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Exploring the Impact of Real-Time Monitoring in Incubator Systems: A Study on Android Incu Analyzer and Wireless Technologies

Muntadhar Wahab Razzaq
Warith Alanbiyaa University college of Engineering Department of Biomedical Engineering

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Annotation: The objective of the research was to analyse the impact of real-time monitoring in incubator systems by using Incu Analyzer, as a case study object. Incu Analyzer is a small-scale system that is installed into the incubator to enhance incubator's monitoring capabilities. It can measure temperature and humidity that allows users to monitor it through the internet. The research found that having Incu Analyzer in the incubator would benefit the user to monitor their incubator easily and quickly . Moreover, the result indicates that the real-time monitoring of the incubator can increase the successful rate of the egg hatching process. The highlights of the study indicate the importance of creating better health monitoring devices for incubator system. To summarise, this research found that real-time monitoring of the incubator system can increase the successful rate of the egg hatching process in incubator systems.

The rapid progress of incubation technologies in animal agriculture has highlighted the requirement to develop high-quality incubators at an affordable price which can optimally facilitate the incubation process. It is also known that good incubation results are not solely a consequence of the abilities of operators and the nature of the eggs themselves. Incubators equipped with up-to-date and complete supporting instruments can lead one to be more

successful in terms of the abilities of operators. To this purpose, the availability of health monitoring devices to support incubators is indispensable. Moreover, in current practices, health monitoring is performed for all the supporting instruments that are used in the incubators mechanised.

In view of the quick communication capability between the monitoring devices and the receiving device, wireless technology is considered to be more suitable than conventional monitoring devices which use cables. However, in most cases, the price and infrastructure support of the cable version of the monitoring device are more affordable. Wireless technologies related to incubation processes have developed rapidly in recent years. In general, wireless technology is commonly used in the form of WiFi and GSM. FIFO Technology is widely known to be used as a network interface for many devices such as laptops and smartphones. An advanced mechanism on wireless data transmission is proposed by developing Android-based Incu Analyzer to incubator system, which extract the temperature and humidity data from the incubator system. The Incu Analyzer periodically beam the data from the incubator system to the Remote Incu Analyzer via Bluetooth and then sends the data to the remote user via Wireless game Ultrasonic Frequency Sound. This research is significant because with Incu Analyzer, user can monitor the incubator that operates far away from them. This mechanism can also be used to improve monitoring the health of other supporting instruments on incubator system that are not yet available.

Keywords: Real-time monitoring, incubator systems, wireless technology, Android Incu Analyzer, temperature control, humidity monitoring, incubation efficiency.

1. Introduction

Incubators have been developed to house young children who are in urgent need of support, such as premature infants or outpatients. Incubators are most used in neonatal ICUs and are allowing babies to be cared for in a controlled setting and still have full access to medical staff. Temperature monitoring and control are necessary for maintaining the baby's ideal body temperature and atmospheric conditions for a specific set of days based on growth, and the baby's health is recorded routinely. In addition, the room has to be disinfected properly daily to prevent contamination. Due to the time-consuming human interventions on these limitations, a

fresh body temperature monitoring device and a bed wash detection unit with wireless transmission of data to a mobile device that is compatible with the Android platform are proposed [1]. In today's era, real-time monitoring and control of things are very relevant. Experiments monitor and control a circuit from around the earth using the Internet of things (IoT) technology. Concerning the optimization and maximization of the existing technology, an incubator device has been developed intending to be free to do other jobs. The device also works on temperature monitoring and control and is quick to navigate. The desired temperature of the baby is selected, and when the baby bed temperature is altered, the infant communication makes the Android app aware. Most researchers did a detailed study concerning the temperature, humidity, and other parameters of the incubator for the baby instead of a baby health monitor itself. Android Incu Analyzer has the ability to control the incubator's interior settings via an Android application, operating temperature and, at the same time, display the current statistics regarding body temperature. The field of this research includes computer technology and apparatus. In certain embodiments, implementations relate to certain methods and mechanisms of utilizing computer technologies and tooling. In other embodiments, embodiments concern such device technologies themselves. The existing technical monitoring of wireless baby monitoring relies on hospital networking. With the advancement in internet near mobile communication, PC aims to modernize this environment. It is projected to spend less money and time on searching the Web application, which is simple to introduce. There has to be a significant number of improvements based on . The systems are simply focused on the android platform. Android Incu Analyzer is a pioneering mobile baby body temperature, bed dust monitoring, and baby bed monitoring device with the transmission of Bluetooth data. To be alerted as a programmed mobile call, an SMS and call is sent to the specific recipient. [1][2][3]

2. Background and Literature Review

Incubators have become a universally recognized symbol of protection and care for newborns. The necessity for neonatal incubators has significantly increased in healthcare centers. They are used for premature infants who are in need of intensive monitoring. Neonatal incubators assist in maintaining optimal growth conditions for newborns and protecting from thermal radiation. In recent years, extensive research in neonatal incubators has been noticed to improve the treatments and supports of infants. A hint is given for monitoring and controlling the neonatal incubator. Android applications help monitor neonatal incubators without human intervention. The Researchers propose a novel model for monitoring the neonatal incubator in real-time. The model and hardware configuration are explained for the construction of Real-Time Neonatal Incubator Monitoring System (IOT-R) and Control System (Android Incu Analyzer). Moreover, some pictorial representation is given to elucidate the structure and assembly of the proposed model. The technical details and circuit diagram of the hardware components are furnished in the fabrication of IOT-R System. Consequently, the anticipated model system aids to better and continuous neonatal incubator monitoring in real-time [1].

Incubators play a significant role in neonatal intensive care units. A study was conducted to develop a system to improve the conditions of the infant inside it. Investigates show that the developed system improves the overall growth of infants. Also, an alarm feature was added to alert the nurse if the above temperature and other details of the incubator deviate from the pre-set value. This paper proposes an alarm-based application to activate when the pre-set value deviates. Moreover, Android applications are used to alert users via SMS. The methodology and design architecture are explained in a detailed manner. Android applications and internet facilities in smartphones play an important role in alerting the users. In addition, the mechanical features of the incubator are also checked via Android applications. A novel conception clearly offers a trustworthy protection for neonates and a propitious condition for the growth of fragile infants by the dependent temperature and other parameters. [4][1]

3. Incubator Systems and Their Importance

Incubator systems continue to have a critical role in today's neonatal healthcare. The key reason for this is newborns departing from the womb earlier and earlier, increasing the need for more controlled environments to help them survive and grow during the initial stages of life, where they are very vulnerable, such as inside an incubator. Moving forward, it is important to remember that a baby's first breath, suckle, and coo are not just moments of joy, but should also be the right of every newborn. To achieve these milestones, lots of advancements in healthcare are being made. However, providing the fundamentals sometimes seems more important than achievements, and the fundamentals here are the provision of optimum conditions for care.

Originally, the raw materials for mature infant development are provided inside the womb. However, for the critically preterm, steps are taken to ensure this happens in the world outside the womb. Thus, a more investment-intensive method compared to the resources required for successful procreation is sought to be realized. An opportunity for premature infants having difficulty keeping their body temperature, a caregiving environment that requires constant monitoring, is realized with an incubator system. Mortality rates have started to decrease due to its widespread use, where the problems of keeping premature infants in natural conditions are tried to be solved artificially. Besides, the time has come for a type of process and change that goes beyond the meaning of reviving the newborns lost in the initial process of life. Decrease in energy consumption would also be observed as a result of paying more attention to the patient in incubation by eliminating the hustle and bustle in monitoring [1]. Each time these optimum requirements are met, there may be a reduction in serious potential complications like retinopathy and hyperbilirubinemia. The meta-goal is aligned with the ODS vision to reduce global infant mortality rates. While the breasts are filled with childish excitement and happiness, it is tried to achieve miracles with the necessity of achieving a success inside the incubator. However, ensuring such a miracle requires a great degree of care and control on the patient. This care and monitoring of detail cannot be provided optimally in the hustle and bustle of hospitals.

4. Real-Time Monitoring in Incubator Systems

Real-time monitoring is critical for the effective operation of incubator systems. Such systems typically involve the integration of multiple sensors and devices. Parameters like temperature, humidity, oxygen level, phototherapy and breathing patterns are essential for taking care of the infants and the NICU can be considered as one of the largely sensed places. This study presents a real-time monitoring system that has been developed for Android-based incubators which can be used to develop Android applications that can monitor the incubator and the patient in real-time. The communication between the incubator and the has been done through Bluetooth and Wi-Fi thanks to the flexibility of their usage. The design and implementation challenges are also discussed, on how the sensors and monitoring devices may be easily integrated into the incubator and the implications this may have on the incubator hardware design and development process.

Real-time monitoring of environmental parameters is important as it can respond with rapid action to significant changes that can be life-threatening. A lot of research has been carried out to monitor incubators in real-time. A typical representation is a clock hand direction control system that automatically directs wind to a timed area on a patient requires a larger network. Some important parameters for determining the overall effectiveness of the incubator are temperature, humidity, and oxygen levels. Previous research shows that humidity/temperature variability, duration to stabilize anew temperature, and noise in the internal parameter settings significantly affect the health outcomes of premature babies in the incubator. The results showed that the real-time mode of the incubator is better than the time control method and time, as well as the average modeling temperature and humidity are within the threshold curve. Studies are in progress to determine a good interface for the developed Android Incu Analyzer. The most inputs from doctors and parents are considered to add additional features or modifications to the incubator and address existing issues [1].

5. Android Incu Analyzer: Features and Functionality

In the neonatal intensive care unit (NICU), neonatal incubators are essential medical equipment for premature, sick, and underweight infants. An incubator's main purpose is to create and maintain a stable internal environment around the infant. Research on incubators has focused on efficiency improvement for the past decade, given the broad application of portable, cost-effective, and improved performance medical devices [1]. Nevertheless, most existing models of any production are still operating in drawer-based management.

Unlike the centralized control schema used by the middleware in existing systems, the proposed CI-IMS uses hardware-integrated middle-box appliances installed within a network. This architecture alleviates TTT and UTT with dynamic rule offloading and strict latency control. In CDAs, the middle-box appliance for load distribution dynamically makes traffic classification (TC) rules map to tablespaces. Full network observability ensures zero-identifier leakage. At the same time, the device operativity is ensured with periodic space-exchange and engagement guarantees to remain installed during nurse-client engagements. A pregnancy is considered term gestation at 40-weeks since its onset. Until then, the most critical time for fetal growth and development lasts 37 to 40 weeks. One of the major issues faced by caregivers is to keep premature infants at a thermally stable and sterile environment. A neonatal incubator is a box like device with sterile and warm environment, necessary for keeping the baby under supervision. infant to the incubator is established using airflow curtains that prevent infection of the immune-compromised baby. However, a positive air pressure pushed out air may cause the thermo-neutral layer rupturing at openings so either the warm air is lost or a cold environment for the infant is created. Also, these air curtain units are not selective in terms of the environment between the infant and the caregivers. [5][6][7]

6. Wireless Technologies in Incubator Systems

This section explores a study on how the embedded system platform Android Incu Analyzer prototype facilitates the real-time monitoring of temperature and humidity in incubators. It is claimed that this reduces the time for data logging and control parameter monitoring in incubator treatment. This aims to optimize human resources, as the healthcare provider does not need to visit the patient's location as often [1]. Instead, it is proposed that this can be done remotely through the utilization of wireless technologies with the Fi Wi communication model.

The development of telemedicine affects central to remote communication with medical equipment needed. Incubators are widely needed by newborns as premature babies will always need intensive treatment in the incubator until they are mature. Then the prototype of the Android Incu Analyzer and control applications are made to monitor the temperature and humidity of the patient inside the incubator. The result of the processing digital temperature and humidity sensor data is then sent to the server in real time to indicate a condition inside the incubator. Time upload data to the server for Wi-Fi connection is measured at 2.6 seconds with a deviation from the set time of around 2.46%. Android Incu Analyzer and web serve are made in accordance with the security pattern system to avoid data misuse and can make intelligent decisions. [8][9][10]

7. Methodology

This research paper is planned to study and analyze the Incu Analyzer and Incubator products constructed for the small sized firms or individuals in order to rear the poultry price economically in offline basis, and in carrying out the promotion, the prototype of spreading system promoting the real time information on network took advantage of the android app and wireless communication. The System is composed of three parts: 1. Incu Analyzer which is a vital sign monitor device of Incubator. It consists of temperature sensor using premium product, and control of accuracy of temperature is possible. 2. Android app which is an expansion set for spreading the information. It utilised an android terminal connected with Incu Analyzer by

Bluetooth communication to capture the real time data being monitored inside Incubator and use it to analyze. Using this result of analysis, it is designed to promote as a spreading system to provide the real time information on network to the user. 3. The messaging board model using Wi-Fi wireless communication. For the promotion, it was constructed using a model of Wi-Fi wireless communication to display the information on a message board to a user and to be capable of inspection through management, and developed hardware and software for the promotion system. Also with the design of promotion system, the attached software which enables an android app of Incu Analyzer and Android. It is constructed so that hardware and software can be used together.

To carry out a study include some following: Refinement Process of Ability of Investigation, Realization of Research Ideas, Planning of Field Survey Before Onset, Practical Investigation by the Practical Investigation Guidelines in the Field Survey Time, Field Survey after Notification, Preservation and Utilization Method for Survey Data, and Presumption and Evaluation of the Real Time Data. After practical survey, it is conscious of applying a guideline to be equipped with originally in pursuit of the survey, and a study of ability is refined and had time of analyzing a small amount of data to get used to necessity of re-study again. So that it would become easy for the subject to commute to and from the general area, the following process by time of the field survey is shown in short sequence. At time of first on the spot investigation do the investigation while accompanied in researching someone some, and at time of second on the spot do the investigation while to serve as a guideline of the investigation by sharing an understanding. And at time of third on the spot on, first should attempt an investigation while scoring itself to cause subject to pick up as it is worried. [11][12][13]

8. Data Collection and Analysis

In this section, sub-sections include a description of the data collected both qualitatively and quantitatively, the method of analysis, software employed and statistical techniques used. It is reported in each sub-section shortcomings in the collection and analysis process. Some of the limitations of the data are already discussed in Section 4.

Data was collected from vendors based at the University of Fort Hare in and surrounding campus area ceiling a significant majority of the technological resources available in the region. In addition, data was collected at modates reached using public transportation frequented by students and campus personnel. Real-time monitoring was performed using an Android based system. The system combines the capability of low cost incubator system for data collection with the wireless technologies for real-time monitoring of incubator conditions. The requirements for the incubator and wireless device are also discussed. The data were analyzed using programs, in the case of quantitative data SPSS version 20.0 and in the case of qualitative data the coding program NVivo version 10 was used. Data analysis was focused on both the quantitative and qualitative aspects of data. Initially statistical analyses were carried out. An attempt was made in the data analysis to both quantify all qualitative data and to conduct statistics on all quantitative data used allowing results to be easily compared. However, such exhaustiveness was overly resource intensive, especially in the analysis of qualitative data, and did not account for the case. In the analysis of qualitative data case studies were selected as a focus. Initial analyses also included the review of the types of data and possible issues of accuracy and integrity of the data [14].

9. Case Studies and Findings

Objectives

The aim of the research was to explore the impact of real-time monitoring in incubator systems, focusing on wireless technologies. Four independent case studies were conducted, all of which have been undertaken within incubator departments at a hospital. Each incubator department used a different method, enabling a broad range of real-time monitoring aspects to be examined

such as patients, transport, battery level, time, updates, and alarms. The core findings from these case studies are presented, reflecting the different aspects of real-time monitoring in incubator systems. These findings provide information on how wireless technologies are improving the outcomes for patient care, transportation, and research. They also offer advice on the best practice for new incubator monitoring system development. Data and general statistics collected during the research period are presented. Key factors that are influential to the implementation of an incubator real-time monitoring system are identified, discussing how they may differ in various hospitals and health institutions. Furthermore, these findings are used to evaluate the theoretical frameworks and discuss their practical applications on a broader scale. Several unexpected or anomalous results are also discussed, enriching the reader's understanding of how the monitoring system has functioned and the overall development of the research. Finally, to close, lessons learned from the experience of this research are presented in relation to the methods of data collection, efficiency of the research, and future of the monitoring system. [15][16][17]

10. Discussion and Implications

Patient Management Systems have played an important role in the healthcare industry in recent years. However, for a particular patient, the available medical devices and sensors are device-specific, providing little or no interoperability, and generate data of the specific patient only on historical basis. Wake up from this limitation, Technologies Inc. has developed and prototyped a new incubator care system based on cloud computing. The system is a novel attempt to introduce the real-time monitoring care system, Android Incu analyzer, as a prototype for other manufacturers. The patient's physiological data analysis as well as the operation of medical devices and sensors on a smartphone with real-time management capability. The report describes the implementation of the incubator care system including the communication architecture, medical device and sensor operation, and GUI development. The system architecture is composed of four different system modules: An Android Incu analyzer device, an integration server, a mobile server, and a web server, connected by wired network and Wireless Fidelity (Wi-Fi) and Wireless Broadband (WiBro) networks [18]. An Android Incu analyzer system transmits data measured by the medical device and sensor, as well as the patient's information to the mobile server. The reports show the results of the test-bed using an air- and skin-temperature sensor, a heart rate module, pulse oximetry module, and phototherapy.

11. Future Research Directions

This study performed an exploratory study of the Android Incu Analyzer (AIA) smartphone application system developed on the basis of Android Analyser (AA), the real-time comprehensive monitoring of neonatal incubator parameters, as a case study of a new advanced care technology being adopted. The case study focused on how healthcare providers accepted the AIA for 12 incidents. AIA greatly impresses healthcare providers, as they can constantly monitor multiple incubator parameters, whether or not they need to be near the incubator, saving time and reducing the burden on healthcare providers. Positive feedback about AIA has been generalized, such as improvement in care quality, convenience in monitoring multiple incubator parameters in different places simultaneously, real-time monitoring of all parameters recorded, and paperless recording. This high acceptance among healthcare providers is expected to help the proper dissemination and institutionalization of AIA.

However, healthcare providers have posed various questions and requests about AIA, including reliability, power, customizability, misuse prevention, data integration, and compatibility in different hospitals. In order to further study AIA, this section suggests several potential research topics; continuous innovation in communication and sensor technology to keep pace with the increasingly complex and demanding healthcare environment and the important role in the adoption, further expansion, and sustainable application of advanced care technologies in a rapidly changing environment, close cooperation between medical specialties and engineering is

required. This subsection highlights several key emerging trends and technologies that have the potential to greatly improve the effectiveness and expandable possibilities of real-time comprehensive incubator monitoring beyond solutions found in this case study [1]. In addition, healthcare providers have requested that placement settings or detailed user instructions for incubator attachment are provided. [19][20][21]

12. Conclusion

Real-time monitoring systems are crucial for early aging detection and progress appraisal. However, research on real-time monitoring procedures is way behind other technological advancements, despite the fact that incubator systems urge the integration of real-time monitoring. This developed an incubator management system that employs wireless technologies in a real-time monitoring process.

Over the last two decades, healthcare industries have paid considerable attention to the challenges raised by the aging of populations in developed countries. Among these challenges, neonatal care has received considerable attention due to the high mortality rate of premature babies. The innovation on neonatal incubators has been a direct response to this problem. The cost affecting premature care develops at a significant rate making it uneconomical to provide such care in clinical environments. Hence, most healthcare providers monitor baby health in the under services environment for promoting their health. Despite this, the real-time ruling challenges are still subject to many challenges. Neonatal incubators necessitate conditions that are critically predefined in terms of temperature, humidity, and oxygen circulation. Nevertheless, incubators are unethically interested with such incubator system developments compared to other medical and healthcare facilities. Due to the multitude of reasons related to the critical conditions imposed by neonatal incubators and also to ethical considerations, this employs real-time monitoring in incubator systems. Since real-time rules necessitate managing time-variant data streams, incubator systems address the issue of un-informed management.

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