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Modeling the Smart Vest in Internet of Things to Detect Hospital Patient Movements Using Wireless Body Area Networks

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The increasing use of wireless networks and the constant miniaturization of electrical invasive/non-invasive devices, usually known as IoT (Internet of Things), has empowered the development of Wireless Body Area Networks (WBANs). A WBAN provides continuous health monitoring of a person without any constraint on his/her daily activities. In this paper, the most common technologies used in WBANs are highlighted. IoT, has allowed some facilities including sensing, processing and communicating with physical and biomedical parameters. It connects the doctors, patients and nurses through smart devices, like this smart vest, and each entity can roam without any restrictions.

Key words: *Wireless Body Area Networks; Internet of Things; IEEE 802.15; Hospital Patient Movements.*

Introduction

Ubiquitous healthcare is an emerging technology that promises increases in efficiency, accuracy and availability of medical treatment due to the recent advances in wireless communication and in electronics offering small and intelligent sensors able to be used on, around, in or implanted in the human body. In this context, Wireless Body area networks (WBANs) constitute an active field of research and development as it offers the potential of great improvement in the delivery and monitoring of human healthcare (Abdullah et al., 2018). WBANs consist of a number of heterogeneous biological sensors. These sensors are placed in different parts of the body and can be wearable or implanted under the user skin. With ageing of the population, existing medical resources cannot satisfy future healthcare

demands of seniors and patients. Resources are limited and it is impossible for most patients to afford long-term hospital stays due to economic restrictions, work, and other reasons, even though their health status must be monitored in a real-time (Cao et al., 2011) or short periodic time mode.

In this context, WBAN supporting healthcare applications can offer valuable contributions to improve patient healthcare, including diagnosis and/or therapeutics monitoring. In a short time, WBAN technology has taken its first steps in the medical rehabilitation and monitoring of patients. However, the underlying technology is still in an early development stage and typically based on very specific wireless communications technologies. Patients may be comfortably monitored at home while carrying out their daily activities, and medical staff have to monitor many patients simultaneously. The balance between these generally conflicting features means that research in this arena is not finished. In this area, data reliability, power consumption, and size are very important characteristics to consider when choosing appropriate WBAN sensor nodes. Many studies have been focused on WBANs for medical purposes. However, few works have been concerned with a global solution for tens or hundreds of patients, each of whom is fitted with multiple sensor nodes, and confined to a relatively small environment like an infirmary or a living or dining room of a hospital. Until now, some of the research and studies carried out for hospital environments have obtained results for different nodes in several experimental subjects.

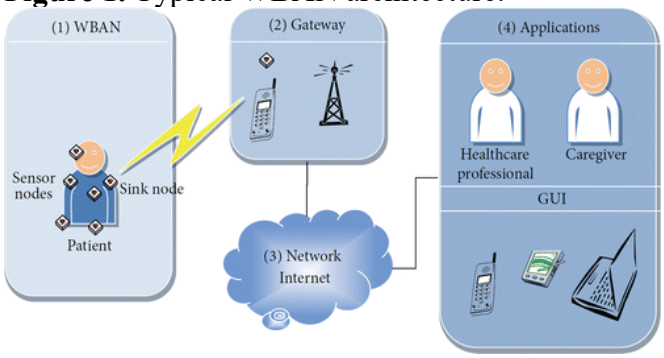
WBANs for healthcare applications are mainly used in patient monitoring tasks. In this type of network, the sensors are distributed on the human body measuring different physiological parameters, which represent the most widely used solution within this domain (Datasheet of MAX30100).

Wireless Body Area Network Architecture

A typical WBAN architecture includes:

a) a small network around the body (about 1-2 meters),
b) a gateway (*sink*) bridging to another network types that can be another node with some routing and data aggregate features,
c) a wide network that can be an Internet or intranet network, and
d) an application with GUI for medical or other healthcare personnel.

Figure 1. Typical WBAN architecture.



Health Level Measurement

The typical extents for an individual's fundamental signs differ with age, weight, sexual orientation, and generally speaking wellbeing. There are four essential indispensable signs: body temperature, circulatory strain, beat rate (pulse), and breathing rate (respiratory rate) are frequently recorded as BT, BP, HR, and RR.

The typical human temperature of an individual changes upon sexual activities, ongoing action, nourishment and fluid usage in a day, and for women, menstrual cycle of period. Starting from 97.8^{0}F in Fahrenheit (equals to 36.5^{0}C in Celsius) to 99^{0}F (37.2^{0}C) of the human temperature can extend from a solid grown-up. An individual's body temperature can be taken in any of the accompanying ways:

a) **Orally.** The use of body temperature checking by mouth using a manual thermometer or digital thermometer can be directly done to measure body temperature.
b) **Rectally.** The measurement of body temperature rectally by using a manual thermometer or digital thermometer generally produces 0.5 to 0.7^{0}F a hotter difference compared to measuring body temperature by mouth/orally.
c) **Axillary.** The measurement of body temperature can also be done under the arm using a manual thermometer or digital thermometer, usually using this method will in general be 0.3 to 0.4^{0}F lower than measuring body temperature by mouth/orally.
d) **Ear.** The temperature of the ear drum also can be use to measure the human temperature (inward organ temperature) by using an exceptional thermometer.
e) **Skin brow.** Skin brow also can be used to measure the human temperature by using an exceptional thermometer.

When the body got some fever, the body temperature might not stable, and sometimes will high temperature or low temperature. When the regular temperature of body increasing about one degree or more than a normal body temperature (around more than 98,6^{0}F or 37^{0}C) and

when indicate the hypothermia, which is the body temperature will drop underneath 95^0F or 35^0C.

Circulatory strain is the power of the blood pushing against the course dividers amid compression and unwinding of the heart. Each time the heart pulsates, it siphons blood into the supply routes, bringing about the most elevated circulatory strain as the heart contracts. At the point when the heart unwinds, the circulatory strain falls.

Circulatory strain is ordered as expected, raised, or phase 1 or phase 2 of hypertension:

a) **Normal** circulatory strain, is systolic of under 120 and diastolic of under 80 (120/80)
b) **Elevated** circulatory strain, is diastolic under 80 and systolic of 120 to 129
c) **Hypertension Phase 1** is when diastolic is near 80 to 89 or systolic is near 130 to 139.
d) **Hypertension Phase 2** is when the diastolic is equal to or more than 90 or systolic is equal to or more than 140.

The heart beat rate is a prediction of the pulse, or the events the heart throbs each minute. As the heart push the bloods through the supply courses, the conduits grow and contract with the surge of the blood. Taking the heart beat estimates the pulse, yet in addition can show the going with:

a) Heartbeat
b) Strength of the heartbeat

The ordinary heart beat for solid grown-ups between 60 until 100 thumps. It might different and increase with exercise, disease, damage, and feelings. Females by the ages of 12 and more established, by and large, will in general have quicker pulses than males. As a comparison, the sprinters, which produce a lot of cardiovascular, may have a pulse approaching 40 beats for each moment and have no problems.

The breath rate is the quantity of breaths an individual takes for every moment. The rate is typically estimated when an individual is very still and essentially includes checking the quantity of breaths for one moment by tallying how often the chest rises. Breath rates may increment with fever, ailment, and with other ailments. While checking breath, it is critical to likewise note whether an individual has any trouble relaxing.

Ordinary breath rates for a grown-up individual very still range from 12 to 16 breaths for each moment.

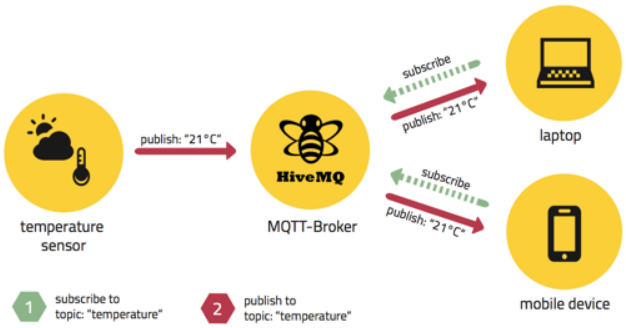
Internet of Things

The IoT, is a system of interrelated computing devices, mechanical and advanced machines, articles, creatures or individuals that are given interesting unique ID (UIDs) and a capacity to exchange information over a system sine expecting interaction between human to human and/or human-to-PC.

ESP8266 worked using economical system on a chip (SoC) that use an open source programming and equipment advancement condition called Node MCU. ESP8266, structured and produced by Espressif Systems, contains every single significant component of the advanced Personal Computer: (Central Processing Unit, Random Access Memory, wifi, and a cutting edge working framework and SDK. If you buy a lot of the ESP8266 chip, it only costs $ 2 USD per piece. That settles on it a great decision for Internet of Things tasks of various sorts.

Figure 3. Micro-Controller Node-MCU.

An accelerometer is an electromechanical gadget used to gauge increasing speed powers. Such powers might be static, similar to the persistent power of gravity or, just like the case



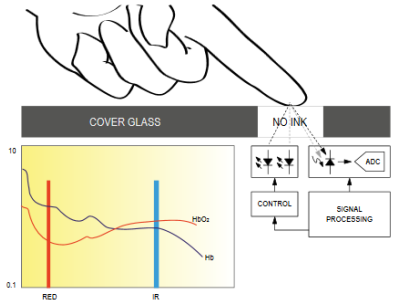
with numerous cell phones, dynamic to detect development or vibrations. Quickening is the estimation of the adjustment in speed, or speed separated by time.

The MAX30100 is a coordinated heartbeat oximetry and pulse screen sensor arrangement. It consolidates two LEDs, a photodetector, advanced optics, and low-commotion simple flag preparing to recognize beat oximetry and pulse signals.

The MAX30100 works from 1.8V and 3.3V power supplies and can be shut down through programming with immaterial reserve current, allowing the power supply to stay associated consistently.

The MLX90614 is an infrared thermometer for non-contact temperature estimations. Both the IR touch thermopile indicator chip and the flag moulding ASIC are incorporated in the equivalent TO-39. Coordinated into the MLX90614 are a low clamour intensifier, 17-bit ADC and amazing DSP unit accordingly accomplishing high exactness and goals of the thermometer.

Figure 4. System Block Diagram of MAX30100.

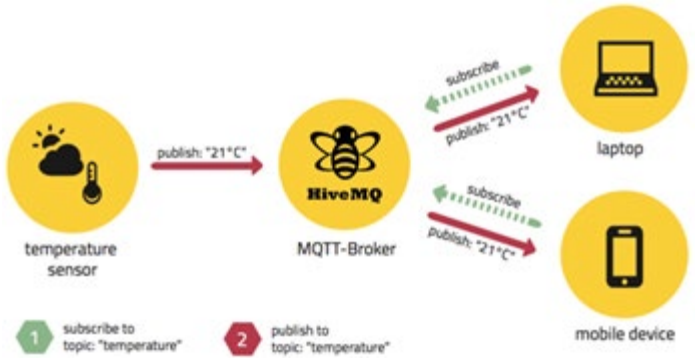


The thermometer comes plant aligned with a computerized SMBus yield giving full access to the deliberate temperature in the total temperature range(s) with a goal of 0.02^0C.

The client can arrange the computerized yield to be beat width adjustment (PWM). As a standard, the 10-bit PWM is arranged to consistently transmit the deliberate temperature in scope of - 20 to 120^0C, with a yield goals of 0.14^0C.

MQTT represents MQ Telemetry Transport. It is a distribute/buy in, amazingly straightforward and lightweight informing convention, intended for obliged gadgets and low-data transfer capacity, high-idleness or questionable systems. The plan standards are to limit organize data transfer capacity and gadget asset necessities while likewise endeavouring to guarantee unwavering quality and some level of confirmation of conveyance. These standards additionally end up making the convention perfect of the rising "machine-to-machine" (M2M) or "Web of Things" universe of associated gadgets, and for versatile applications where transfer speed and battery control are including some hidden costs.

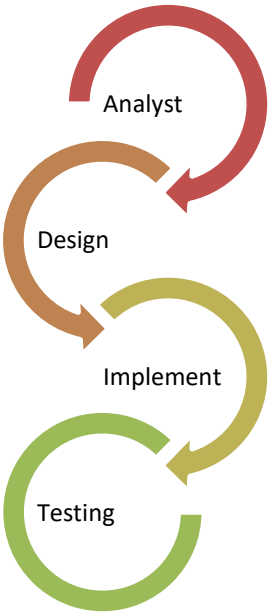
Figure 5. MQTT Architecture



Methodology

The methodology of the smart vest in Implementation of Internet of Things Based Wireless Body Area Networks is:

Figure 6. Methodology of Smart Vest.



Analyst the need of the system of smart vest, including how the sensor work and sending the data through the wireless.

Design the prototype of the smart vest that can be comfortable to wear and can send the data for analyst and monitoring by the user.

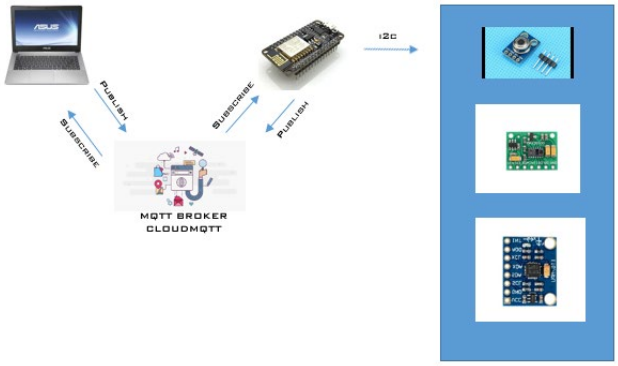
Implement the smart vest through the network and report the monitoring data analyst for important information to the user.

Testing the smart vest on various condition of the user, so the result will be the most accurate.

Result

The system architecture of smart vest implementation can be shown below

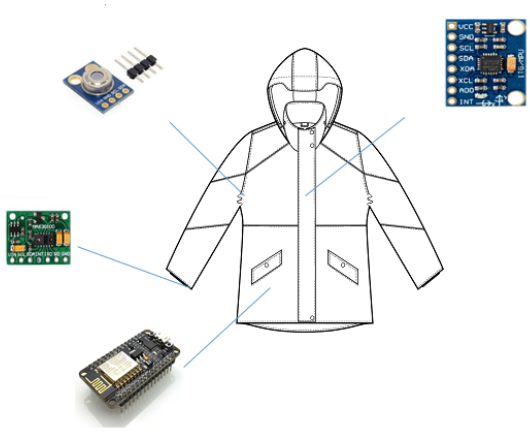
Figure 7. System Architecture of Smart Vest



The system starts from the Client accessing the website that has been created by logging in and filling in the UserID and Password to access the main menu. After entering the main menu the Client selects the **Live Monitoring** menu to monitor the device. When the web browser is finished displaying the Live Monitoring menu and if the device has not received the input value, the website will display a notification to retrying the input value to the device again.

Communication between tools and client devices is connected to the MQTT method where the client and the device publish and subscribe to each device sensors. In using the MQTT method the author uses MQTT Broker CloudMQTT. Published data from the Client device in the form of the name and age of the device user, while for the microcontroller the data is published in the form of measurement data of each sensor (Michael, n.d; Olkiewicz, 2018; Sánchez, 2018).
The position of the sensor in the smart vest can be shown below.

Figure 8. Smart Vest Sensors Placed



The implementation of software includes designing web applications that function as clients or as a medium for monitoring microcontrollers (Saudi etal., 2019; Saudi etal., 2019; Shuang et al 2013). In the web application that will be built there are 2 different subsystems, namely the monitoring system and the log record system. The monitoring system is built in the form of monitoring sensor measurement results through the MCU node microcontroller, and the log record system is just only for recording all the data coming from the sensors. Data in the log record database is obtained by means of the microcontroller doing the GET method on the database server which in the message contains sensor measurement data on the microcontroller that sends data every 1 (one) minute (Sinaga et al., 2019; Sinaga et al., 2019; Taib et al., 2018; Víctor et al., 2012).

Discussion

The smart vest is able to monitor the health of people and send the real-time report using the live monitoring application. The accelerometer also can help to inform that the person who wears the smart vest is in a stand-up position, a sitting or squat position, or a lying down position, and can also inform the location of the user using GPS Mapping. The accuracy of the hospital patient movement while using accelerometer is not too good at present. So it is recommended to use a gyroscope device. A gyroscope is a gadget that utilizes Earth's gravity to help decide introduction. Its plan comprises of an openly turning plate called a rotor, mounted onto a turning pivot in the focal point of a bigger and progressively stable wheel. As the pivot turns, the rotor stays stationary to show the focal gravitational draw, and in this manner which path is "down".

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