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Context Aware Computing: IOT for Neonatal Health Monitoring

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Abstract

Bringing radical changes in human life, Information Technology is integral part of human life. Common man can't imagine the life without digital machines and internet. Every sector having impact of these changes on it. Human kind always use technology to secure the health benefits. Technology is not only helping to improve the essential health services with various applications but also supporting with data for predicative and comprehensive analysis. Pervasive health care solutions are minimizing the workload of care giver and hospitals. Also potential manpower can be used for the intensive care and most priority patients with the help of ubiquitous surveillance and monitoring system. Demand of contemporary era is to provide the quality care for infants of working parents. The energy efficient, scalable, secure, cost effective, easy to use and unobtrusive designs are in demand to handle the challenges in health care. This paper discussing the review of existing health monitoring system with special reference to neonatal care and also emphasizing on major challenges.

Keywords: Biosensors, Distributed ICT, NHMS, Context awareness, WLAN, WPAN, and WBAN.

I. INTRODUCTION

Present technology is aided smart health centers with real time data and pervasive computing which are supporting for ambient living .Wireless sensor network assisting in various health care solution by measuring physiological parameters .Patients care in chronical diseases as well in elderly and infants is possible with potential technology and devices. This paper providing the horizontal overview of health monitoring systems for neonatal care and role of IOT. Literature review covers almost aspects of health monitoring system like summery of relevant technical protocols, application issue, quality of service and current requirements. There are many new opportunities and possibilities of improvements in health care if the information is well managed. IOT based Monitoring system imparting a key role in radical transformation of health care along with the drugs evolutions.

A. *ICT features supporting to Health Monitoring System*

As per the need monitoring system should be the cluster of multiple environments. The environment may include human-centered, personal social and economic environments as well as physical environment of living things (ecologies) and inanimate physical phenomena. Researcher's biggest challenge is to combining these context with computing properties without disturbing its individuality. Any monitoring system should have the significant features of distributed ICT systems given below [2],

1) Computer need to be networked, distributed and transparently accessible.
2) Human computer interaction needs to be kept more hidden.
3) Context aware computing.
4) Computer should handle multiplicity of dynamic actions and interactions, governed by artificial intelligence and special architectural designs.

II. INTERNET OF THINGS

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. In this context various monitoring system for neonatal care are and adults are discussed in literature review.

A. Health Monitoring Systems

Modernized patient centered monitoring system is the need of today's health care. Neonatal care is very sensitive issue considering at most care required in this phase of life although baby is normal or at risks. Every parent is thinking about that, their just born tiny, fragile and tender baby should get pain free and non-disrupting care. Advancements in designing and development of wearable biosensors, bio-sensing devices, microelectronics, cameras, image processing and wireless communication

motivating the practices of technology in neonatal surveillance [1].Here we are summarizing work done by few researcher, C. Wei et al., the team develop a smart jacket with sensors, BlueSMiRF and Arduino pro mini. This cover the transmission of data within the range of 20m and sufficient for 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 via sensor and Bluetooth technology [4]. S.Victor et al., identifying impact of sensor development and combining it with the RF technology and CodeBlue software is discussed in the paper. A query based software and validate all the experiments served with the sensors like MicaZ, Telos mote designs, motion-activity, EKG and pulse oximeter. The effectiveness is 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 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[8]. B. Hadi et al., focused on the data mining task for wearable sensor. To analyse the data separately with the special task algorithms. These focused 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 [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. 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 importantance family centered care in premature births. In such cases hospitalization may cause delay in parental-neonatal attachment. Neonate's behavior pattern will decide the neonate centered care so that isolation from the family will not lead to anxieties [11]. Few examples of health monitoring systems are discussed here.

B. Need of NHMS

Most of the systems are for hospitals ICU or NICU and having heavy set of equipments. Considering the limitations of hospitalization in case of space and cost of quality caring options at home care with monitoring system are come up. Neonatal care of a normal or premature child with the health issues such as underweight, SIDS cases that are manageable at home and with continuous communication with clinical centers. On the basis of task of monitoring system it can be depict as shown in [9] fig1.

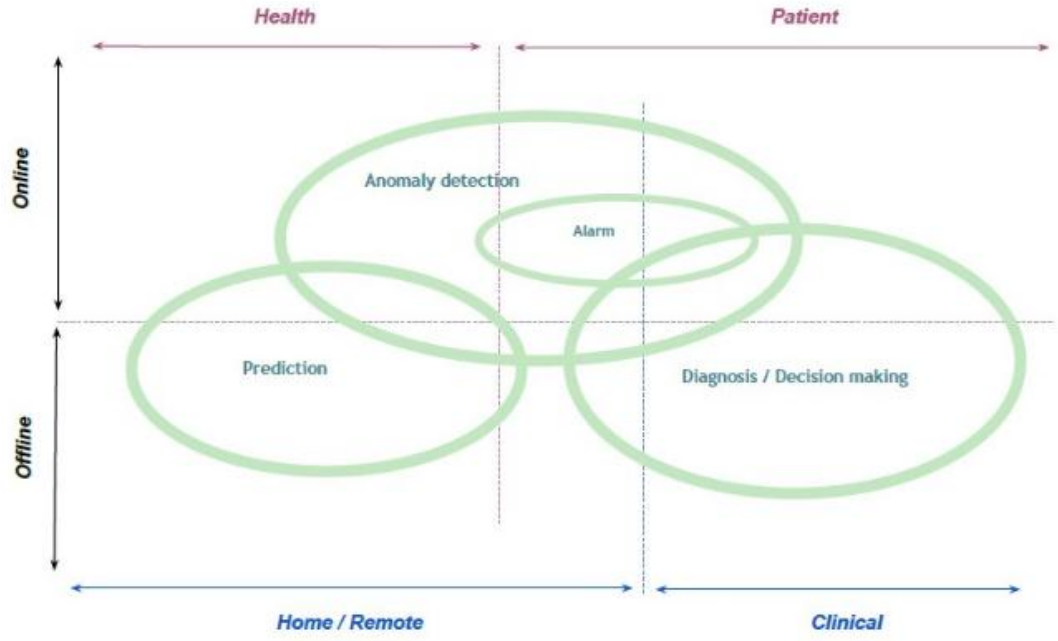

Fig 1. Neonatal Health Monitoring System (NHMS) Tasks.

III. MODELLING OF IOT INSPIRED NHMS

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 and Human Environment and ICT context. 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 parents/care givers and infants are participating, 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. System should be Active context aware if responding to a situation automatically and Passive when an alarming of the situation is given. In medical monitoring application most of the time user context is overlap with iHCI property and thus following Passive context awareness. For example, setting the timer or configuring the system at initial stage.

A. .Architectural Design for NHMS: Smart DEI model

The basic architecture design with ICT system for neonatal monitoring system may use smart devices, smart environment or smart interaction. It is an environment which autonomously operated at some extent with active digital controls and resources (memory, battery etc.) that can communicate via networks. Fig2. Shows the architectural design patterns for ubiquitous and IOT based systems.

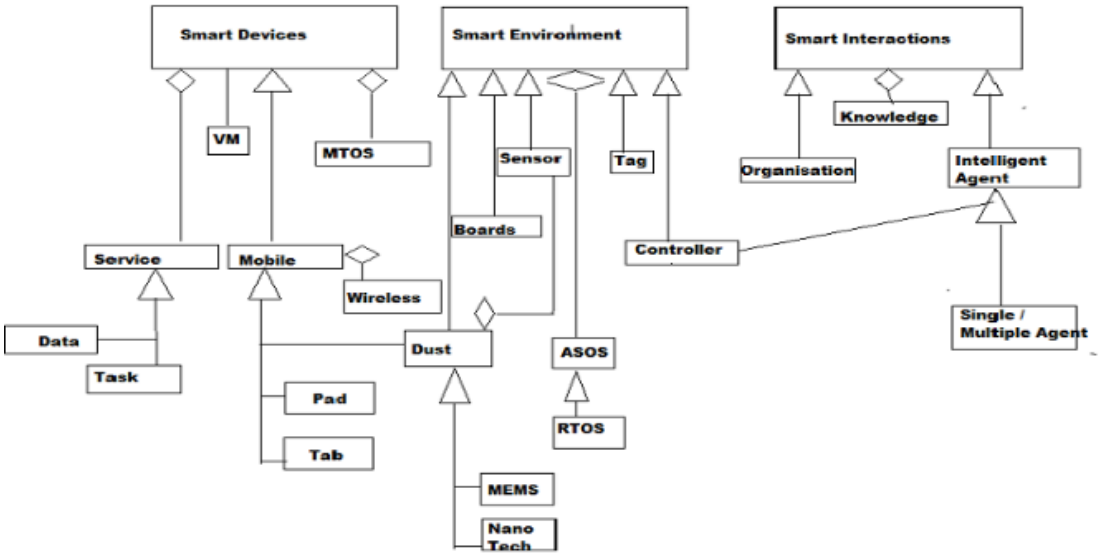

Fig 2. Smart DEI Model for NHMS.

The overlapping of devices, environment and interaction is possible. But most of the user selecting smart devices over the smart interaction as simple devices like mobile phones are affordable and can smoothly integrated with any environment .The DEI Components are as follows:

1. Smart Devices:

Neonatal health monitoring system have range of options of choosing a smart device. User can prefer smart device based on mobility, dynamic services and upgradation facilities. The additional features of multifunctionality, ease access, flexible run time interoperatabilty tends to user to own their personal smart devices. Light weight and smaller size devices i.e. tabs, pads, boards, personal computer, laptops, cell phone etc. with embedded system. The advances like dust, skin and clay are also at the stage of development [2]. These are basically MEMS miniature designs for smart devices. Mobility of smart devices have dimensions such, it can be accompanied, portability, hand-held, wearable, implanted or embedded. Volatile service access of these devices allows to discover the services dynamically. Sensors allowed home care for neonates.

2. Smart Environment

An environment is able to acquire and apply knowledge about itself and its inhabitants to improve the experiences in that environment, is referred as smart environment [13]. It is consists of the set of networked devices that establishing connection to the physical world. The smart environment devices can be categorized on basis of function and interaction. Tagging e.g. RFID tags, Sensing and monitoring the physical environment, basis on sensing filtering and adapting, controlling, Assembling (industrial use), regulating etc. are few types of smart environment interactions that are possible with device support. Smart environment devices are available in variety of sizes and can be fabricated with integrated chips.

3. Smart Interactions

It is needed to coordinate several activities of smart devices and smart environment. Smart interaction supporting to the continuous interaction between network and interconnected objects to achieve the shared goals. Smart interaction having the ability of self-organization and fixed interaction protocols are being used among different entities. The types of interactions are such as coordinating the devices, policy or convention based interactions, dynamic organizational interactions and semantic or linguistic interactions etc. Basis of synchronous and asynchronous interaction specific protocol or instruction can be design. Distributed system communication making it more reliable with the request and reply responses. This plays an important role in any monitoring system.

III. BASE TECHNOLOGIES FOR NEONATAL HEALTH MONITORING SYSTEM

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]. This replaces wire to provide 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 customized approach by using optimum services and medications in treatments is possible with the Technology. The industrial standards like IEEE, Bluetooth SIG, ISO, ASTM is developing or developed by research community for the medical equipment with wireless applications.

IV. POTENTIALS OF IOT IN NEONATAL HEALTH APPLICATIONS

Real time monitoring systems are a renowned applications in the medical field. The hospitals, ICU and NICU are well equipped with the monitoring, surveillance and tracking equipments. More simple and regular utility equipments are equally important in neonatal care. Patient centric home monitoring system are in demand as normal but known cases of critical events need a non obstructive care. In case of neonates where mother's contact is playing an important role in initial period of the growth health monitoring system will reduce the hospital stay and restriction of staying away from baby. Parents can take care of their babies without disturbing their routine activities. Data from the initial stage of life will be helpful in further long term clinical history with the database can easily integrated with other medical applications.

V. CHALLENGES OF IOT IN NEONATAL HEALTH 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.

Infant should get monitoring care at home.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 with light *weight equipment* 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.

VI. CONCLUSION

In the above article we discuss the various medical application specially focused on health monitoring system. Article also described architecture and base technologies for neonatal health monitoring with IOT approach. Care and surveillance are the two important aspect of medical treatments. Understanding the special needs of neonates and parenting as well as limitations of hospitalization have to think about special design of neonatal health monitoring system, thus infant could get quality care under medical conditions at home also.

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