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The Impact of Human Computer interaction via Internet-of-Things (IoT) based Smart Health

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ABSTRACT: Human computer interaction is the state of interaction that exists between human and the computer system, their ability to use them and explore the hidden resources it can provide to solve human daily needs. This paper proposed and implemented a smart doctor, a wearable device IoT smart health systemthat can be used to overcome the challenges of physical contact/meeting with the doctor by patients or in situations where the doctor is too busy to see the patients physically; the smart doctor can come in and allow access of health care services of the Doctor by the patients without any physical meeting or contact. The proposed Smart Doctor was able to measure three basic health signs: the body temperature, the heart or pulse rate, and blood oxygensaturation level. The system used a NodeMCU microcontroller, MAX30102sensor,and LM-35 body temperature sensor to implement the measurements. The dataset obtained was stored remotely using ThingSpeak IoT cloud server so that a Doctor or caregiver can access it and take immediate action fromwherever he or she is located. The system was implemented in various towns in Enugu State Nigeria and over 500 datasets was collected from over 500 patients.

KEYWORDS:blood oxygen saturation level, pulse rate, body temperature, oximeter, smart doctor, IoT, human interaction, smart health.

I. INTRODUCTION

Smart Doctor is a technological solution that maximizes the health and well-being of work teams, through a healthy ecosystem that allows them to create new habits and to control their physical, emotional, and nutritional status. Furthermore, it could be seen as a community network of professional medical doctors sharing or exchange of knowledge on interrelated, or common critical sickness treated and measures taken to combat them.

A natural Doctor is a professional trained to assist humans whenever there is a health challenge, Humans consult natural doctors in their clinics through scheduled appointments and must pay consultation fees. But it does not guarantee you must be attended at the time of visit; the patient will fill out a form and wait for their turn. If a patient is diagnosed with a disease after test, such a patient is placed on monitoring and close observation, which involves a regular visit to the hospital. Figure 1 depicts the normal traditional healthcare access where several patients must go to the hospital and meet with the doctor physically.

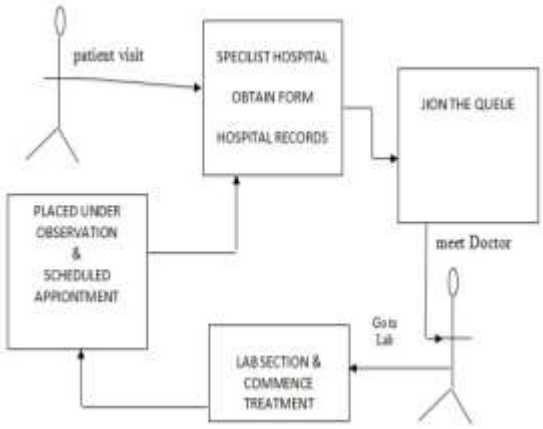

Figure 1: Traditional healthcare access block diagram

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The traditional medical system involves different procedures to access quality health care and to access the doctor the patient must follow the following steps:

i. The patient will pay for a hospital card where he will fill in some important information
ii. The patient will wait for his turn to be called by the doctor.
iii. The doctor will send the patient to the lab after which the doctor will commence treatment.
iv. Then after the treatment the patient will be given a date for the next meeting.
v. The only time the doctor will see the patient to know his or her improvement is on the day of the next appointment.

Some critical cases are better handled through close observation and monitoring, this helps discover another strange development in the system, early diagnosis will help to save lives rather than waiting for the next appointment with the doctor.
Smart Doctor could further be defined as a digital platform that provides services by professionals such as General Practitioners, Specialist Physicians, Psychologists, Nutritionists, and Therapists. Figure 2 shows the smart doctor flow diagram.

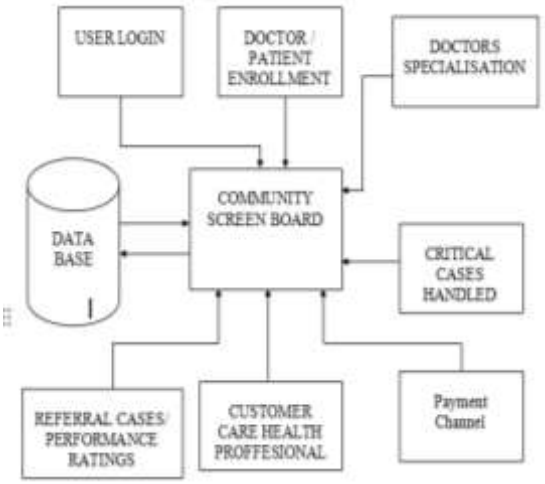

Figure 2: The smart doctor healthcare access flow diagram

From Figure 2, it can be seen that in the proposed system, patients are meant to enroll in the system and discuss his/her health issues; if has some series of tests he has undergone it will be accessed by the doctors in the network, however, if the case is beyond talking or chatting, the health care customer professional will direct the patient to a specialist whose area or field is to handle such critical health case. The doctor's cv will be uploaded in the system and specialization as well. Any referral case will attract some percentages to the system, smart Doctor will engage highly skilled health professionals that have twenty – forty years' experience in the field to ensure quality healthcare services to the community, especially here in Nigeria.

A computer human Interaction and medical devices is the study of people, computers, and embedded devices such as electronic equipment used for medical services and their interactionand how they communicate with each other. The interaction between humans and computers is centered in the design of the system. It is observed that people make use of machines in their daily life which has its applications in production activities, and for efficient performance and results in the medical industry, people's communication with machines must be a cohesive one. Since the introduction of computers in various human endeavors, it has affected human life and made humans seek more applications and better ways to deploy computers in everything that has electronic components in them as well as internet protocol. The human interaction stresses in the way people continue to interact, understand, communicate, application skills in the usage of computer programs installed in any device. Computer interface considered using a user-friendly environment to interface between computer and human. The level of system interaction is dependent on the design architecture of the computer system. Today, the design is focused on user experience and quality of life, the design of human-computer interaction interface affects the user's operation mode and device experience, and plays a crucial role in the practicability and ease of use of machines and computer equipment.

Vital Signs for body's function [1]:

Vital signs are measurements of the body's most basic functions. The four main vital signs routinely monitored by medical professionals and healthcare providers include the following:

- Body temperature
- Pulse rate or heart rate
- Respiration rate (rate of breathing)
- Blood pressure (Blood pressure is not considered a vital sign, but is often measured along with the vital signs.)

Vital signs are useful in detecting or monitoring medical problems. Vital signs can be measured in a medical setting, at home, at the site of a medical emergency, or elsewhere.

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Figure 3 depicts the various sensors that can be connected and integratedwith a microcontroller device in a smart doctor health system to enable the doctor to gather all the health parameters from the patient remotely without any physical contact or meeting.

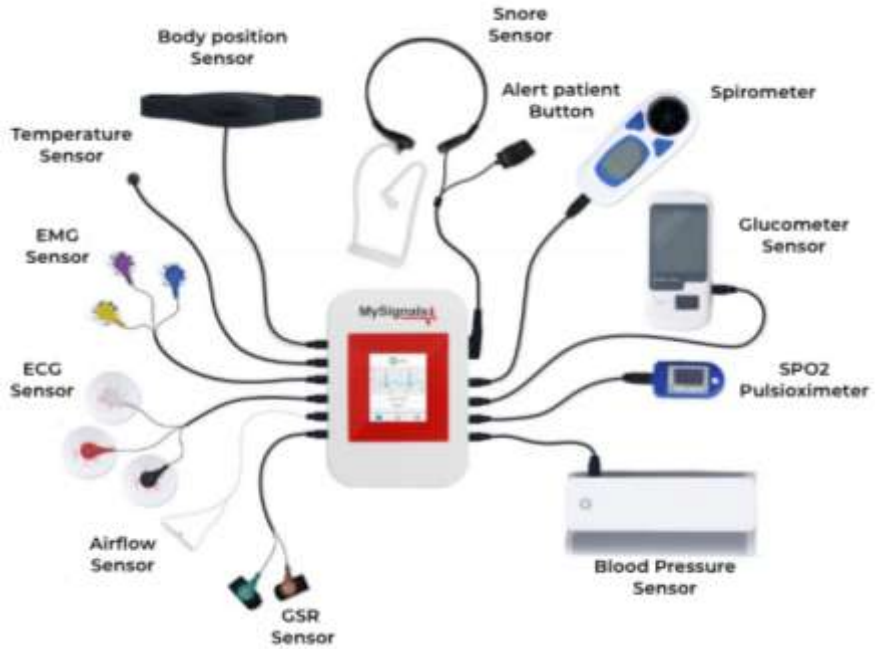

Figure 3: The smart health sensors' composition [2]

Who will benefit from the system?

- Doctors enrolled in the system
- Hospital where the patient will be treated in the case of appointment
- User enrolled in the system to obtain professional health care.

II. EXPERIMENTATION

The Smart Doctor was implemented in this research paper by integrating the hardware and software sub-systems which include the microcontroller, biomedical smart sensors, and using Arduino Uno IDE and C++ program codes software sub-system.The following components were used:

1. **Esp8266 NodeMCUMicrocontroller:**Esp8266 NodeMCU has been used as the main control and sequencing unit. It is an open-source Lua-based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that is based on the ESP-12 module. Esp8266 NodeMCU has been used as the main control and sequencing unit. It is an open-source Lua-based firmware and development board specially targeted for IoT based Applications. It includes firmware that runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware that is based on the ESP-12 module.

The mission of Smart Doctor

- in as much as Smart Doctor provides a visual platform for interaction with their patient, Smart.

2. **Max30102 Pulse Oximeter & Heart-Rate Sensor:** MAX30102 Sensor is a highly integrated pulse oximetry and a heart-rate monitor module. The Analog Devices MAX30102 includes internal LEDs, photodetectors, optical elements, and low-noise electronics with ambient light rejection. This highly sensitive device operates on a single 1.8V power supply and a separate 5.0V power supply for the internal LEDs. Communication is through a standard I2C-compatible interface. This sensor can be shut down through software with zero standby current, allowing the power rails to remain powered at all times.This sensor has been used in this resource work to measure the Heart Rate, SP02(Blood oxygen concentration level), and the Temperature of a patient.Oxygen saturation (SpO2) is a measurement of how

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much oxygen your blood is carrying as a percentage of the maximum it can carry. For a healthy individual, the normal SpO2 should be between 96% to 99%. High altitudes and other factors may affect what is considered normal for a given individual.

3. **LM-35 Body temperature Sensor**:LM35 is used to measure the body temperature. Body temperature is a basic parameter for monitoring and diagnosing human health.

Software Sub-System:

The software sub-system was implemented using several software components and tools such as the Arduino Uno programming IDE and Programming Language. The implementation of this Smart system was done in Embedded C/C++ Programming language in Arduino Uno programming IDE. This language was chosen as it had been optimized for talking to machines. It is easier to access the pins on microcontrollers or other programmable chips and program them using C++ compared to other high-level programming languages like java, c# etc. The main component of the proposed system that is programmed is the LUA ESP8266 NodeMCUMicrocontroller. The code (sketch) is written in C/C++, verified (Compiled), and finally uploaded to the chip for all control. The sensor dataset was collected from the patients via wearable gadgets and stored online in the ThingSpeak Cloud server. The dataset can be accessed remotely by the doctor or any healthcare practitioner. Figures 4, 5 and 6 show the hardware construction tools, Smart Doctor's integrated system with all the hardware and power supply, and The Smart Doctor's ready for testingusing wearable respectively**.**

Figure 4: The smart Doctor's hardware construction tools

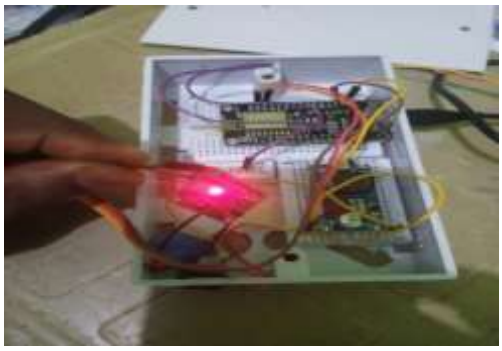

Figure 5: Smart Doctor's integrated system with all the hardware and power supply

Figure 6: The Smart Doctor's ready for testing using wearable

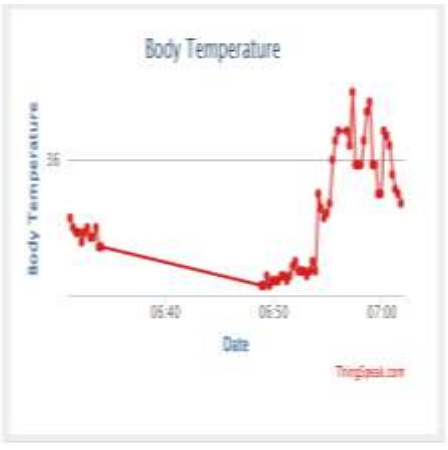

Figure 7: Body temperature reading in Thingspeak Cloud server

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Figure 8: Heart rate or pulse reading in Thingspeak Cloud server

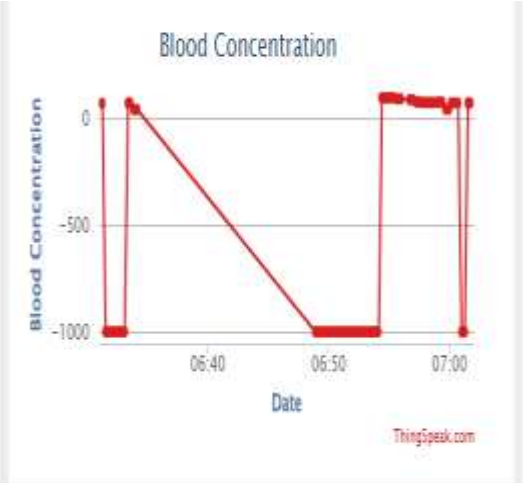

Figure 9: Blood oxygen concentration level reading in Thingspeak Cloud server

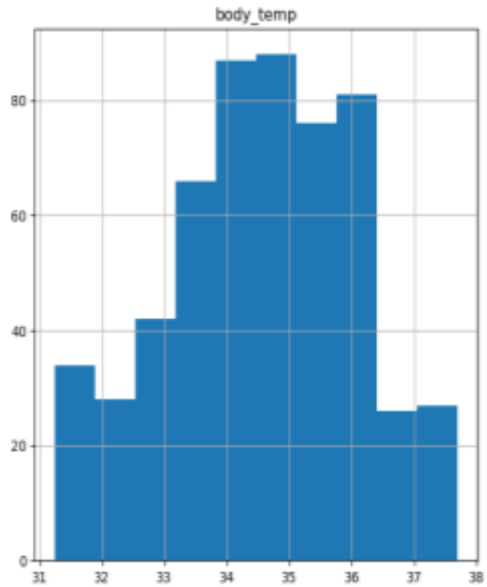

Figure 10: Histogram plot of body temperature readings in Python 3 programming environment

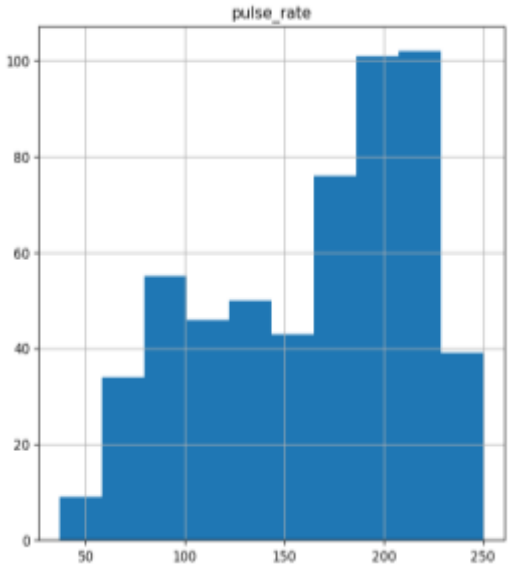

Figure 11: Histogram plot of pulse or heart rate readings in Python 3 programming environment

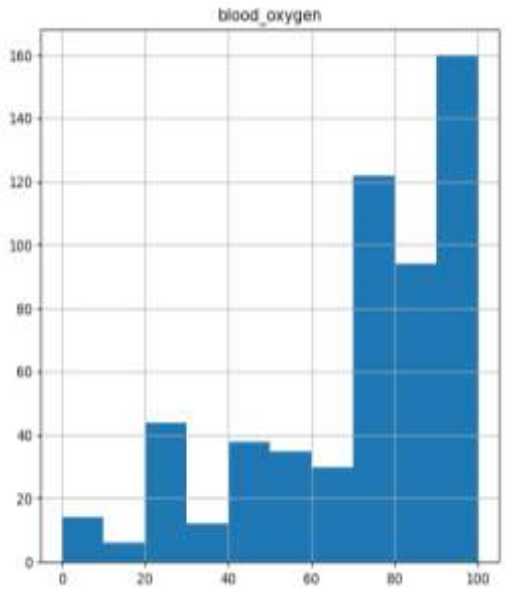

Figure 12: Histogram plot of blood oxygen concentration level readings in Python 3 programming environment

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MICROCONTRLLER VIA ARUDINO UDO IDE :

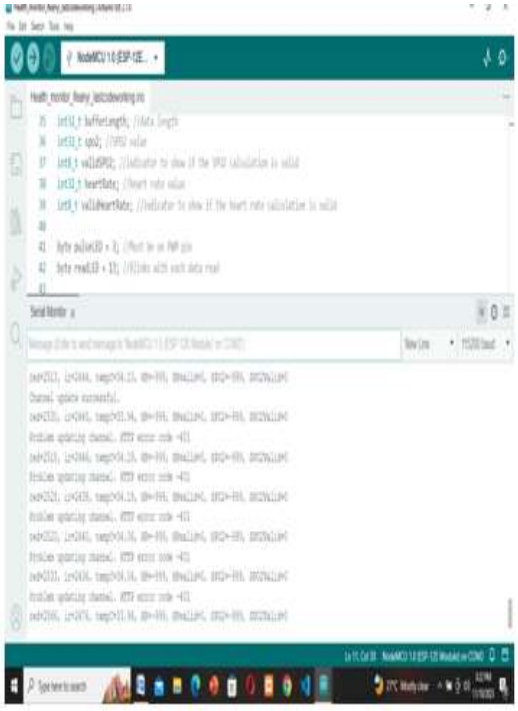

Figure 13: Software sub-system implementation using Arduino Uno programming environment

III. OBSERVATIONSAND RESULTS

After testing the Smart Doctor's IoT Health system to measure several patients' three basic health parameters such as body temperature, pulse or heart rate, and blood oxygen concentration or oxidation level, and storing the readings on the IoT ThingSpeak Cloud server, we can confidently say that Smart Doctor IoT Health system can measure basic health data smoothly and send the data to a human Doctor remotely by using an active internet connectivity.

The system was successfully implemented by using a wearable on the finger of the patient to measure the body temperature, heart rate, and blood oxygen situation level. Over 500 datasetswere obtained from different patients scattered in different locations in Enugu State, Nigeria.

IV. CONCLUSION

Health care is a system with the responsibility to alleviate human health-relatedissues through the help of qualified doctors andtrained health assistant workers. searching for where to obtain quality health care is a big challenge to our country, where we have our young and old leave the country for greener pastures and if you see one, he will overshoot his hospital fee to a height that a common can't access health. Smart doctors will ensure that doctors in the system don't take advantage of registered patients in the system. Smart doctors will ensure that redundant doctors will become busy by referring cases to them. This will reduce death among young and old in the country. Human and computer interaction should be taken seriously as user tends to rely on the internet to solve their problems and the design of any computer application should be attractive and appealing to the eye, should be made simple in other to increase human interaction to the computer system and applications.

In this paper, we implemented a Smart Doctor by coupling a NodeMCU microcontroller to three smart health sensors(that measure body temperature, heart pulse, and blood oxygen saturation level and stored the data obtained from patients remotely to an internet-basedcloud server. The dataset is then used by the Doctor who is not physically present to the patient to assess the patient's health and take immediate action.

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