SMART HEALTH CARE SYSTEM IMPLEMENTED USING IoT

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Abstract: The convincing development in Internet of Things (IoT) enables the solutions to spur the advent of novel and fascinating applications. The main aim is to integrate IoT aware architecture to enhance smart healthcare systems for automatic environmental monitoring of hospital and patient health. Staying true to the IoT vision, we propose a smart hospital system (SHS), which relies on different, yet complimentary, technologies, specifically RFID, WSN and smart mobile, interoperating with each other through a Constrained Application Protocol (CoAP)/IPv6 over low-power wireless personal area network (6LoWPAN)/representational state transfer (REST) network infrastructure. RADIO frequency identification technologies have been increasingly used in various applications, such as inventory control, and object tracking. An RFID system typically consist of one or several readers and numerous tags. Each tag has a unique ID. The proposed SHS has highlighted a number of key capabilities and aspects of novelty, which represent a significant step forward.

Keywords: CoAP, healthcare, hybrid networks, radio frequency identification (RFID), REST, 6LoWPAN, smart environment, wireless sensor network (WSN).

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. 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.

Recent advances in the design of Internet-of-Things (IoT) technologies are spurring the development of smart systems to support and improve healthcare- and biomedical-related processes [2]. Automatic identification and tracking of people and biomedical devices in hospitals, correct drug–patient associations, real-time monitoring of patients' physiological parameters for early detection of clinical deterioration are only a few of the possible examples.

Among others, ultra-high-frequency (UHF) radio frequency identification (RFID), wireless sensor network (WSN), and smart mobile represent three of the most promising technologies enabling the implementation of smart healthcare systems. RFID is a low-cost, low-power technology consisting of passive and/or battery-assisted passive (BAP) devices, named tags, which are able to transmit data when powered by the electromagnetic field generated by an interrogator, named reader. Since passive RFID tags do not need a source of energy to operate, their lifetime can be measured in decades, thus making the RFID technology well suited in a variety of application scenarios, including the healthcare one [3]–[5]. The recent availability of UHF RFID tags with increased capabilities, e.g., sensing and computation [6]–[8], represents a further added value. In fact, RFID-based sensing in healthcare enables zero-power, low-cost, and easy-to-implement monitoring and transmission of patients' physiological parameters. Nevertheless, the main drawback of RFID tags stems from the fact that they can operate solely under the reader coverage region, i.e., up to 15 and 25 m when, respectively, fully passive and BAP tags are used. Clearly, such an aspect limits the use of UHF RFID technology to object/patient identification and monitoring within quite small areas.

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 . In such a context, RFID and WSN represent two complementary technologies whose physical integration might provide augmented functionalities and extend the range of applications , e.g., in the healthcare domain.

II. RELATED WORK

Recent advances in micro electro mechanical systems (MEMS) have opened up great opportunities for the implementation of smart environments. Especially in the medical field, several sensors to evaluate different types of vital signs (i.e. ,heartbeat, body pressure and temperature, ECG, and motion) have been developed, thus enabling the design of innovative services able to substantially improve citizens' healthcare. In this field, among the several research activities already presented in the literature, those related on the use of the UHF RFID technology are mainly focused on tracking patients in hospitals and nursing institutes.

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.

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 patient/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 WSN providing patient localization, tracking, and monitoring services within nursing institutes is 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. In [6], a wireless localization network able to track the location of patients in indoor environments and also to monitor their physical status is presented. A location-aware WSN to track patients using a ranging algorithm based on environment and mobility adaptive filter (REMA) is proposed in [6]. A quite complete project providing patients' monitoring and tracking is WSN4QoL [16]. Specifically, WSN4QoL relies on a three-tier system architecture ,where, at the lowest tier, a Bluetooth-enabled wireless body area network (WBAN) connects sensor nodes to a local collector which, in turn, sends measurements reports toward a gateway through an IEEE 802.15.4-based Zig Bee network. Finally, the gateway performs local computation and forwards data to the public IP network toward the professional caregivers for real-time analysis.

In [7], the 6LoWPAN standard and smart mobile communication techniques are combined to monitor the health condition of patients and provide several effective healthcare services. More in detail, the proposed solution makes use of WSN devices to measure photo plethysmo gram (PPG) signals and deliver them to a server through the Internet. An Android device is used to provide a mobile healthcare service by means of a customized application. Unlike the UHF RFID technology, the use of WSN allows the patients to be monitored in a more efficient manner at the cost of complex algorithms required for their precise tracking.

III.EXISTINGSYSTEM

Patient and environment monitoring would be considered as a individual application system in healthcare automation environment. Integration of environment and patient monitoring does not exist. Doctor has to generate the patient report in a hospital.

In case of any emergency the doctor must be in hospital to generate a prescription. If a doctor in some other location apart from hospital, doctor may send report via messages or by call may lead to conflicts. So a mobile based application of a patient is mandatory to the doctor, so that a doctor can provide prescription from any location.

IV.PROBLEM DEFINITION:

- Redundancy of data in existing sensor network.
- Communication and Data management issues in sensor Network.

- Increasing the traffic overhead and bandwidth requirements of the sensor networks.
- In case of any emergency for the patient, doctor must be in hospital to generate prescription.

V.PROPOSEDSYSTEM

Our proposed system is to implement an IoT Smart Healthcare System.Smart Healthcare Systems for automatic monitoring environmental conditions of a hospital and monitoring health conditions of a patient.Sensors are used to sense the environmental conditions i.e.(temperature, humidity, ambientlight,etc..)The local staffs in the hospital are responsible for tracking the ward environmental conditions. Radio Frequency Identification Technique (RFID),which is used to identify the sensors.By using a RFID reader sensor identity can be verified to ensure Authenticity and Integrity.

The Nurse is responsible for tracking or monitoring the patient health condition. Based on the patient Description the patient id will be updated to the nurse. The monitoring data of the patients are a temperature and a heart rate. The Nurse starts monitoring the patient details i. e (temperature and heart rate) are updated in the nurse page and based on the temperature and a heart value will be displayed in a dynamic graphical chart. After that monitored details will be sent to the doctor. Based on the patient details doctor will generate a graphical chart and give the prescription. The graphical chart and the prescription will be created as a PDF File and send to that patient.

VI.ARCHITECTURE

This work aims at designing and implementing an IoT –aware SHS having as main peculiarity, the capability to readily combine different, yet complementary, technologies enabling novel functionalities. Basically, the system we envision should be able to collect, in real time, both environmental conditions and patients' physiological parameters and deliver them to a control center. At this point, an advanced MA should analyze the received data and send alert messages in case of emergency. The conceived SHS has been put into effect according to the architecture illustrated in Fig. 1. As shown, it is composed of three main parts:

- The RFID-enhanced WSN, called HSN .
- The IoT smart gateway; and
- The user interfaces for data visualization and management

The same interface allows doctors with specific privileges to access both real time and historical patient data. Such information can also be managed remotely by the medical staff through a mobile software application.

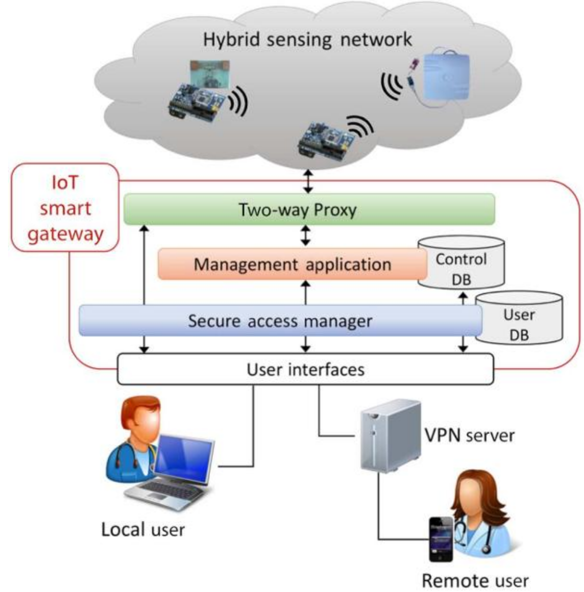

Figure 1. OVERVIEW OF THE SHS ARCHITECTURE

The HSN consists of an integrated RFID-WSN 6LoWPAN network composed of four typologies:

- 6LowPAN border routers (6LBR);
- 6LowPAN routers (6LR);
- 6LowPAN router readers (6LRR); and
- 6LowPAN host tag (HT).

According to the 6LoWPAN standard, the 6LBR is in charge of connecting the network to the Internet by translating 6LowPAN packets into IPv6 packets and vice versa, whereas the 6LR provides forwarding and routing capabilities. Referring to the proposed RFID-WSN integrated system, the 6LRR is defined as a 6LR node interfaced with an RFID Gen2 reader while HT identifies a typical 6LowPAN Host (i.e., a node without routing and forwarding capabilities) interfaced with an RFID Gen2 tag.

The proposed SHS assumes that several 6LR are deployed in the hospital to collect data from the environment, such as temperature, pressure, and ambient light conditions. In addition to the sensing capabilities, the main function of 6LRR nodes, instead, is to track patients, nursing staff, and biomedical devices labeled with RFID Gen2 tags. In particular, we envision patients wearing an HT node, which is capable to detect important physiological parameters, such as heartbeat and motion. Sensed data are periodically logged on the user memory of the RFID Gen2 tag, thus allowing

6LRR nodes deployed in the environment to retrieve and deliver them to the IoT Smart Gateway. This last one is connected, on one hand, directly with the HSN and, on the other hand, with the Internet through a local area network (LAN). Therefore, in the proposed architecture, the gateway plays the role of 6LBR, enabling the communication between WSN nodes and remote users. An MA running on the gateway analyzes the received data and stores them into the database (control DB in Fig. 1).

To make the collected data easily accessible by both local and remote users, the REST Web-based paradigm has been adopted. Specifically, a Web-based graphical interface allows network operators to manage environmental parameters of sensor and actuator nodes. The same interface allows doctors with specific privileges to access both real time and historical patient data.

VII.EXPERIMENT

We did our experiment in four modules which includes Environment Sensing, Registration and Ward Allocation, Patient and Environment Monitoring and Report Analysis Here the modules are explained as follows:

A.ENVIRONMENT SENSING:

The hospital consists of a different type of wards, in an each ward sensors are planted and sensor are used to sense the environmental condition i.e. is (temperature, humidity, ambient light etc..)of that ward. Each sensor has its own tag id.

Once the sensor starts sensing data, each sensed data will be updated in that particular ward. Each patient should be required to fill out a patient details form. Each patient should describe the description of their disease in that patient details form, based on the patient description the patient id will be automatically updated to the ward. The localization problem is also addressed in [8], where a grid of UHF RFID tags is used to enhance the localization accuracy of standard RSSI-based WSN algorithms propose the integration of WSN nodes and UHF RFID readers.

B.REGISTRATION AND WARD ALLOCATION:

In a hospital, each ward has a specialist doctors and a nurses. Each doctor and nurse should be register with the hospital web application. Each nurse has its own specialist doctor identity. List of patient id are updated in the nurse page. The local users in the hospital are responsible for tracking the ward environmental conditions. The monitoring data of the patients are temperature and a heart rate. The local users have a unique login and user should be login to see the details of environmental condition of each ward. All the sensed ward details are continuously updated in a local user main page.

C.PATIENT AND ENVIRONMENT MONITORING:

In this module, in the nurse main page list of patients id are displayed. Then nurse click on the patient id to monitor the patient details, now the patients monitoring information which is temperature and the heart rate are updated in the nurse page. If the nurse wants to monitor some specific data either temperature or heart rate, that specific information only monitored for that patient. When monitoring the patient values the dynamic chart will be updated based on the sensed value of the patient. The abnormal status of the hospital ward is maintained separately and once abnormal values detected it will be automatically informed to that particular ward. The dynamic chart will be updated based on the monitored value of the temperature and heart rate. In the local user main page, monitored sensed ward are continuously displayed. The query process which is the local user query different wards of data. Based on the values of the sensed data . The dynamic chart will update and it will be monitored by the local staff.

D.REPORT ANALYSIS:

The nurse will send the monitored details to the doctor. After the patient details are analyzed the doctor will generate the image chart based on the values of a heart rate and the temperature. Based on the condition of the patient, the doctor will give the prescription, and the details of the prescription and an image chart are integrated and generated as a PDF document. The generated report will be send to the patient by the doctor..

The mobile based application for a doctor and patient. the feature of that application is:

1. Patient has the option to see the report.
2. The doctor can provide prescription and generate a report for a patient from any location.

VIII.PROOF OF CONCEPT

The Medical App is installed on the Mobile phone and uses the Wi-Fi or 3G Internet access. When a patient-fall event is detected the application receives the PN sent by the MA and notifies the doctor with a sound. The Medical App also allows the doctor to retrieve from the IoT Smart Gateway further details on the occurred event and the last registered patient location (i.e., the last location where the patient's HT node has been successfully read by a 6LRR)

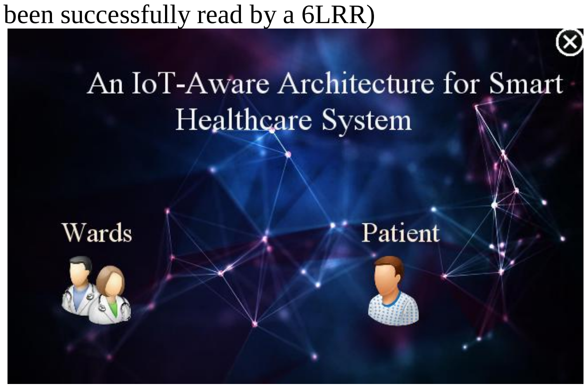

Figure 2: Login page for smart health care system

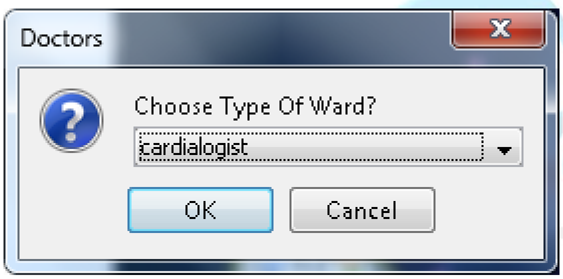

Figure 3: Deciding the type of ward

Figure 4: Sensing the ward

To demonstrate the efficiency of the proposed SHS, the functional validation has been conducted considering two different use cases: 1) patients' monitoring and 2) emergency event handling. In the former, the following operations are performed.

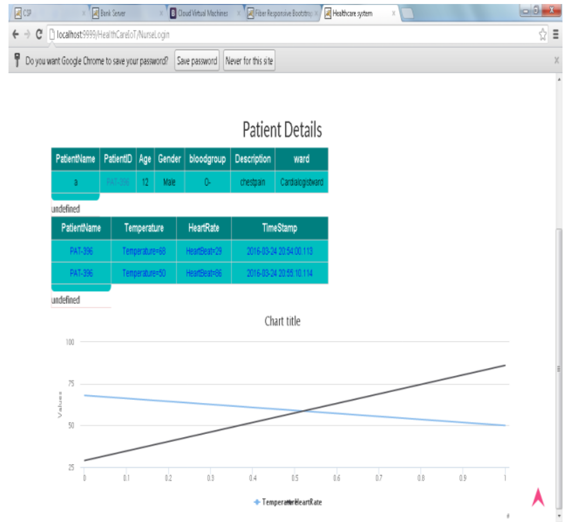

Figure 5: generating a graphical chart

IX. CONCLUSION

In this paper, a novel, IoT-aware, SHS architecture for automatic monitoring and tracking of patients, personnel, and biomedical devices within hospitals and nursing institutes has been proposed. With the IoT vision in mind, a complex network infrastructure relying on a CoAP, 6LoWPAN, and REST paradigms has been implemented so as to allow the interoperation among UHF RFID Gen2, WSN, and smart mobile technologies. In particular, taking advantage of the zero-power RFID-based data transmission, an ultra-low-power HSN has been implemented. It is able to collect the real-time variation of any critical patients' physiological parameter as well as of the environmental conditions. The sensed parameters are delivered to a control center where they are made easily accessible by both local and remote users via a customized REST web service. Two different use cases have been implemented to validate the proposed SHS. The former deals with patients monitoring, the latter with the management of an emergency situation caused by patient falls promptly detected by three-axis acceleration measurements. The achieved results demonstrate the appropriateness of the proposed system to perform not only identification and tracking of patients, nursing staff, and biomedical devices within hospitals and nursing institutes, butalso to provide power-effective remote patient monitoring and immediate handling of emergencies.

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