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Brewing Heterogeneous Devices for Monitoring Cerebrovascular Oxygenation

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ABSTRACT

Technologies encumbering Wireless Sensor Network with its effulgence and ubiquity in Sensing plays a dominant role in Health care industry and Health monitoring System. Impeccable blending of Actuators and networking them for a viable communication across varied platforms paves gateway for triumphant IoT solution. IoT plays a predominant role in revitalizing the healthcare sector with appendages of several smart devices deliberated to facilitate medicos, surgeons and subjects to monitor each and every aspect of their health. Customary health checkups allow patients to distinguish health issues sooner and get treatment accordingly. IoT offers a cost effective solution adjunct with a timely intervention.

Keywords: Internet of Things (IoT); Traumatic Brain Injury (TBI); Hypoxia, Anoxia; Wearable devices; $Pbto_2$

1. INTRODUCTION

The Internet of Things (IoT) is one of the most sophisticated technologies that has the potential in effecting the health, safety, efficiency of replacing billions of people thereby

having a major economic impact. It is a conglomeration of physical objects which are embedded with sensors, actuators, computing and data communication devices. The final assortment is coupled to networks for data transportation. Heterogeneous resources can be cumulated and abstracted according to tailored requirements, thus enabling Things as a Service prototype, or "Cloud of Things"

2. TRAUMATIC BRAIN INJURY (TBI)

Traumatic Brain Injury is defined as brain and head injury which leads to one of traumatic consequences like concussion, contusion, Coup-Contrecoup, Penetration and Acquired Brain Injury (ABI) [1]. Traumatic Brain Injury (TBI) is a silent pandemic of recent times, as unidentified head injury patients are usually neglected until the outcomes are somber. It is very difficult to owe an adequate standardization, capture on data of incidence rate caused by TBI and swerving quantification of the burden caused by TBI. TBI leads to serious conditions like Anoxia and Hypoxia. Anoxic Brain Injury is an outcome when the brain does not receive any oxygen and Hypoxic Brain Injury is a consequence when the brain receives some, but not enough oxygen. Such irksome effects even sometimes lead to fatal bereavement i.e. death. Rehabilitating patients after post hospitalization under such a grave condition is fraught with challenges. Concocting devices to ascertain surveillance is the need of hour for these recuperating patients. A rehabilitation support of social workers or caretakers can be reinstated by the state-of-art devices.

3. METHODOLOGY

Cerebral Oxygenation evaluates the balance between oxygen delivery and consumption. Oxygen guided Management could lead to improve neurological outcome

4. $PBTO_2$ MONITORING

$Pbto_2$ monitoring technology has been used in varied number of functionalities like brain tumor surgery. It has also been used for continued postoperative monitoring. This representation is noteworthy because it demonstrates technology that can be safely used in subjects undergoing physical exercises. It also demonstrates the cortical hyper oxygenation in a human breathing natural air without oxygen supplemental [2]. $Pbto_2$ is a sensor consisting of 2 electrodes is placed in the brain. A polarographic electrode which continuously measures real time $Pbto_2$ in blood tissue

5. BRAIN TISSUE OXYGENATION

Tissue Oxygenation and Hemoglobin concentration are sensitive indicators of tissue status. Tissue oxygenation is determined by incessant and mellifluous flow of oxygen, which in turn is reflected by product of blood flow and oxygen content and consumption. The golden

standard for continuous oxygen monitoring is by inflicting an intraparenchymal probe and enforcing a direct measurement of local $PbtO_2$. As the measure of oxygen is highly dependent on the locality of probe, a closed polarographic clark type electrode is imposed over a tissue area of around $15mm^3$ in order to streamline the brain blood flow and metabolism heterogeneity. Oxygen disseminates into the permeable membrane adjoining the probe and enters into an electrolyte solution thereby creating an electrical and projects percentage of oxygen's existence in blood such that which the probe is able to measure an area of $18mm^2$. A viable solution to augment monitoring is by acquiring strengthened signals to interpret the readings is by placing the probes in white matter or it can be a choice of the neurosurgeon. Normal range is and $PbtO_2$ <15 mmHg is considered. When Brain Hypoxia ($PbtO_2$ <10-15 mmHg) is associated with worse conditions and increases the likelihood of death after severe TBI. According to the history the normal range for a rivulet blood flow is 25-50 mmHg. When the observation of $PbtO_2$ <15 mmHg it indicates critical threshold for Hypoxia. With further decrease in values it is possible to realize detrimental effects ensuing Brain Hypoxia and Anoxia. The microcontroller designed to be used for this work is a wearable device which has a LCD to view and monitor the values of $PbtO_2$. The microcontroller is programmed in such a way that when the threshold value or critical value is reached, it alerts the subject.

6. MICROCONTROLLER

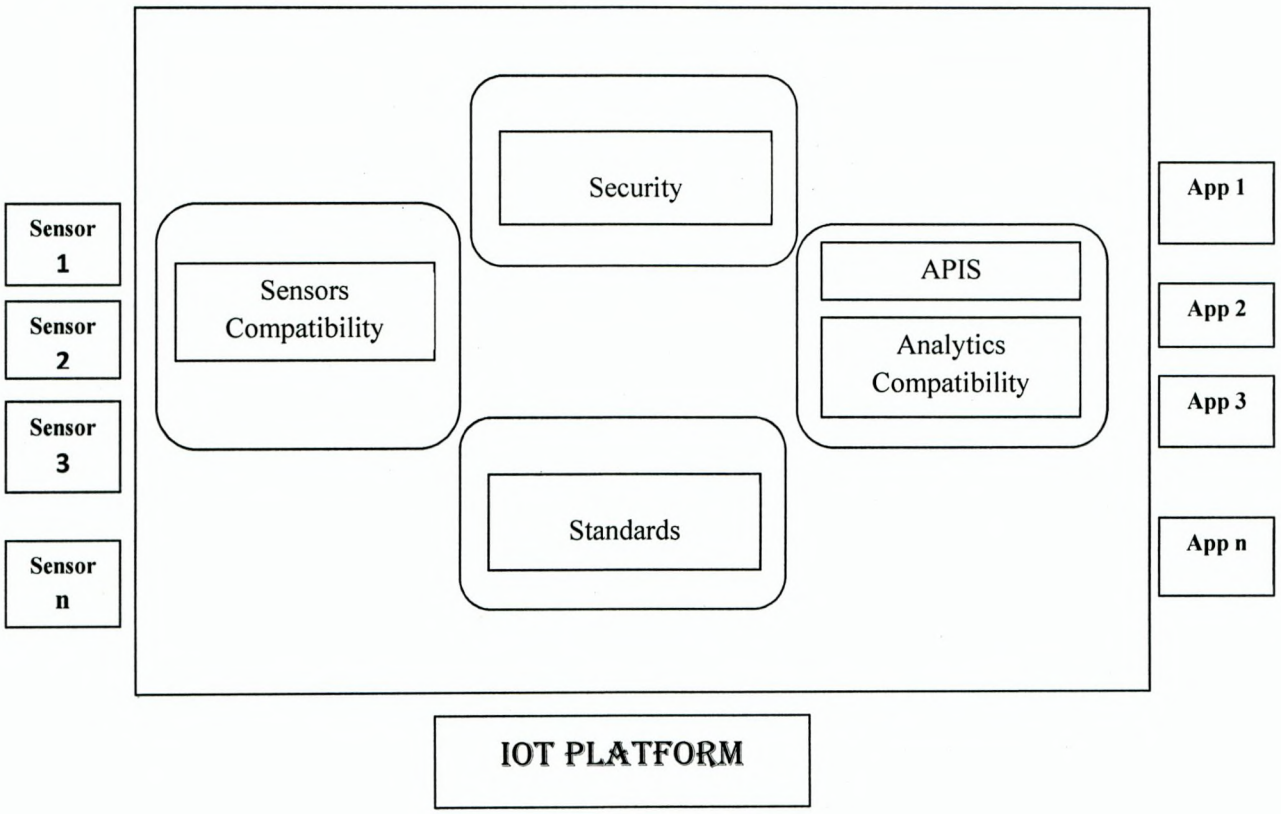

Figure 1. Platorm of IoT.

As microcontroller plays an imperative role in designing an application, some of the factors considered in choosing a pertinent microcontroller are:

- Calculation of data available from PbtO2
- Supporting LED to view the values in the wearable unit
- Transmitter used to convert analog to Digital values
- Harmonizing with a Bluetooth's Receiver
- Miniscule Size of microcontroller with utmost number of pins

Arduino pro microcontroller outfits to all the aforementioned criterion .The next paramount matter of contemplation is to probe into different communication standards. Bluetooth standard attires the mode of communication which builds a wireless bridge between the microcontroller and phone application. Microcontroller program was developed in Arduino IDE an open source Arduino environment. Illustration of how a platform for IoT can be fabricated is given below

7. BLUETOOTH COMMUNICATION

The cerebral data which is of vital importance and processed by microcontroller is to be transferred to user's android device [3]. As the distance between the microcontroller and device is stable and short employing Bluetooth as a wireless technology standard for exchanging data. This communication uses short wavelength UHF radio waves in the unlicensed industrial scientific and medical ISM band from 2.4 to 2.485 GHz from fixed and mobile devices.

After establishing a connection between Microcontroller and Bluetooth data is being sent via Bluetooth. Communication path is established and the calculated values exit from Microcontroller's Transmitter pin T_xD and reach the Bluetooth's Receiver pin R_xD. Thus transfer takes place in the android device. The real intricacy lies in Bluetooth communication and following are the essentialities in deriving one:

- Setting up Bluetooth connection
- Tracing out devices and checking out if they are either paired or available in local area.
- Connecting to the available device
- Transferring data to the device

To implement the tasks, we need to call several classes and interfaces such as Bluetooth Adapter, Bluetooth Socket, Bluetooth server socket and Bluetooth profile Next.

8. ANDROID APPLICATION

These days' mobile phones are very much dependable, reliable, very easy to handle and can be equipped with software features and in order to make the best use of the features a phone app was designed that incorporates Google android OS. The predominant feature of using Android OS is the liberty it offers in invoking Bluetooth APIs. An android phone application connects with the Bluetooth and is used for real time record of oxygen saturation.

Another function that was included in the application is that we can send the result to another phone. The hardware and software were integrated is an intertwining of $Pbto_2$ sensor, wearable micro-controller and fully fine wearable devices.

To develop the app an integrated Device Enterprise Eclipse IDE is used which contains a base workspace and extensible plug – in system which helps in tailoring to the needs of the user. The language used is Java. After combining the phone app with the system, the project is more usable. The function of our phone app is to record real time O_2 saturation data by clicking the connect button on user interface and by tapping the send button the result can be sent directly to android phone by using text messages [4].

9. CONCLUSION

TBI in India is a significant social and financial burden which requires prioritized attention and urgent therapeutic intervention. The mortality rate ought to be reduced with better structured systems of trauma care. TBI is an issue that requires a gamut of acute care. A post trauma consequence like Hypoxia and Anoxia can be put under surveillance with cost – effective planning and tools. One such tool is to delve the usability of Heterogeneous devices to acclimatize a system to provide universal emergency care at a right time. Cost-effectiveness should be the concern while designing the tool. The currently designed tool brewing Heterogeneous devices facilitating android application support is an appropriate one and offers a gamut of the functionality support and care for a post Traumatic Brain Injury patients.

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