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Internet of Things Architecture for Smart Remote Healthcare System

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ABSTRACT: The Internet of Things (IoT) is the most promising technology in recent years, which is used for network of physical objects or things embedded with software, electronics, sensors and network connectivity, which enables these objects to collect and exchange data. The IoT can be used in various fields like Home automation, Building automation, Industries and Hospitals. The proposed Remote Healthcare System (RHS) is used for automatic monitoring and tracking of patients by make use of RFID Tag and RFID Reader, and biomedical devices within hospital and home. The RHS is to collect in real time both patients' heart beat rate and temperature parameters and environmental conditions using Renesas RL78 microcontroller. Sensed datas are delivered to an Android Application device where an Monitoring Application (MA) makes them easily accessible to monitor and analyze received data. In case of emergency send push notification to respective doctor. The doctor can track patient location using Global Positioning System (GPS) in is Android mobile.

KEYWORDS: Internet of Things (IoT), Renesas RL78, RFID Tag, RFID Reader, Monitoring Application (MA).

I. INTRODUCTION

Improving the efficiency of healthcare infrastructures and biomedical systems is one of the most challenging goals of modern-day society. In fact, the need of delivering quality care to patients while reducing the healthcare costs and, at the same time, tackling the nursing staff shortage problem is a primary issue [10]. As highlighted in [1], in fact, current procedures for patient monitoring, care, management, and supervision are often manually executed by nursing staff. This represents, de facto, an efficiency bottleneck, which could be a cause of even tragic errors in practices.

The Internet of Things (IoT) makes smart objects the ultimate building blocks in the development of cyber-physical smart pervasive frameworks. The IoT has a variety of application domains, including health care. The IoT revolution is redesigning modern health care with promising technological, economic, and social prospects and smart mobile technologies are leading this evolutionary trend [11].

The main objective of this paper is to monitor the heart rate and temperature continuously through heart beat rate sensor and temperature sensor respectively and the respective datas are sent to android device via Bluetooth. The heart of the project is Renesas RL78 microcontroller, two sensors namely heart rate sensor and temperature sensor (LM35 sensor device) is to monitor the heart beat rate and temperature, LCD is used to display the sensor outputs, and Bluetooth is the wireless medium to send these results to android device as shown in Figure 1.

The microcontroller located at the centre of the block diagram forms the control unit. Embedded within the microcontroller is a program that helps the microcontroller to take action based on the inputs provided. The Internet of Things (IoT) android app is developed for Remote Healthcare System to receive data from microcontroller through Bluetooth. Two sensors are used to read data means to monitor the heart beat and temperature and data from these sensors is received by the microcontroller and this data is then sent to the IOT android app using Bluetooth and same data is displayed on LCD. When either four keys of Renesas RL78 control key any one key made high then for every 10 seconds updated data is sent to android app and it is displayed on that app and same result is displayed on LCD.

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II. RELATED WORK

Recent advances in the design of Internet-of-Things (IoT) technologies are spurring the development of remote systems to support and improve healthcare- and biomedical-related processes [2]. In [3], authors combine together wearable tags and ambient tags to develop a fully passive RFID system, named NIGHT-Care, for monitoring the state of disabled and elderly people during the night. Specifically, NIGHT-Care relies on an ambient intelligence platform which is capable to estimate sleep parameters, classify the human activity, and identify abnormal events that require immediate assistance. In [4], RFID Locator, a web-based application developed at the University of Fribourg (CH) in collaboration with Sun Microsystems, has been proposed to improve the quality of hospital services. Passive RFID technology has been successfully used also in [5] for equipment localization in hospitals. As evident from the cited literature, since RFID tags can operate solely under the reader coverage region, the use of UHF RFID technology is limited to patients/devices monitoring and tracking in quite small environments. Another set of related work proposes the use of WSN technology to implement solutions able to meet the specific requirements of pervasive healthcare applications. In [1], a wireless sensor network (WSN) providing patient localization, tracking, and monitoring services within nursing institutes are presented. The localization and tracking engine rely on the received signal strength indicator (RSSI) and particle filters while biaxial accelerometers are used to classify the movements of patients. Compared to UHF RFID tags integrating sensing and computing capabilities, WSN motes consume significantly more power, thus making the overall network lifetime the major limitations of such technology [6]–[8]. In such a context, RFID and WSN represent two complementary technologies whose physical integration might provide augmented functionalities and extend the range of applications [9], example in the healthcare domain.

III. PROPOSED ALGORITHM

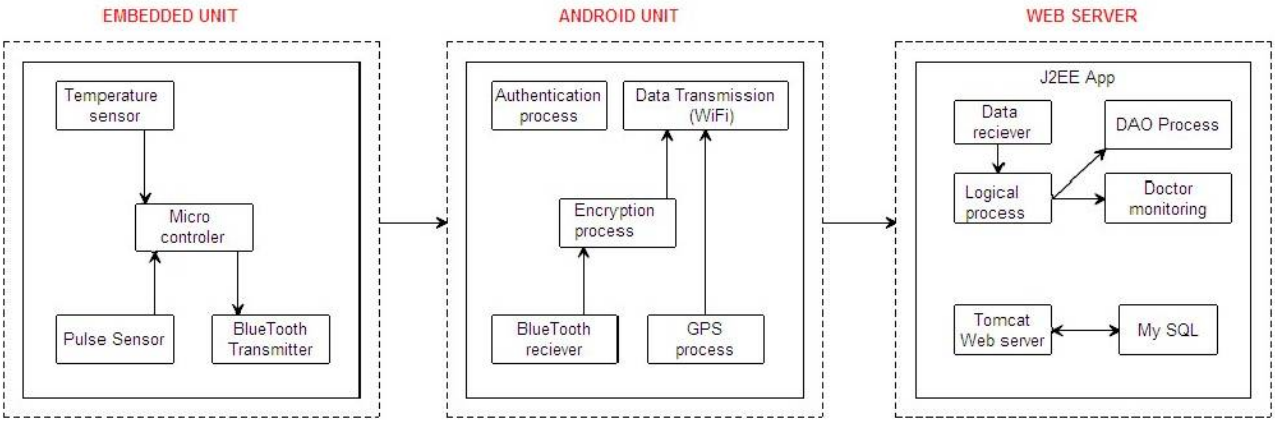

Figure 1: Remote Healthcare Architecture.

A. *Design Considerations:*

- Micro controller located at the centre of the block diagram forms the control unit.
- Temperature Sensor and Pulse (heart beat rate) Sensor is placed on the Embedded Unit to monitor.
- LCD is to display the sensor outputs, and Bluetooth is the wireless medium to send these results to android device.
- Android device must be Bluetooth enabled; once the device receives the Data an AES encryption is performed for security proposes.
- By make use of mobile internet or Wi-Fi Data transmission is performed.

B. *Description of the Proposed Algorithm:*

Aim of the proposed algorithm is to monitor patient's the heart beat rate and temperature continuously through heart rate sensor and temperature sensor respectively and send the respective datas are sent to android device via Bluetooth.

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Step 1: Start.
Step 2: Identify each patient with the RFID Tag.
Step 3: RFID Reader is used to read the Data from the RFID Tag.
Step 4: Performing Critical Analysis process for example-temp > 102 or < 95 an SMS has to be sent to the Doctor.
Step 5: Doctor can track the location of the patient using GPS.
Step 6: Stop.

IV. PSEUDO CODE FOR CRITICAL ANALYSIS PROCESS

Step 1: Begin.
Step 2: Let N be number of Readings.
Step 3: For I=I +1 to N (I= patient).
Step 4: Read Nth Reading.
Step 5: Extract details of PID (patient Identity), Temperature, and Heart Pulse.
Step 6: Check the below condition for critical analysis process
    If (Temp > 102F or < 95F)
        Move to critical table
    Else
        Move to PID table
Step 7: Check the below condition for critical analysis process
    If (Heart pulse > 120bpm or < 60bpm)
        Move to critical table
    Else
        Move to PID table
Step 8: go to step 3.
Step 9: End.

V. SCREENSHOTS

In order to ensure the proper operation of the designed RHS, an initial setup phase is required. During this phase an authorized medical operator registers the new hospitalized patient to the RHS. Specifically, as shown in some screenshots in Figure 2, the operator accesses the system via the Android application and requires the MA to observe the health sensor resources.

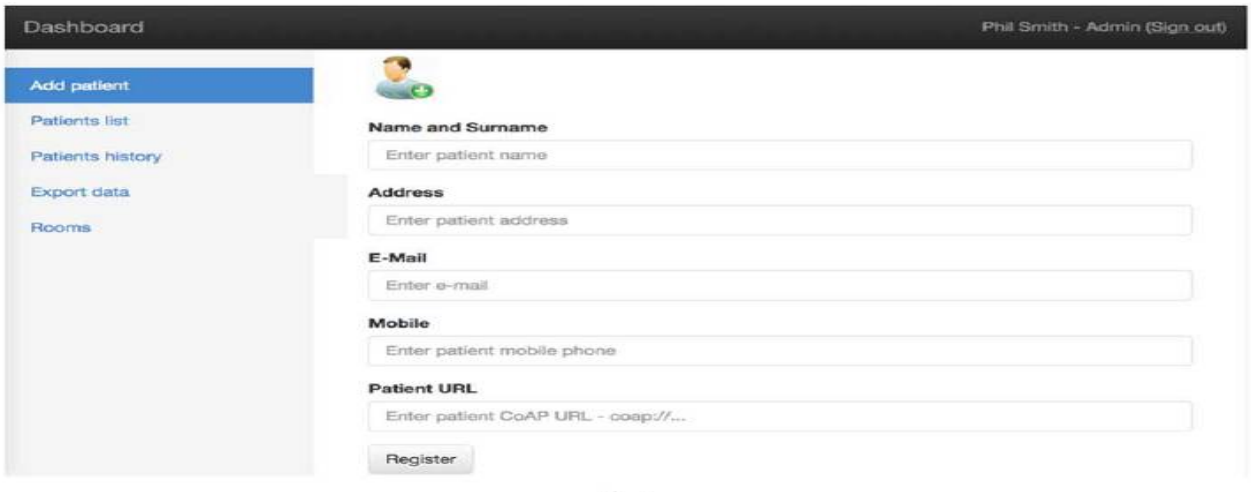

Figure 2: Operator registers the new patient [10].

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To demonstrate the efficiency of the proposed RHS, the functional validation has been conducted considering two different use cases: 1) patients' monitoring and 2) emergency event handling. Specifically, as shown in some screenshots in Figure 3 Operator requires the Management Application (MA) to observe important physiological parameters.

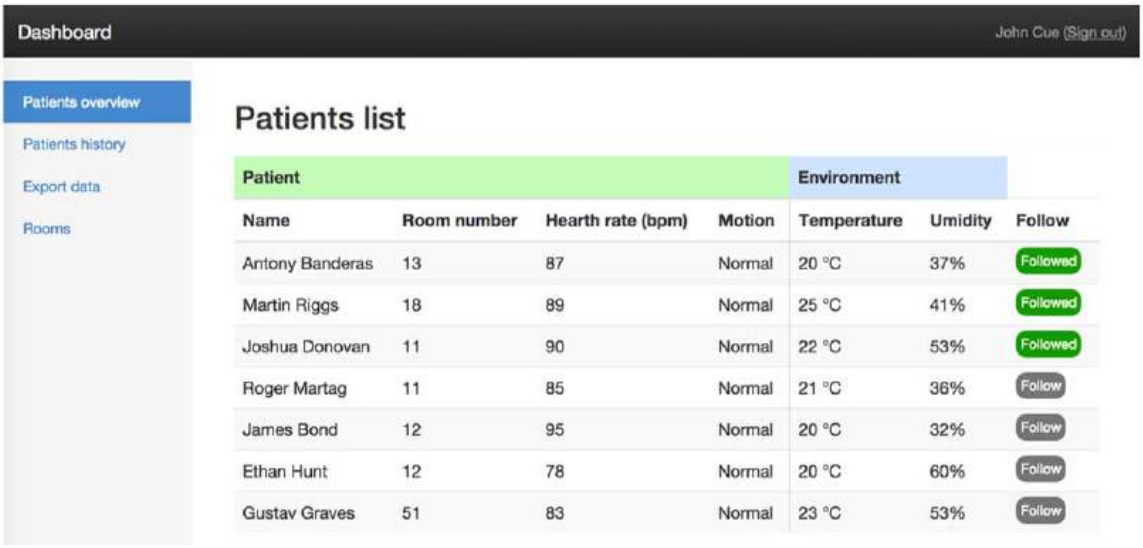

Figure 3: Operator requires the Management Application (MA) to observe important physiological parameters [10].

The Critical Analysis detects the patient fall and sends a notification message to the MA. The MA retrieves from the database information about the nearest doctor/nurse in the hospital example the mobile phone number and sends him/her a Push Notification (PN). The doctor/nurse receives on the Medical App the emergency notification [Figure 4(a)] and visualizes the actual location of the patient [Figure 4(b)]. The doctor visualizes details about the patient fall and promptly provides to handle the emergency. As shown in Figure 4(c), the Medical App is also able to retrieve all the information stored in the control DB concerning hospitalized patients.

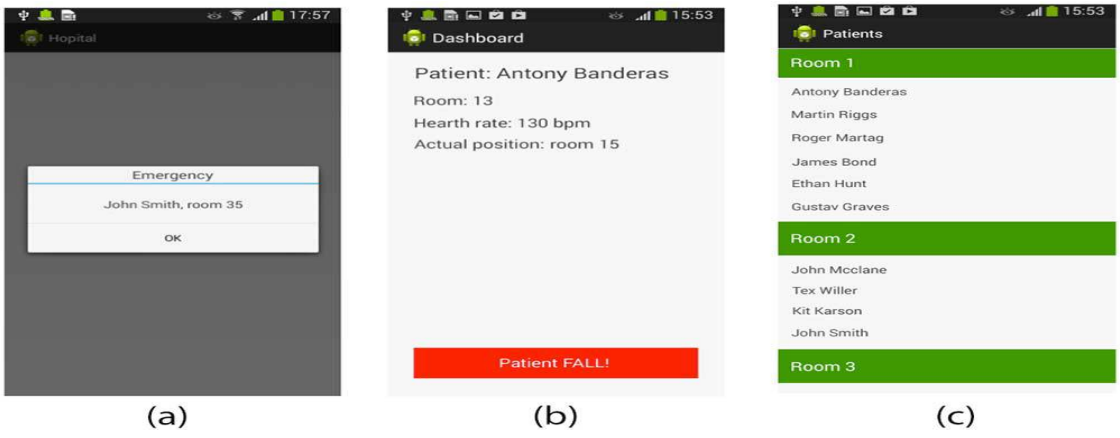

Figure 4: (a) PN (Push Notification) on the mobile phone. (b) Visualization of details about the emergency situation. (c) List of patients and their location [10].

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VI. CONCLUSION AND FUTURE WORK

The proposed system is able to collect in real-time both environmental conditions and patient's heart beat rate and temperature parameters and deliver to center controller. At this point an advanced monitoring application (MA) should analyze the received data and send alert message in case of emergency. "Prevention is better than cure", keeping this in mind this system is developed. Before the emergency exits this system will predict it and help to save lives. We have used only two sensors namely heart beat rate sensor and temperature sensor is to monitor the heart beat rate and temperature. We can use N number of sensors and analyze system performance.

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BIOGRAPHY

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