applications is partly due to network intricacies, and partly because GUI (Graphical User Interface) development is generally complicated and time consuming. In view of this approach as "transpose" in that the development focus is on presenting functionality from an application model as graphical components in a GUI, rather than on retroactively attaching functionality to manually added graphical components and employ a middleware framework called PalCom to manage the former, and focus the research on the problems of the latter, by expanding the scope of PalCom to also enable GUI development.

INTRODUCTION

Monitoring of the hospital infection free is being the most crucial phase of these days. Types of bacteria existent inside hospitals differ from other types, which exist in other places due to their resistance to the repeatedly used antibiotics Currently, infection causes and transmission pathways have been varied and the Hospital Acquired Infection (HAI) became a real problem. HAI needs to be solved quickly to save people lives.

The principal goal of this work is to use the Internet of Things (IoT) and Communication technologies to design a low-cost system for combating the HAI and thus reducing to the mortality rate and the financial burden. The future design of SmartBand enables Tracking and collecting data about the physician sand patients' activities inside a hospital room.[1]
The future SmartBand design will be able to perform the following tasks:

- Recognizing the SmartBand holder' identity basing on ZigBee technology so that the system identifies the SmartBand holder's name as he is within the system range,[2,3]
- Tracking of SmartBand holders and identifying their positions (door, bed1, bed2, sink, and toilet) in real-time based on RFID and ZigBee technology.
- Monitoring the hand hygiene procedure by measuring the hand hygiene duration identified by the World Health Organization (WHO)
- Reading the hands 'motions during the sanitation using an accelerometer sensor and ZigBee technology
- Issuing alerts appropriate with the nature of each event and the place to remind and encourage physicians and patients to comply with the hand hygiene rules in proper times.
- Storing the data gathered by the monitoring system about the person negativities in a special file stored in the base station.[4]

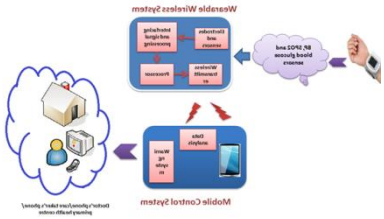

Fig. 1.1 Block Diagram of Remote Patient Monitoring System

PROBLEM STATEMENT

HAI transmission ways, particularly contaminated hands, inside a hospital room, by monitoring physicians and patients activities is major issue which is taking the patient's life away [6,20].Thus a system can be designed to recognize physician sand patient's identities, identify their places ,and track their compliance with the hand hygiene rules including the hand hygiene duration time and recognizing hand motions during sanitation. Forreal-time tracking of physicians' positions and activities inside the hospital room, them multifunctional SmartBand is required which can be held by all physicians and patients within a hospital to provide alerts and the alerting mechanism involves the wireless network and other hardware-software aspect.

LITERATURE SURVEY

In the developed countries, such as USA, and EU states, a percentage of 5–15% of the patients becomes infected during their stay in the hospital for treatment, while infection ratio rises (9–37%) during their stay in the Intensive Care Units (ICUs).The infection rate in hospitals is ranging between 4.6% to 9.3%. In U.S.A, the mortality rate resulting from the infections is higher than that caused by Breast and prostate cancer.[7]

In 2002, the HAIs ration as almost 4.5% and the (HAIs) rate was around 5% of hospitalized patients or 1.7 million infected patients eachyear in U.S.A. This situation in turn increases the level of financial spending to US $4billion, raising the mortality rate upto 100,000 deaths per year.[8]

In addition, the annual financial loss caused by the HAIs in U.S.A was around 6.5 billion dollars in 2004.[9]

In Europe, the number of HAIs cases is almost 5 million per year; the percentage of cases thatmayleadtodeathwasnearly2.7%(135,00(persons each year) and the financial expenditure was evaluated to range between 13–24billion Euros, in addition to prolonging the duration of stay in hospitals (around 25 million additional days).[10,11]

A study that was conducted in India, between July 2004 and March 2007 showed that the HAIs average was4.4%, in addition to 9.06 infections per each 1000 ICU-days. In Argentina and Turkey, the ICU acquired infection rate exceeded 50 cases per 1000 patient- days and the mortality rate was 35.0%, 25.0%, and 5.0% for the following infections: VAP (Ventilator Associated Pneumonia), CR-UTI(Criminals' Urinary Tract Infection) and CR-BSI (Catheter-related blood stream infection) in the same order. In an "800-bed, tertiary care, university hospital in Malaysia", the HAI rate was 13.9%, and the used antibiotics cost was around US $521000 annually. The nosocomial sepsis rate in India was 1.5% to 37%, and in USA was0.9% to 7%.[13-19]
A proper filtration system is vital factor for infection prevention; so that the airflow must be in the correct direction. The contaminated hospital air should be disposed of outside, or purified inside through the filtration system. Air pressure and airflow tests must be done inside the facility rooms by using the smoke to be sure that the airflow is done properly. The airflow direction from one place to another is based on the pressure difference principle (from the operating room to the elimination room with the low pressure).

Appropriate procedures must be followed for storing the sanitizing products and appropriate preparations for operating room environment must be performed before and after the operation which include:

Leaning and sterilization of all surfaces and surgical equipment.

Using the appropriate attire such as double gloves for the high risk procedures, and the staff attire should be water proof ,easy to be washed and decontaminated, and must be changed after exposure to body fluids or sweating.It is preferred to include the less number of staff and without conversation if possible
The patient body must be cleaned by using appropriate anti-microbial product before any procedure, and it must be covered except the part identified for the procedure.Provisioning adequate human resources and the concentration on monitoring the hand hygiene protocols are considered vital factors for infection prevention.

Protocol watch supports making clinical decisions within hospitals very quickly; that it includes guidelines to combat the surviving sepsis, it simplifies sepsis treating, and has its own mechanism to check the monitoring data according to the protocol criteria, it identifies the required interventions and urges the clinicians to perform them and helps the HCWs to detect variations in patient's situation rapidly. The resulted data are invested to improve the performance quality.

MOTIVATION

The hospital acquired infections as a big problem nowadays, with figures and statistics to indicate the risk of infection and the importance of its combating. Various infections causes in the hospital environment, especially the contaminated hands and the role of medical staff in fighting them have been reviewed. This motivated in an exploration of the traditional methods of combating the HAI, the importance of hand hygiene and the importance of following the five moments specified by the World Health Organization (WHO) as a vital factor for infection prevention. The traditional methods contribute to solve the HAI problem by giving certain compliance rates, but they stay unpractical and don't provide successful solutions to stop the HAI spread, where as ICT solutions are a better choice for solving the HAI problem.

OBJECTIVE OF THE PROPOSED RESEARCH

The main objectives of the system are the following:
The possibility of deploying a network of sensors and communication devices, in addition to employing modern technologies in any hospital, reliably and at low cost. Effective integration with the hospital workflows, monitoring the health care worker's Compliance with the predefined rules, in addition to specifying and monitoring the other medical workflows without harming the existing workflow so any negative impacts on the HCWs work. A successful in-corporation with the hospital information system done using the medical standards. Setting out the network of sensors and other required devices to evaluate its performance is considered as a part of the project development policy, which can avoid the possible errors and thus reach the best solution.

Monitoring the hand hygiene procedure by measuring the hand hygiene duration identified by the World Health Organization (WHO), Reading the hands' motions during the sanitation using an accelerometer sensor and ZigBee technology, Issuing alerts appropriate with the nature of each event and the place to remind and encourage physicians and patients to comply with the hand hygiene rules in proper times, Storing the data gathered by the monitoring system about the personnel activities in a special file stored in the base station.

METHODOLOGY OF THE PROPOSED RESEARCH

The aim of this system is to prevent the HAI by fighting with one of its most important causes, which is the contaminated hands and thus reducing the HAI spread.

The system is intended to monitor the medical staff members' activities inside a hospital room, by identifying their locations within the room in real-time, and recognizing whether they are following the correct hand hygiene rules in the right moments. At the same time, the system will ensure monitoring the patients' entry into the toilet and their compliance with the hand hygiene rules after going out of the toilet. The system also intended to help the medical staff members to follow the hand hygiene protocols, and to issue alerts in case of breaching the predefined hand hygiene rules.

The main use case of this system is based on a logical sequence of events. It starts at the room entrance during the entry of a medical staff member, where the system is able to recognize his/her identity and the same scenario is repeated when the medical staff member leaves the room. After entering the room, the physicians (doctors/nurses) should use the washstand to sanitize their hands before doing any other action, then they proceed towards a patient to care for him/her, and after that they should go again to the cleaning to sanitize their hands before going to the next patient. The physicians handle the next patient and then they should go to the washstand to disinfect their hands before leaving the room.

Regarding the patients, when any of the patients enters the toilet, the system is able to recognize his/her identity at the toilet entrance and after the patient comes out of the toilet he/she should proceed to the hands cleaning are to sanitize his/her hands before going back to bed. The below figures shows the setup of wireless network of the system and SmartBand block.

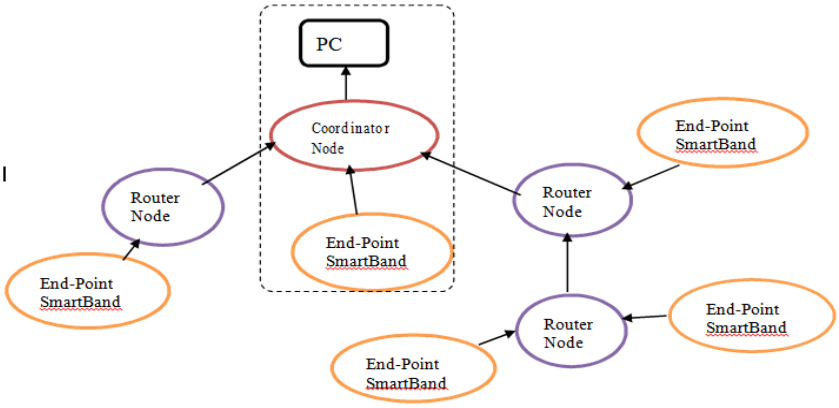

Fig. 6.1 The wireless network of the system

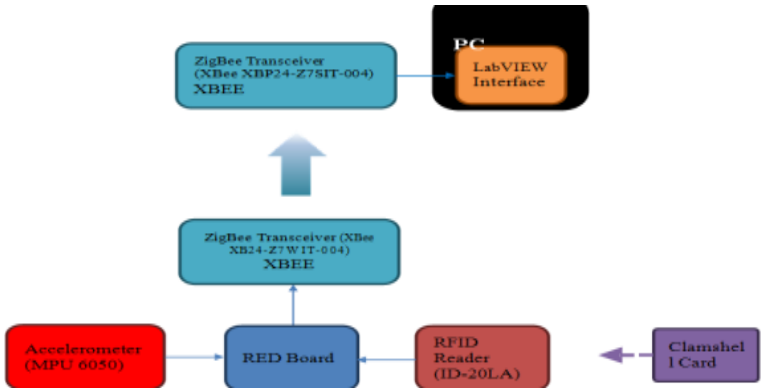

Fig. 6.2 Smartband B

EXPECTED OUTCOME OF THE PROPOSED RESEARCH

Recognizing the SmartBand holder identity. Identifying the SmartBand holder position. Measuring the hand hygiene duration. Reading the hands motions and presenting them on the base station in real-time. Taking decisions and emitting alerts at proper times Recording the clinical activities of the physicians and patients inside the hospital room including the event time, theSmartBand holder's name, his position and the alarm form. The resulted data is stored in a file in real-time.

CONCLUSION & FUTURE ENHANCEMENT

In order to enable end-users with no programming experience to build GUIs, programming needed to be eliminated from the development process. To that end, defined an "inverted" approach to GUI development. With this approach, the development focus is on presenting functionality from an application model as graphical components in a GUI, rather than on retroactively attaching functionality to manually added graphical components. The first step in supporting the new approach was to design a language for describing GUIs, and implement interpreters that communicate with PalCom services and render GUI descriptions as fully functional GUIs. In the domain of e-health, the presented language has been used in a number of research projects to build the GUIs of multiple applications. In order to make the language more accessible and efficient to use its implemented a graphical editor. This tool was evaluated by direct comparison to a market leading product in a controlled experiment. Its found that the editor is accessible to new users, and can be more efficient to use than the commercial alternative.

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