Profile Based E-Healthcare Systems Using Internet Of Things (IoT)

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Abstract:
Health is the fundamental capability humans require to perceive, feel, and act effectively, and as such, it represents a primary element in the development of the individual, but also of the environment humans belong to. That is why it is necessary to provide adequate ways to manage healthcare by monitoring and medical assistance. Increased life expectancy of the elderly and technological evolution led to innovative and effective solutions for in-home monitoring and treatment of patients. This paper introduces the use of telemedicine and home monitoring using Internet of Things (IoT). A solution for a sustainable and adaptable patient oriented infrastructure development is presented with the help of Raspberry Pi and Sensor Shield V2.0. Thus this paper hopes to achieve a solution that is cheap and economically stable. This paper proposes an architecture for the system, which is developed using the above mentioned devices. At the end of the paper we conclude that one of the main applications of IoT can be in healthcare, which increase the availability, quality of care and reduces costs. The system that the paper proposes will help in real time monitoring of the patient but will be cost efficient. Thus we can make use of Raspberry Pi for developing cheap systems in healthcare using IoT.

Keywords: IoT (Internet of Things), E-Health, Raspberry Pi, Sensor Shield V2.0, Do-It-Yourself (DIY) Self-Monitoring Device.

I. INTRODUCTION
Internet of Things (IoT) is a growing, high-end technology, which has the potential to change the way healthcare is delivered. The IoT allows people and things to be connected anyplace, anytime, with anyone and anything, ideally using any network/path and service[1]. The ability of everyday devices to communicate with each other and/or with humans is referred to as the Internet of Things (IoT). It is a dynamically distributed networked system, composed of a very large number of smart objects. IOT has three main system-level characteristics that are: anything communicates, anything is identified and anything interacts. The main credit for thriving use of IoT can be attributed to the growth of smart phones and tablets. Mobiles act as a bridge between people and the world of IoT. They have the ability to perform the extensive tasks for the patients, doctors, along with features like mobility and connectivity.

II. E-HEALTH
A. Concept of E-Health
The e-Health concept is used to describe the new “model centered on consumer” of health systems. The aim behind introducing e-health is using technology to enhance the quality of healthcare, thus allowing both the patients and medical professionals to access wide variety of resources to make healthcare more cost effective and efficient. It allows patients to gain a deeper understanding of their health and suggests ways to manage it.

B. Goal of E-Health
The e-Health includes a wide range of information, communication, and technology applications. The ultimate goal is to improve the management and use of information in order to support a wide range of clinical processes at operational, financial, and decision-making level as well as to improve the health service delivery.

The e-Health potential benefits may include:

- **Increased access to information and resources:**
- This increases the patients’ ability to make better choices related to medical healthcare.

- **Improved organizational processes:**
- This increases the efficiency of decision making, thus enhancing the safety and quality of patient’s life.

- **Improved education:**
- Patients are made aware regarding their health conditions as well as the doctors are constantly kept updated about the patient’s wellness allowing him to treat any risk immediately.

C. Forms of E-Health:
E-Health can be implemented in the following forms [4]:

- **Wireless Monitoring Systems:**
  Wireless monitoring system makes use of devices that are attached internally or externally to the patient through which the patients’ vital functions are kept under constant remote surveillance. This has led to a new form of healthcare, where data is being transmitted in real time between patients and doctors. This provision of healthcare is particularly beneficial for disease management such as hypertension, coronary heart disease, diabetes and asthma. E.g. wirelessly monitored pacemakers, automatic defibrillators, etc.

- **Mobile System Access:**
  Mobile system access enables mobile virtual access to the current clinical systems such as electronic health records [EHRs], communication systems and picture archiving etc. Use of mobile for monitoring and delivery of healthcare, led to the area being termed as m-Health. Examples: portals, websites, mobile apps.

- **Medical Devices:**
  Doctor uses medical devices as solutions for tracking of patient activities and smart diagnostic by capturing the data from the sensors, for further analysis. Examples: blood
pressure devices, digital glucometers, pedometers, wearable, Google glass, etc.

- **Virtual Consultation:**
  Virtual consultation is an application based on concept that enables virtual care consultation, medicine delivery and therapy procedure through remote connectivity. This avoids the long appointments and waiting times letting majority of routine care delivered within minutes or even seconds. Examples: Tele-consultations, mobile video solutions.

- **Aging in Place:**
  This application is mainly used to enable monitoring for independent living of aging populations. Wearable devices are mostly used for monitoring the elderly, without manual intervention. The vital signs of the elderly are obtained from their monitoring devices and transmitted to a standard device that acts as a network node for transmitting the real-time data of the patient, to the doctor. This information often gives medical assistance to patients and in case of serious abnormalities, alerts a nearby hospital. Examples: video consultations, Personal emergency responses systems (PERS), activity monitoring and fall detection.

### III. IOT AND E-HEALTH

To improve human health and well-being is the ultimate goal of any economic and technological development. The concept of the IoT allows the use of electronic devices that capture or monitor data connected to a private or public cloud, enabling them to automatically trigger certain events [1].

Internet-connected devices, introduced to patients in various forms, enable tracking health information that is vital for some patients. Thus, smarter devices deliver more valuable data, reducing the need for direct patient-doctor interaction [2]. With faster, better insights; providers can improve patient care, chronic disease management, hospital administration and supply chain efficiencies and medical services to more people at reduced costs.

A. Confluence brought about by IoT in E-Health

IoT is rapidly changing the healthcare scenario by focusing on the way people, devices and applications are connected and interact with each other (as shown below)[1]. Hence, it can be concluded that the emerging technology breakthrough of the IoT will offer promising solutions for healthcare, creating a more revolutionary archetype for healthcare industry developed on a privacy/security model.

![Figure 1: Confluence bought about by IoT](image)

**B. Functions of IoT in E-Health**

Typically, IoT powered e-health solution includes the following functions:[1]

- Tracking and monitoring (e.g. patient monitoring, chronic disease self-care, elderly persons monitoring or wellness and preventive care)
- Remote service
- Cross-organization integration

### C. Requirements of IoT in E-Health

The requirements of IoT communication framework in e-health applications are:[1]

1. **Interoperability** - Interoperability is needed to enable different things to cooperate in order to provide the desired service. All the systems and devices should be operable with each other.

2. **Bounded latency and reliability** – Latency and reliability is needed while dealing with emergency situations in order for the intervention to be effective. There should be minimum latency in the system. The system may be used for sensitive monitoring and other real-time monitoring purposes for which recording immediate responses is extremely crucial.

3. **Authentication, privacy, and integrity** – Authentication, privacy and integrity check is mandatory when sensitive data is exchanged across the network. Hackers can access the data that is stored over the cloud. Hence it is necessary to provide appropriate security.

### D. Basic Requirements of IoT in E-Health

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<tr>
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Different technologies and architectures of IoT for healthcare can be found in various papers but next building blocks are common for all of them:

- **Sensors** that collect data
- **Microcontrollers** that analyze and wirelessly communicate the data.
- **Microprocessors** that enable rich GUI.
- **Healthcare-specific gateways** through which sensor data is analyzed in detail and sent to the respective cloud.

**Table 1: Healthcare specific security standards [1]**

### IV. EXISTING SYSTEMS

In previous research, a health care system for monitoring of patients at risk in a smart environment was proposed, using IoT technologies. These existing systems are made up of components like:

a. DIY Self Monitoring Devices (Body Sensor Network)
b. DIY Monitoring Devices (Raspberry Pi and Sensor Shield V2.0)

These components are described in brief in the following section.

### V. DIY SELF MONITORING DEVICE

A. **Body Sensor Networks**

The main application domain of body sensor network. BSN (a network of sensors attached to the human bodies) is continuous health monitoring and logging vital parameters of patients. In other words, these networked systems
continuously monitor patients’ physiological and physical conditions, and transmit sensed data in real time via either wired or wireless technology to a centralized location where the data can be monitored and processed by trained medical personnel. Today’s personal health monitoring systems and similar medical devices must use a variety of design techniques to protect the underlying design as well as protect the sensitive data stored within or transmitted to/from the device. Many personal health monitoring devices must also be portable, so they need to be small, lightweight, and low-power.[8]

B. DIY Monitoring Device

In order to build a DIY device, we make use of:

- **Raspberry Pi**- to interface with the sensors.
- **Sensor Shield V2.0**- for connecting the sensors.

a) Raspberry Pi

In order to build own health monitoring device with aforementioned characteristics, this paper proposes a usage of ultra-cheap-yet-serviceable, small and powerful computer board - Raspberry Pi (RPi). A RPi has built in support for a large number of input and output peripherals and network communication, and it is the perfect platform for interfacing with many different devices and using in a wide range of applications. Beside of that, enabling end-user programming on RPi, a complete open-source and low cost system based on IoT concepts can be created.[5]

The architecture of the raspberry pi is shown below:

![Figure 2: Architecture of Raspberry Pi][5]

b) Sensor Shield V2.0

Sensor Shield V2.0 (SSV2.0) performs biometric and medical applications where body parameters monitoring is performed by using 10 different sensors: pulse, oxygen in blood (SPO2), airflow (breathing), body temperature, electrocardiogram (ECG), glucometer, galvanic skin response (GSR - sweating), blood pressure (sphygmomanometer), patient position (accelerometer) and muscle/electromyography sensor (EMG).[1]

SSV2.0 enables real time monitoring the state of a patient or getting sensitive data in order to be subsequently analyzed for medical diagnosis. The biometric information gathered can be wirelessly sent using any of the six connectivity options available: Wi-Fi, 3G, GPRS, Bluetooth, 802.15.4 and ZigBee depending on the application. Using a RPi’s support for DSI (Display Serial Interface) and for CSI (Camera Serial Interface) solution easily can be expanded with display and camera, respectively.

PROPOSED ARCHITECTURE

This section describes the architecture of the entire system and defines its functioning The basic architecture is shown:

![Figure 3: Architecture of the proposed system][1]

As shown in the above figure, the patient is monitored using the Raspberry pi and Sensor Shield V2.0.

1. Gathered data is sent to the cloud using either one of the above-mentioned protocols.

2. From the cloud, the data is sent to the respective institutes such as hospitals, homes and respective preventive healthcare institutes.

3. The RPi and Sensor Shield will send the monitored data to the mobile device using either Bluetooth, ZigBee, 3G, Wi-Fi, GPRS etc.

4. The data received from RPi and SSV2.0 from the mobile device is sent to the cloud using Internet.

5. Thus, the data from the cloud is sent to the particular institutions. One of the main concerns is where the data will get aggregated. The data may get aggregated at the monitoring device itself if the traffic on the Internet is high or it may get aggregated in the cloud. The choice of method to follow will be dependent on the type of application being developed.

C. Use Case Diagram

The use case diagram for the entire system is shown below:

![Figure 4: Use case diagram of the system][1]
will be monitored by the system and all the data will be sent to the doctor. Next, the aggregated report will be sent to the doctor and the insurance agent. The alerts produced will be sent to the doctor, insurance agent and the family members.

VI. ADVANTAGES AND DISADVANTAGES

A. Advantages
There are various advantages associated with this system. Some of them are listed below[8]:

- **Reduces staff stress**: If more people are monitored at their homes then less people will be going to the hospitals. Hence, it reduces the stress on the staff.
- **Makes an efficient and accessible patient record**: The data stored on the cloud is aggregated and accessible all the time. Thus, being more efficient.
- **Time saving**: These systems will save a lot of time since monitoring is done at patient’s home itself.
- **Reduces indirect works**
- **Reduces Cost**: If the visits to the hospital reduce, then obviously costs will be reduced.
- **More Health care delivery**.

B. Disadvantages
With every system there come certain disadvantages, in this case they are:

- **Developing is a bit expensive**: If we use the Sensor Shield V2.0 for sensing parameters, then it costs around Rs. 45,000, which is a big amount. Hence, developing is expensive.
- **Security risk**: Since the data is going to be stored on the cloud, it is susceptible to various attacks from hackers
- **No face to face interactions with the doctors**.

VII. FUTURE SCOPE
Our world has been radically changed by digital technology. Smart phones, tablets, and web-enabled devices have changed our daily lives and the way we communicate. A greater and smooth flow of information within a digital health care (basic equipment needed for a business or society to operate), created by electronic health records (EHR), encompasses and leverages digital progress and can change the way care is delivered and compensated. The future scope would include adding more sensors to the existing system. Other than this, reducing the size of the monitoring device will also be focused on in the coming future. Next, to deploy the system on a nationwide GSM network and add some elements of natural language processing to include translation of some local languages in order to increase the acceptability by the non-literate people in the country. As we can see, e-healthcare applications have a tremendous scope for improvement and thus improve healthcare service.

VIII. CONCLUSION
With the appearance of the Internet of Things concept, elements, such as sensors and sensor networks, are becoming available and applicable in all fields of human activity, thus providing conditions for the creation of expert systems that can operate anytime and anywhere. The discussed concepts can find applications in health monitoring, diagnostics and treatment making it more personalized, timely and convenient. All this results in significant improvement in healthcare by increasing the availability, quality of care and reduced costs.

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XI. REFERENCES


