STUDY OF CONTEXT REQUIREMENTS AND SPECIFICATIONS FOR NEONATAL HEALTH MONITORING SYSTEM: SIDS CARE AT HOME

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ABSTRACT:

The hand hold and mobile equipment with context awareness is part of the today's health care scenario. Specially the country like India where the health care resources are having the limitations with number of professional, clinics, hospitals at rural area, researcher have lot of potential to develop IOT base health care applications and monitoring systems. The IOT base monitoring system are support system to avoid hospitalization for the Neonates in cases of SIDS. Continuous surveillance and physiological data availability without any disturbance in daily life is the need of such patients and their care takers. Mobile devices has no context barriers for surveillance and data transmission. Using easily available IOT services for monitoring of care of infant at home is the main concept of this research.

Keywords: *SIDS, IOT, Biosensors, Distributed ICT, Neonatal health care, Context awareness, WLAN, WPAN, and WBAN.*

1. INTRODUCTION

Internet of Things bringing innovative ways changes in the system architecture and service based systems. This proposed systems endeavours the new practices in neonatal care to prevent the Sudden Infant Death Syndrome (SIDS) which is also known as cot death or crib death is sudden unexplained death of a child less than the age of 180 days (i.e. 2-4 months) of age usually occurs during sleep .The gateway for data acquisition through temperature sensors and pulse oximeter (or respiratory) sensors with IoT can avoid such accidental deaths. As most of the time the baby in normal health condition and at home it is under parental care, hence to monitor the baby at home, IoT could provide the best and cheapest solution [1].

Many devices and techniques are available for the respiratory and temperature monitoring. The stethoscope and thermometer are very basic devices modified up to oximeter sensors and temperature sensor, in today's era. Now a day's medical science facilitate personal care through technology. NICU and ICU are well equipped with such resources. But when the question is of neonatal care at home in SIDS syndrome the care solutions are not available. Neonatal care is previously discussed by various researcher, here I am reviewing technical solution provided previously. The proposed system is conceptual model of requirement and specification is facilitate the healthcare from remote places also i.e. parents may monitor the baby's respiratory pattern from their work places, at hospital and at home.

2. Purpose:

The purpose of the system is to provide a monitoring system at home where parents could get alarms of SIDS system without disturbing the natural growth environment of infant**.** Parents could get simple alerts about the babies pulse rate, body temperature so precautionary measures can be taken before to get the proper medical help. The data is going to be captured continuously by sensors and

microcontrollers alerts are going to passed on mobile. The system is helping to the working parents in monitoring the above mentioned parameters where baby is in care of nanny or employed care taker or at day care or when they are not in direct contact. On the basis of above purpose the basic objectives of the system are as given below.

1. To identify the requirements of sensors in the Sudden Infant Death Syndrome.
2. To choose the suitable algorithm for retrieving data and to demonstrate it using simulation.
3. Parsing and visualisation of the collected data.
4. To provide remote accessibility of analysed data through internet and alarming for critical events.
5. An architecture is to be conceptually designed to build a robust, scalable monitoring system.

These objectives will be basis for further software and hardware requirement and specification.

Fig.1 Functions performed by Monitoring System

3. Overview

With Internet of Things medical profession list and technologist are trying to merge the various environment together to build a strong monitoring system. Connection of things to internet with standard protocols and suitable architectural changes facilitate unobtrusive health monitoring for all day and any place [2]. In this context various monitoring system for neonatal care are and adults are discussed in literature review

Here I 'm summarising work done by few researcher, C. Wei et al., the team develop a smart jacket with sensors, BlueSMiRF and Arduino pro mini. This is a wireless system which can successfully cover the transmission of data within the range of 20m.Sytem is develop considering the non-invasive care for fragile infants [3]. C. Oriana et al., given a prototype in clinical context for premature babies. The prototype is recording and monitoring ECG, temperature and respiratory activities. The unit is consist of a sensitised belt with chest dilation monitoring and aided with extrinsic transducers for temperature and respiratory activities. The device can process the signals and samples are transmitted via Bluetooth technology. Receiver is a PC with a software for accepting transmitted data. Neurological long term outcomes, reliable data handling and stress reduction provides real time behavioural organisation of premature infants [4]. S.Victor et al., identifying the impact of sensor development and combining it with the RF technology and CodeBlue software is discussed in the paper. This is a query based software and validate all the experiments served with the sensors like MicaZ, Telos mote designs, motion-activity, EKG and pulse oximeter. This prototype system is based on publish/subscribe routing substrate which is validating 30-node sensor network. Also testing the scalability and robustness of handling simultaneous queries, data rate, and transmission of sensory data. The effectiveness multiple paths, patterns of packets loss, system's ability to sustain despite of change in location and various

data rate. The future work concern to maintain the alarming priority when numerous patients are monitored [5]. E.Gronvall et al., in this article assembly of heterogeneous platform is discussed prior to introduce the concept of IOT. The system developed is allow end user composition and control. The environment of different devices, services and processes concurrently enhance monitoring process. The importance is given to the flexibility and end-user control by assembling various technologies for NICU [6].

A. Fabiola, develop a respiratory belt and test the relationship between belt expansion and voltage generated. Using MATLAB software the simulating the results of respiratory sensor belt based on periodical expansion and extraction of a plastic container. The construction of respiratory sensor PR2012 with its features like physical dimensions and displacement is discussed. The sensor testing is done and results given in analytics [7]. O.M. Sumanthi et.al. focus on wireless transmission technology used in neonatal care for infants admitted in NICU.

The wires and adhesive electrodes were no longer agree in neonatal care which crate an obstacle in handling the fragile patient .To achieve this a ZigBee based wireless sensor technology with Arduino and ATMEGA 328P microcontroller is developed. The system is improving quality medical care and data [8]. B. Hadi et al., focused on the data mining task for wearable sensor. With significant use of sensor in health monitoring system it is must to analyse the data separately with the special task algorithms. These are mainly focus on prediction, anomaly detection and subtask like decision making for diagnosis, raising alarms. Support vector machines, Wavelet analysis, Decision tree, Gaussian Mixture, Markov models are used for anomaly detection. Finding abnormalities in regular patterns of ECG pulse, SpO_2, and blood glucose are few example of the anomaly detection. This is very useful in finding stress level and sleeping disorders. Instant reaction of life saving alarms are proven measures. Continuous data pattern are useful in decision making for prolong treatments. Data about raise and downs of parameters in certain time period or external environment can be noticed. Evidence base context aware medication can be decided on the basis of these data pattern or predictions [9].

Nangalia V. et al., discuss the tele monitoring system with the five components data acquisition unit, transmission of data, data integration with other data about the status of patient, synthesis of appropriate actions or response or escalation in care of the patient and decision support and the last one is storage of data. Limited use of tele monitoring shows it has to go far away. Lake of full range sensors, battery life, and available bandwidth/radio signals, network coverage limitations, cost of data transmission are also the obstacles in adapting tele monitoring for health care[10]. Ramezani T. et al., discussed the how family centred care is important in premature or early birth babies.400000 American families undergoes with premature births annually. In such cases hospitalisation may cause delay in parental-neonatal attachment. Neonate's behaviour pattern will decide the neonate centred care so that isolation from the family will not lead to anxieties [11].

These are few examples focusing on various dimensions of health monitoring systems. Monitoring systems are playing a

vital role as lifesaving and alert system, doctors and care givers can plan precautionary measure with present status of data.

4. Understandin Context Requirement for Neonatal health monitoring system

With easy assembly of context aware equipments, monitoring system implementation is possible in any environment. This is distinguish feature of the IOT which is supporting in health care monitoring system. IOT supports some forms of artificial intelligence such as,

- Incomplete and non-deterministic interactions.
- Richer interaction through sharing of context, semantics and goals.

Seamless computer enabled environment is represented by IOT thus interleaved into the world where people live, work, play or entertained etc. Mark Weiser's vision to bring the digital technology more interactive yet more non-obtrusive and pervasive [2].

While modelling neonatal monitoring system three important things related to external environment,

- Physical environment :This should include some physical dimensions like location, time, temperature
- Human Environment : Interactions decided by user constrained, terms of identity, user experience and requirements, priorities as a type of user (a service provider and mediators),
- ICT context: A component in a distributed system is aware of the services available internally and externally, locally and remotely i.e. a virtual environment.

A greater awareness of the immediate physical environment could increase the throughput and access of resources. User awareness, Active or Passive Context awareness are also equally important in modelling a monitoring systems [12]. For example, who is participating as user? Here in neonatal monitoring and care parents/care givers and infants are participating, parents/care givers are applying sensors for the acquisitions of physiological parameter of infants. The physical environment represents the home or room i.e. location and ICT context is bandwidth signals consumed for communication purpose of overlapping environments.

The DEI Components like smart device, environment and interactions can provide the best model for monitoring system [2].Other than these there are six modelling option can be compare for the context modelling such as key-value, mark-up schemes, graphical, object based, logic based, and ontology based modelling[13].

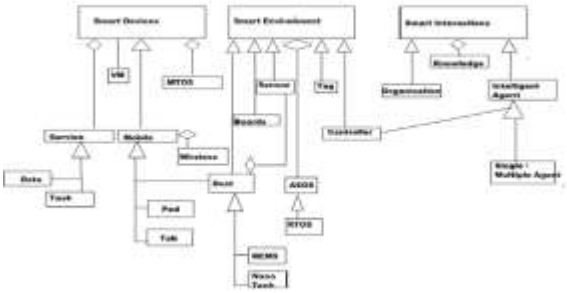

Fig 2.Smart DEI Model for Neonatal Health monitoring system.

5. Technology Specification available for Neonatal Health Monitoring.

The base technology supporting neonatal monitoring system may be any with the latest trends of wireless

communication i.e. 3G and beyond, WiFi mesh and WiMAX is coming under the large scale wireless network and mobile computing solution. For data transmission in different context many solutions with pervasive computing are available like RFID, Bluetooth, ZigBee and WSN. WiMAX has different deployment domain, with high data rate of 70Mbps and security over long distance, it is a proven solution of communication with IEEE 802.16 standards. Also supporting to the advances in radio transmission technologies AMC, FEC, QoS and OFDM [14]. WLAN is oldest wireless technology developed with many extensions of standards since 1997 and serving up to the throughput of 200 mpbs and transmission on 2,4GHz band. WLAN providing wireless technology to almost US hospitals. WPAN is personal area network popularly known as ZigBee (IEEE 802.15.4) and Bluetooth. These are the most affordable solutions for Neonatal monitoring. Because of the feature of mobility, tracking of the data from other devices is ease with WPAN [5]. Most important is that it replaces the wires from a room for non-obstructive neonatal monitoring. WBAN is wireless body area network, it is having body integrated devices. These devices are low powered or ultra-low powered, tiny, lightweight physiological sensors or ICs. Real time data integration of these devices with ZigBee and Bluetooth are providing basis for computer assisted rehabilitation [15]. Along with these many other standards and technologies are used with medical applications RFID, 3G, 4G, sensor network etc. [16]. Neonatal care monitoring with special customised approach by using optimum services and medications in treatments is possible with the Technology.

With various applications in global market, the idea of significant industrial standards for medical applications is coming up. The industrial standards like IEEE, Bluetooth SIG, ISO, ASTM is developing or developed by research community for the medical equipment with wireless applications.

6. Identifying Challenges in designing a Neonatal Monitoring System:

Considering the neonatal care, tender and fragile babies' preference is to provide a non obstructive surveillance with maintaining natural environment is the main challenge. This will also help to select proper technical/network specification for the neonatal monitoring system.

There are several research challenges with various *anatomy of networks*, *fault tolerance*, data integrity, low power consumption, transmission delay and node failure etc. [17].With high risk patients the services are incorporated with higher QoS should be used. *Reliability* is important issue in neonatal healthcare. Different modes of network communication should be opted in appropriate situations. Ensuring smooth functioning of sensor nodes and network is the main issue in neonatal monitoring. The *computation* related challenge includes the *Context awareness study* as device can be operate differently in different situation, specially sensor devices, inter-operatibilty of devices and human response issues. Rather than these the other communication system related challenges such as network delays, radio wave interference, battery exhaustion or power management, guaranteed security and privacy issues. To overcome these challenges and provide

worth applications developers and research are taking lots of efforts [13].

7. Functional requirements on the basis of objectives:

System have to perform following function on the basis of above objectives and context [18].

Req1: Data Acquisition will be performed by multiple wearable sensors that measures physic logical biomarks, such as skin temperature and respiratory rate as well as posture. For data acquisition sensors should be connected to the network through an intermediate data aggregator which would be typically a smartphone located nearby patient.

Req2.: Data Transmission component of the system will be responsible for conveying recordings of the infants to the server where data will be secure. The sensory acquisition plate is equipped with a short range radio such as lower power Bluetooth, which it uses to transfer the data to concentrator. This data transfer relay to the parameters or/and server via smartphones WiFi or cellular data connection.

Req3: The two distinct-components can be maintain here through network processing storage and **analytics**. The system will store the details from above mentioned parameters which will be helpful in diagnosis. The data can be mined with essential frame work and used by individuals for machine learning and further experiences to process the knowledge.

Req4: If the abnormalities are going to be measured by simulated values then mobile phones will provide **alarms** to the users via device. These alerts will helpful to take precautionary measures in certain critical situations like changing the position of body by identifying wrong sleeping position or postures no sensation in respiration for given (say 10 seconds) seconds of time or/and drop or raise in temperature . Special program will be designed to raise the alarms and also tests alerts can be send via mobile devices.

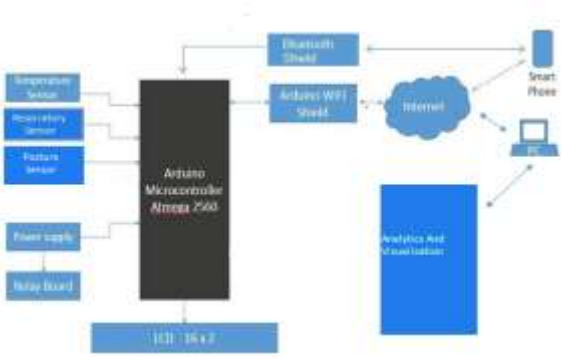

Fig3. Conceptual design for Neonatal Monitoring System on the basis of functional requirements.

8. Conclusion: The conceptual design of Neonatal monitoring system by surveying various updated options of technical specification is given in the above paper. An architecture with affordable and flexible home care and monitoring system using smart phone is proposed. Using Bluetooth and web server to communicate between remote users and home devices. The system will be useful to identify the risk in the SIDS. Early detection in unusual and irregular breathing pattern will helpful in parental guidance and precautionary activities can be planned. Reliability of the system is subject to execution of the system and medical information.

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