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Health-IOT Platform That Integrates Unobtrusive Bio-Sensor and Smart Medication Box for Elderly People

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ABSTRACT

Health care challenges are steadily growing with the increase in the chronic diseases and ageing population. Quality health services are high in demand which necessitate to refine capabilities of hospitals and medical service providers with the intention of improving patient outcomes. These challenges have paved for integrating advanced technology like Internet of Things (IoT) in healthcare services. IoT in healthcare may greatly benefits ageing people who are not able to take care by themselves and needs a stable support, constant supervision and regular care. As a service to the ageing people in this paper we proposed a Health-IoT Platform that Integrates Smart Packaging, Unobtrusive Bio-Sensor and Smart Medication Box for Assessment of Adherence to Medication in the Elderly People. The proposed system consists of an IoT enabled medicine box which gives timely messages for the patients about their medication time. It alerts the patients to take medicines at the proper time by intimating an alert to their hand-held devices. The medicine details can be recorded in the mobile application by the patient himself or by the caretaker of the patient. The system helps to realm track of medicine intake, the stock of medicine and so on. As an outcome, patients are able to take their medicine on time, which help to monitor the time pattern to take the pills.

Keywords*---*Internet of Things, Unobtrusive Bio-Sensor, Smart Medication Box, Health-IoT Platform, Intelligent Medication.

I.INTRODUCTION

The progress of Internet of things in healthcare has changed the medical industry and is majorly benefiting the doctors, patients, hospitals, and health care service providers. The reason for this trend is that integrating IoT features into medical equipment greatly improves quality and effectiveness of service, bringing specifically high value for the ageing patients with chronic conditions, and those requiring constant supervision. In addition to this the satisfaction rate of patients is increased and remote interaction of patient and doctors makes them realize IoT as an efficient and comfortable choice.

Srinivas et al [1]proposed an intelligent medicine box along with sensors for monitoring health using IoT platform.An android wireless application which works as an intelligent home-based medicine box also aid in communication between patients and doctors. The intelligent medicine box gives timely alerts to the patients regarding their medication at prescribed time. At the right time the system automatically gives alarm to intimate the patient to consume prescribed medicines. It also alerts the guardian if any notable changes in the patient's behaviour. Minaam & Abd-ELfattah [2] proposed an idea for design and creation of pillbox to overcome the issues in medical area by sorting out the pills by itself which can be used in hospitals and retirement homes. This medication box is aimed to help the patients who regularly take medication pills, vitamin supplements and for attendants

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who deal with many patients with varied medications. The proposed medication pill box contains the total amount for the pill, number of times need to be consumed, timing when to consume which helps the care takers.

Bhati and Soni [3] proposed a smart medication box for the patients who take medications regularly with permanent diseases like diabetes, blood pressure, breathing problem, heart problems, cancer diseases etc and aged patients suffer from problems of forgetting to take pills on proper time which may cause certain health issues. Whether the patient had taken the pill or not, also the system will sense if the patient tries to postpone the time of taking pills.Shinde et al [4] proposed a smart pillbox with remind and consumption function which gives alert to the patient to take pills on prescribed time avoiding confusion among different medicines. The system is designed in such a way that it collects the feedback from the patients and place the order in medical shop.Zanjal and Talmale [5] discussed about the elderly people and people who are victim for chronic diseases who need to intake medicines daily basis may miss it due to their daily routine are finding .Reminding the patients to take pill on regular time and remote monitoring and updating new medicine data for the patients and caretaker is studied in this paper.

Yang et al [6] proposed an intelligent home – based platform ,the iHome -IoT which contains an open -platform based intelligent medicine box (iMedBox) this medicine box has ; intelligent pharmaceutical packaging (iMedPack) with communication capability authorized by passive radio-frequency identification (RFID) and actuation capability and a flexible and wearable bio-medical sensor device (Bio-Patch) authorized by the state-of-the-art inkjet printing technology and system-on-chip. da Silva et al [7] Presented an IoT application which is applied for smart medicine box which is of low cost compared with other smart medicine box which is already available and also meet the features like scalability, latency and time to response. The cost-effective medicine box employs edge computing for adding intermediate layer for improving the communication between the devices.

Tsai et al [8] Presented a Smart Pill Box (SPB) for aged people and nursing homes which uses the webduino module installed in SPB to achieve two-way messaging with remote relatives via internet of thing (IoT).Initially the module reads the sensing signal in the kit and makes use of WIFI to transmit the signal to the router and then it sends the medication information to a mobile device (cell phone).The care takers send a signal back to the Wi-Fi Router and then to Webduino module. After receiving the signal, Webduino will send it to Arduino for text display and voice playback in the SPB.With this application elderly people who are staying in home or nursing home institution can easily manage their medication using this application. Sung et al [9] proposed a medication reminder system using IoT platforms to help elderly people for tracking the medication schedule. The proposed medication reminder service consists of a pair of off-the-shelf pill bottle and container box embedded with an NFC tag and reader respectively, three types of actuators including a LIFX LED lightbulb, Musaic speaker, Microsoft Band 2, and smartphone applications. Maju and Abeera [10] proposed an IoT application in the health platform which contains sensors for reading the human heart rate in digital format and with this intelligent medical box with a light sensor to indicate the variations in the medicine slots by counting number tablets patients' needs to take and the time ,alarms if consumed the wrong medicine and it will also remind the time to take medicine by alerting the patient which can be widely used in old age homes for aged people.Similar IoT application for smart medication box is discussed in [11-15].Sensors and their separate applications towards health monitoring is discussed in [16 -20]

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The rest of the paper include following sections includes section ii) Internet of things for smart capsule kit, section iii) Proposed IoT enabled capsule kit with unobtrusive bio-sensing, section iv) Experimental results, section v) Conclusion.

II.INTERNET OF THINGS FOR SMART CAPSULE KIT

Internet of Things (IoT) appears as one of the best choices in health care which is deeply involved in saving human lives. IoT in health care industry considerably benefits several people's lives. Specifically, elderly people from old age homes and those who are not able to take care themselves and in need of constant supervision and regular care are benefitted by IoT healthcare platform. As the ageing population seems to be increasing day by day and it is very common that home health services are now becoming an essential element in healthcare industry. Aged people and people who are suffering with chronic diseases need to consume pills regularly at prescribed time. It is undoubtedly difficult for those patients to remember the time of intake of medicine and the name of medicine and so on. To overcome such difficulty for patients we proposed a Smart capsule kit in IoT platform that Integrates Smart Packaging, Unobtrusive Bio-Sensor and for Assessment of Adherence to Medication in the Elderly People'.

The vital aspect of the system is to send the notifications to the elderly and chronic patients about their timely intake of medicines

1. Dispense of medicines from capsule box at a scheduled time.
2. Medical alerts to the caretaker.
3. Generation of Online report about medicine.
4. Real-time health statistics monitoring of drugs.
5. Configuration data is sent through a mobile app.

III.PROPOSED IOT ENABLED CAPSULE KIT WITH UNOBTRUSIVE BIO-SENSING

Our smart medication box system is developed for, aiding aged people who are taking care of themselves in taking their medications. It is necessary that pills need to be consumed at the prescribed time and in the required amount which is easily taken care by our proposed smart capsule kit. It is very common that people are much engaged with their daily routine and distracted with many other things which in turn make them forget to consume their medicines at proper timings which may result in further health issues. Timely alerts and remainders from smart medication system can really be a helpful step for those patients. Most elderly people suffer with dementia which in turn direct them to consume medicines in irregular way which in turn leads to several unsuccessful health implications. Proper dosage is also another important factor needs to be considered, over intake of medicines may also lead to further health problems which needs further treatment. Another problem like intake of expired medicines may result with additional health issues. All these issues can be overcome by the proposed Smart capsule kit in IoT platform that Integrates Smart Packaging, Unobtrusive Bio-Sensor and for Assessment of Adherence to Medication in the Elderly People'.

The proposed system consists of an IoT enabled medicine box which gives timely messages for the patients about their medication time. It alerts the patients to take medicines at the proper time by intimating an alert to their hand-held devices. The medicine details can be recorded in the mobile application by the patient himself or by the caretaker of the patient. The system helps to realm track of

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medicine intake, the stock of medicine and so on. As an outcome, patients are able to take their medicine on time, which help to monitor the time pattern to take the pill.

3.1 FUNCTIONALITIES OF THE SMART CAPSULE KIT

The 3 major functionalities of the system are:

1. In "caretaker" mode, the user can save the details about the medicine to take, timings and dosage.

2. The self-alerting the user about medicine timing and notifications to the caretaker.

3. Providing Cloud-based access to the caretakers where they can customize the holder.

3.2 ARCHITECTURE OF SMART CAPSULE KIT

There are several compartments available in an IoT enabled Capsule-kit. It was designed in such a way that elderly or normal people can use it effortlessly for their medicinal purpose. The capsule-kit comprises of sensors for observing and reporting the atmosphere state and its correlated control software, which recurrently checks the medicine is taken on time or not. Whenever the drug is loaded into the Capsule-kit it will be updated and the data will be stored in the database. Capsule-kit contains Arduino Uno R3 which is an open-source electronics platform and Arduino boards are incapable of reading inputs and turn it into an output, for example turning LED onetc.

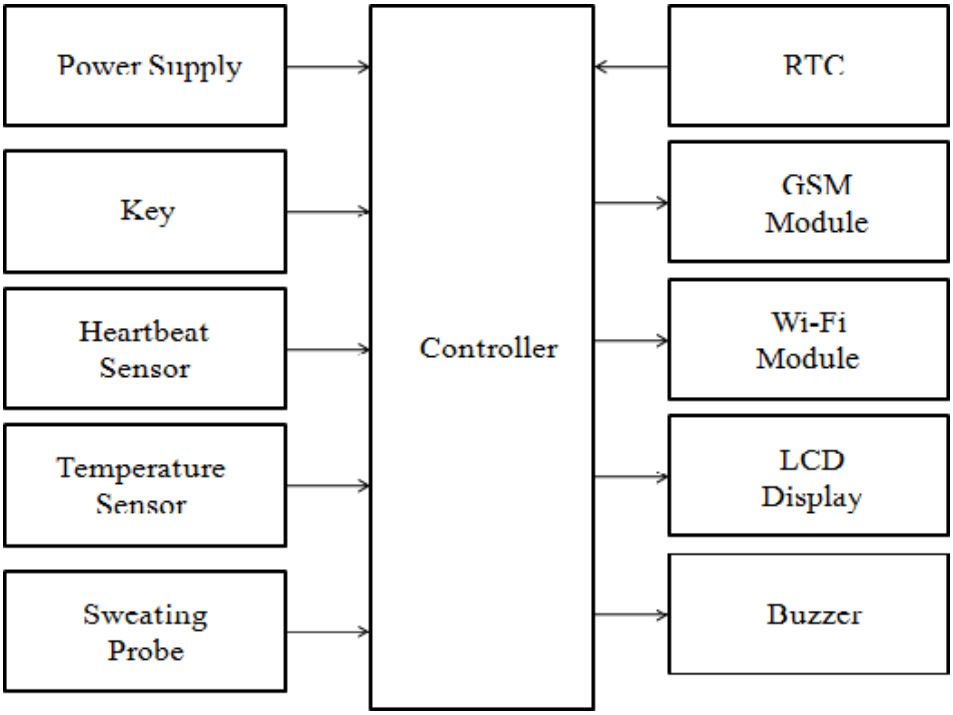

Figure 1. Architecture of Bio-Sensor and Smart Medication Box

Consumer or pill taker can control the board by sending a set of instructions to the microcontroller on the board. He should register with device ID on this device, before using it. The

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same device cannot be used for two different consumers or users to register. The consumer should maintain a username and password authentication using the device ID. A drug taker should register with the application and the IOT device to start using it. The access should be provided to the pill taker to set a medicine reminder and other functionalities. After logging to the device, he will get the compartment's detail and availability status of the medicine. There will be an alarm system in the Capsule-kit which alerts the patient to take the medicine on time. It also indicates the consumer about which medicine to take by that time. The caretaker of the elderly patient will also get notifications by using the mobile application. The device will read the details from the database and generates the notifications to the pill taker to take the drug and it also transmits a notification message to the mobile application. A message consisting of medical data and time stamp will be displayed. The caretaker will get an alert message whenever the medicine stock reaches a predefined minimum level of medicine. The system will read the data from the database and generates the reminder to the user indicating available medicine stock in the Capsule-kit. A report will display a message consisting of medical info and available inventory of medicines.

Heart Beat Sensor: The Heart Beat Sensor is designed to provide digital output of heart beat when a finger is placed on it. When the Heart detector starts working, the top most LED will starts flashing with every heartbeat. The output of this sensor can be connected to Micro Controller directly to measure the heart Beat Per Minute (BPM) rate. It functions on the principle of light modulation by blood flow through the nerves of the finger at every pulse. The module output mode, Digital output mode is simple, Serial Output is with exact reading.

Temperature Sensor: LM35 is used for the sense body temperature. Body temperature is a basic parameter for monitoring and diagnosing human health.

GSM Module: This is a very low cost and simple Arduino GSM and GPRS shield. We use the module SIMCom SIM900A. The Shield connects your Arduino to the internet using the GPRS wireless network. Just plug this module onto your Arduino board, plug in a SIM card from an operator offering GPRS coverage and follow a few simple instructions to start controlling your world through the internet. You can also make/receive voice and send/receive SMS messages.

3.3UNOBTRUSIVE BIO-SENSOR

Unobtrusive Bio-sensor is used for continuous monitoring of physical activities, behaviours and also physiological and biochemical parameters. The Primary habitual measurements include heart rate, Blood pressure, ECG, oxygen saturation level, temperature, movements and physical activities of the patient. Sensing with unobtrusive sensor can be executed in two ways 1. Sensors worn by the patient e.g. clothes, gloves, wrist watch, shoes, specs 2. Sensors can be embedded in other objects with which the patient interacts chair, sofa, bed, mattresses, steering. Information from the sensor can be collected by a smartphone and transmitted to a remote device for storage and analysis. Unobtrusive Strain sensors helps to measure body motion such as respiration, heart sound and BCG. It also includes evaluating health-related indexes that are risky to measure unobtrusively by using a combination of various physiological signals measured in a non-invasive and unobtrusive manner. Unobtrusive sensing technologies, which can be implemented in the form of wearables and IoT devices, may be a good solution for the future healthcare, but these sensor signals are of low- quality which is difficult in retrieving and processing.

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IV. EXPERIMENTAL RESULTS

The proposed smart capsule kit uses Arduino Uno R3 which is a type of ATmega328P based microcontroller board. It includes the necessary features to hold up the microcontroller. It can be used by attaching it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery. The R3 Arduino Uno is the 3rd as well as most recent modification of the Arduino Uno. Our smart capsule kit is tested in home environment and carried out the evaluation of different pills management and generating alerts are tested with an elderly patient with basic authentication of patient name and password .The estimation clearly shows that our system clearly distinct pill name and mg variation (10mg,50mg,200mg) with the use of RTC alerts are given for the patient at prescribed time additionally the ardino module detects the temperature and heartbeat of authenticated elderly patient and thus our smart capsule kit is a better choice for home environment.

V.CONCLUSION

The IoT enabled smart capsule kit which works with the basic authentication using the patient name and password helps to set medicine remainder and other related functionalities like availability of the medicine, alerts during prescribed medicine intake time for the patient, the name of the medicine to be taken at that particular time. The smart medication kit also sends timely alerts or notification to the care takers who are remote location via the mobile application. To improve safety and to avoid confusion in consuming the medicines among the elderly people our smart capsule kit will be a best choice in home care needs and old age homes.

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