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BIG DATA AI: DESIGN AND IMPLEMENTATION OF BABY-CARE SYSTEM BASED ON CONTEXT-AWARENESS USING WEARABLE BAND

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Abstract

Death of infants is constantly occurring mainly because of dyspnea and sudden infant death syndrome. In particular, since it occurs in the night time when parents have difficulty in checking the infant's conditions constantly, system that can constantly monitor infant's vital sign or discomforts is necessary. We suggested a baby care system based on context-awareness using a wearable band. This system uses a wearable band to collect context information, including body temperature, humidity and movements and vital signs, such as the heart rate and blood oxygen saturation. The baby-care application in the protector's smart phones uses the collected context information to interpret the infant's context and to provide monitoring and alarms against emergency according to the inferred context.

Keywords: *Baby-care system, dyspnea, infant death syndrome, SIDS.*

1. INTRODUCTION

The health care industry is continuously growing and its market is also being expanded. The health care system and their initial stage have been developed has medical tools to diagnose disease for inpatients in medical instutions. They were used to examine conditions for example by sensing such accident cardiacarres. However the present health care systems are developed to prevent any risky situation and those for the elderly are good proofs of such a change. There is a system that connects a smart phone with a device to monitor various vital signs that ruin health conditions of the elderly including blood sugar and blood pressure and uses a database to allow hospitals to make remote control and management.

The main causes of death of infants include dyspnea due to wrong sleeping postures or the use of inappropriate bedclothes and sudden infant death syndrome. Sudden infant death syndrome occurs among infants aged less than twelve months, especially among those aged less than six months and is characterized by the absence of specific causes. Death of infants primarily occurs while they sleep and their parents have difficulty in checking their condition constaly. So a system that can monitor infants sleeping conditions or vital signs is necessary. As more women participate in public affairs the protectors who have to deal with economic activities as well as household works have difficulty in focusing on children. In particular in the nighttime when it is difficult to monitor the sleeping context it is hard to immediately perceive and treat apnea, if any. There is a research finding that the incidence of SIDS is higher in developed countries, such as the Pakistan. Although infants can feel discomforts including cold, heat and stuffiness, due to excessive or insufficient heating their poor communication makes it difficult to let their protector know their needs immediately.

The context awareness enables one to interpret emergency situations, such as heart arrest or apnea, and changes in body temperature and discomforts due to excessive or insufficient heating. It provides monitoring, alarms at general and emergency levels, and information about the history according to the conditions.

2. CONSTRUCTION AND WORKING

Fig 1 shows the overall architecture of the baby-care system based on context awareness. The system is composed of wearable band and a baby-care application. The proposed system uses information about infant's vital sign, including the heart rate and oxygen saturation and their body temperature, movements and humidity as context information to interpret the context. At the stage of context collection a wearable band is use to collect such context.

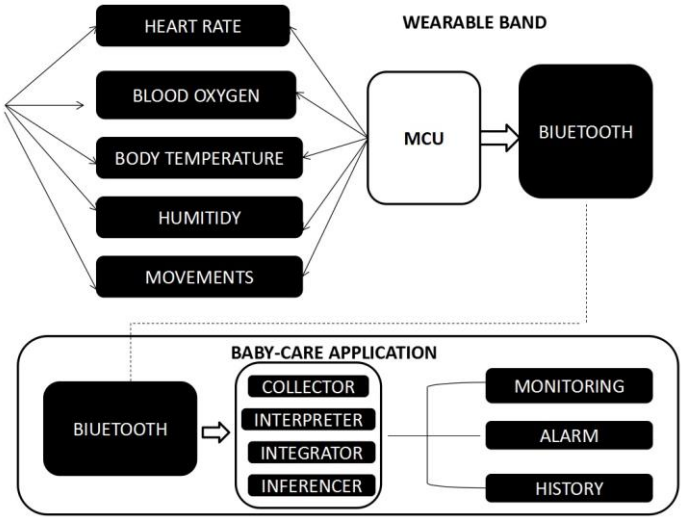

Fig1: Overall architecture

At the stage of context information delivery, Bluetooth wireless communication is used to deliver the collected data to the baby-care application in the protector's smart phones. At the stage a context interpretation, the context information delivered from the wearable band is used to interpret the context. Lastly it provides baby-care services, including monitoring, alarms and history on the basis of the inferred context.

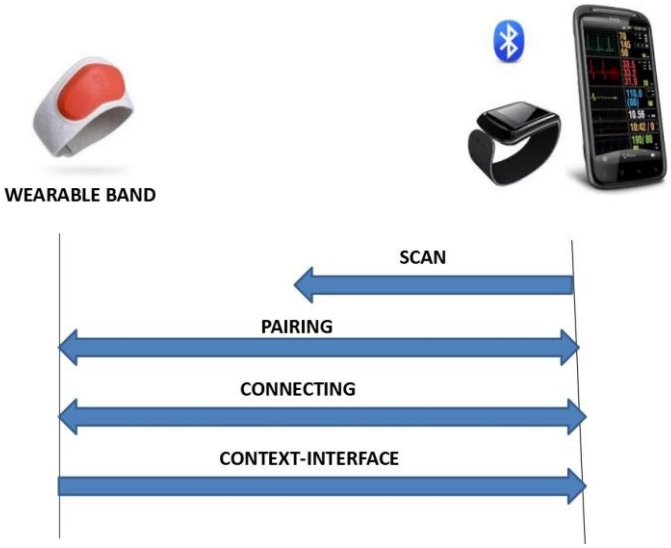

Fig2: Connection between wearable band and smart phone

Fig 2 shows connection sequence between the wearable band and the smart phones. When the baby-care application is executed in the smart phone, it activates the Bluetooth device in the smart phones and explores the wearable band around it. When a new wearable band is discovered, Bluetooth goes through a pairing process or a connection process for a paired wearable band. When the wearable band has been connected with the smart phone, context information is regularly delivered from the band to the smart phone.

3. SYSTEM DESIGN

Among the data demonstrated above, researchers have chosen various forms of sensors to monitor infant movements. For instance, of the 30 articles, 20 papers use accelerometer sensors to monitor babies, while three of them use pressure sensors. Figure 3 illustrates the baby-related movement monitoring research from 2010–2016; the usage rate of the acceleration sensor is decreasing gradually, while that of the IMU is obviously increasing. That is because IMU measurements provide data with more degrees of freedom for movement monitoring

4. EXTERIOR STRUCTURE

On the other hand, the exterior structure does make a difference on comfort ability and user experience, which is an aspect to be considered in the design process. Table 4 demonstrates various wearable forms for monitoring infant movement, including gadgets, soft belts, bracelets, cloth bands, and jackets. Let proposed a band that was built of medical-grade silicone integrated with an accelerometer to track the baby's position and motion, a contactless sensor to gauge the baby's temperature and an optical heart-rate sensor to monitor the baby's pulse. In the band is wrapped around the ankle in a comfortable way to the infant, and the sensors are wrapped in medical-grade silicone and easy-to-remove non-wearable components. The accelerometer sensor is directly bound with the infant's ankle and placed above the foot so that the position of the lower leg can be monitored the best and, in this way, it is accurate and convenient to obtain the baby's body position and its movement and, thus, if the baby falls or rolls over, it can give a warning signal to the parents. Another novel and distinctive part of this band is that a base station doubles as a wireless charger, using magnetic resonance to provide enough power to run the band for one to two days at a time. Moreover, the data were sent wirelessly instead of using wired transmission and that improves the comfort ability significantly. Rihar Gravem Hayes and Fan et al. use a similar form of the system to monitor infant.

5. DESIGN CRITERION

For more specific tasking scenarios, like general movement monitoring in infants, the appearance design needs to satisfy the aesthetic requirements, the system needs to be small and light enough, and it should not restrict the infants' movements and other actions. Additionally, risks of radiation and other kinds of health hazards should be eliminated. In Bootstrap's research, she put forward the following requirements for wearable sensor system design for neonatal monitoring which can be used for reference in further investigations. Be able to achieve continuous monitoring when the infant is inside an incubator or during

a. Kangaroo mother care. Be non-intrusive and avoid disturbance of infants and avoid causes of stress or stimuli
b. Be safe to use in the NICU environment or at home
c. Provide appropriate feedback that is also interpretable for parents and doctors or related people
d. On whether the system's components are functioning correctly. Look friendly, playful, familiar, and attractive to gain a feeling of trust from parents. Be

scalable to include more monitoring functions, such as wireless communication and local signal processing.

Be made of easy-to-remove non-washable parts. Found influence over motion identification. In Rihar employed IMUs placed on the upper arm and forearm, in combination with a pressure mattress in order to measure the trunk position, rotation, and associated movement's surface. Five IMUs were attached to the test subject, which were set inside the particularly-designed silicone bracelets. Singh et al. used accelerometers placed around the wrists and ankles of infant to predict cerebral palsy. In Figure 3, from 2010–2016, most studies on infant movement choose to put the sensors at the position of wrist or ankle. Furthermore, user acceptance is an important issue to consider during the system Design.

Affecting factors include infant comfort, the nature and level of user involvement in the development and implementation of the system, direct and indirect impacts of the new system on work practices, data reliability, battery life, etc. As can be seen above, none of the 30 articles mentioned seizure detection with wearable systems, which is a promising area worthy of further study. Therefore, a more baby-friendly seizure detection system is in demand to be invented, developed, and verified by clinical trials.

6. BABY-CARE APPLICATIONS

The baby-care service in this study has been composed of monitoring, alarming and history services. The monitoring service is to check context information and humidity on the screen. The alarming service is to provide an alarm against the infant's conditions inferred from the context information to the protector, who can make proper treatment. When the infant's condition is inferred as Alarm Level Middle, the protector is given an audible alarm on the screen. When it is inferred as Alarm Level High, the protector needs to make rapid checking and treatment, an audible alarm message is displayed on the screen and if the protector makes no check within a designated period of time, an SMS module in the smart phone is used to send an emergency message to the designated number.

The material is organized in five sub-sections devoted to summarizing applications focused on:

1) Health and wellness monitoring.
2) Safety monitoring.
3) Home rehabilitation.
4) Assessment of treatment efficacy.
5) Early detection of disorders.

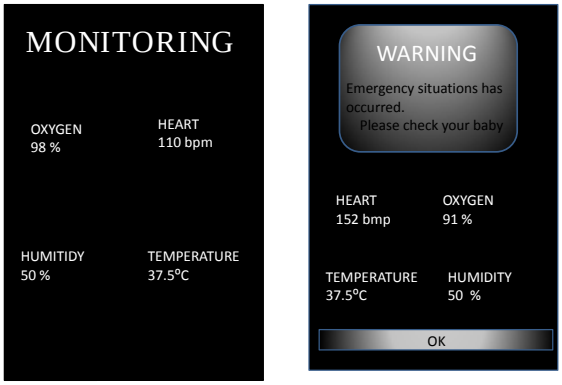

Fig 3. Baby-Care Application

7. CONCLUSION

Health care service is one of the very important IT application fields. While the existing health care service targeted adults or the old and the weak, the service that targets infants is recently on the greater demand. As more women participated in public affairs in developed countries, they have to deal with both economic activities and household works and have difficulty to monitor the sleeping context, it is hard to immediately perceive and treat apnea, if any. A system that can continuously monitor vital sign for discomforts for infants is needed.

Since Bluetooth communication has limitation in terms of distance, efforts should be made to overcome the limitations by applying other wireless communication techniques. Further research is needed to apply a more improved context interpretation technique to determine infants sleeping posture, provide an alarm, andhniq reduce the rate of risk for death of infants. The application of the positioning technique to add a child missing prevention function in the outdoor environment is expected to make it more useful in the outdoor environment.

So far, much progress has been made in the area of wearable sensor system of infants' movement monitoring and there are good prospects for future applications. New systems need to be developed and verified by more clinical trials before promotion to a wider population. For instance, the accuracy of the results obtained from the wearable motion sensors, the preferable choice to place the sensor for data collection in various applications, the reliability and comfort index of the system, and the aspects that could affect the results of the wearable sensors are expected to see improvement. Moreover, the application of wearable sensor-based movement monitoring in infants has not yet reached its full potential. The available literature does not show successful examples to detect infant seizure conditions based on the use of wearable motion sensors. Thus, there is a great development space of infant motion monitoring with wearable sensors for the detection of infant seizures. Another important trend and research direction is to create a "baby care system" to achieve feedback between clinicians and infants using wearable sensors. Through the "baby care system", monitoring infants' daily physical activities and

understanding the real-time development status are within reach. Once these issues achieve any substantial progress, it will be a great attraction for both parents and clinicians for significant improved care of infants.

Due to the miniaturization and lightweight of wearable motion sensors, they can be integrated into clothing or accessories from an ergonomic point of view. Devices that attach to the wrist or ankle with a band seemed to be the most popular placement in those studies. To the best of our knowledge, up to now, there is no relevant study that examines the design of wearable sensor systems for infant movement monitoring from an interactive or ergonomic viewpoint.

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