Smart Baby Care with 3D RFID Positioning

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ABSTRACT— ***In the recent years Radio Frequency Identification (RFID) becomes a popular labeling and positioning system. One of the biggest fears of parents is, without a doubt, losing of their newborn babies. The current condition at Chang Gung Memorial Hospital (CGMH) uses passive RFID in order to identify the baby and matching with parents. In this paper, we propose three dimensions (3D) position systems to improve the current condition in CGMH. 3D RFID positioning system in baby care is one kind of improvement of existing positioning system, which is development of mapping technique with 3D space coordinates (x, y, and z). The main reason to use 3D RFID positioning systems are to make baby more safety from inside factor (wrong identification by nurse) and outside factor (snatcher baby). In 3D RFID positioning system also can possibly to multi tracking and accurate adjustment so it helps nurses to identify each baby whether still lying down or drop to floor. We hope that that, our suggestion systems can improve security of the baby using advanced tracking babies.***

Keywords— Active RFID, Baby Care, 3D Positioning

1. INTRODUCTION

Wang et al. [1] said that infant tracking with RFID is becoming more and more common as hospitals in today's competitive environment realize the benefits. Although new born babies usually do not have the strength and skill to move out of the nursing room, it is not uncommon for babies to get abducted by cold-hearted baby thieves once in a while.

According to Want [2], there are two kind of RFID for positioning system that uses active and passive tag. Active RFID and passive RFID are fundamentally different technologies. While both use radio frequency energy to communicate between tags and readers, the method of powering the tags is different. Active tag uses an internal power source (battery) whereas passive tag relies on RF energy transferred from the reader to the tag. On the other hand the communication ranges for active tag are longer than passive tag.

Cheng et al. [4] feel that one of the greatest fears of parents is, without a doubt, losing of their newborn babies. Safety for newborn babies is empowered by letting hospital staff know exactly the location of every newborn baby inside the hospital. Han et al. [3] described that information is also strongly connected to the correct identification of the newborn babies, which is the base of healthcare management process for every newborn baby.

After visiting and discussion with one of doctor from Chang Gung Memorial Hospital (CGMH), the current condition in that hospital is still using passive RFID to take care the babies, that system only for identifying the baby and matching with parents.

The objectives of this paper are hence to provide suggestion for CGMH to enhance the current system in order to improve the protection of newborn baby. In this paper we will give suggestion for CGMH using 3D RFID positioning and other application from current hospital in around the world.

Furthermore, another suggestion comes from advanced hospital from around the world. The application such as: indoor global position system (GPS), smart door technology, drugs and milk control system, newborn heart rate and oxygen levels sensor and baby monitoring system.

This study proposes a real-time location and newborn baby monitoring system based on active RFID. In order to reduce the potential risks of the theft, misuse hold, the proposed monitoring location system not only can recognize different babies but also can track instantly the locations of newborn babies by using 3D RFID positioning. Further, the proposed real-time location system can send off warning signals when the theft, misuse hold.

2. LITERATURE BACKGROUND

2.1 RFID tags of principles and positioning

Hassan & Chatterjee [5] studied that RFID systems can be classified in two main categories in accordance with their usage: monitoring and authorizing. The first class includes RFID systems where tags are attached in an inseparable way to the items they identify. Such networks provide the capability to check, monitor and authenticate which tags are present in the interrogation zone.

The second class includes RFID systems where RFID tags are not permanently attached to entities. Due to this property, the identity of the entity in possession of the RFID tag cannot be verified. Typical usages of authorizing RFID systems are access control in a building where tags are embedded inside cards or keys.

2.2 Leveraging RFID hospital patient life cycle and mobility perspectives

According to Cangialosi et al. [6], if further care is needed, the patient is assigned a bed and transported to a room by an orderly. At regular intervals, the following procedures could be carried out: Blood is drawn (by a phlebotomist) and analyzed; blood pressure, heart rate, temperature, and oxygen saturation are recorded; intravenous (IV) fluid levels are recorded and replaced as needed. During the course of care, the patient may be transported to other departments for treatments, tests and examinations.

2.3 Indoor localization and tracking in hospital

In hospitals the location tracking of medical personnel in emergency situations has become increasingly important. Medical applications in hospital also include patient and equipment tracking, e.g. fall detection of patients. Precise positioning is required for robotic assistance during surgeries. Existing analytical devices can be replaced with more efficient surgical equipment said by Mautz [7].

2.4 RFID benefits

With RFID integrated into a hospital information system, much of the critical information regarding care can be input fairly automatically. Patients can be tracked from the time they enter the hospital to the time they leave, with the process starting when a patient is issued an RFID wristband (during admission). Wicks et al. [9] said that the real-time tracking can show what medication was dispensed and when it was administered. At any time during this physical process, software can check for errors and notify hospital staff if the wrong medicine was dispensed.

2.5 RFID support for accurate

According to Chon et al. [8], an essential part of the telematics is navigation and it is mainly based on GPS as the choice of positioning technology. The skeleton of the idea is as follows: install RFID tags on roads in a certain way, store very accurate location information along with other necessary information in the tags, add an RFID reader module to the navigation system, and use this new location information along with GPS and a gyroscope to produce highly accurate location information.

3. METHODS

According to Han et al. [3], taking a 3D position processor unit Like RF-based 3D positioning system with active RFID tag array, this is an improvement from a classical 2D positioning system, and this is a new device to implement. We have done survey already in GIPS technology in Tainan to see the advance and detail of 3D RFID positioning system. Furthermore we also visit in Chang Gung Memorial Hospital in newborn department to look the current condition and technology what they use it.

4. DISCUSSION

4.1 2D RFID position system

3D RFID positioning now still new in healthcare environment because previous approaches the system only based on 2D design and cannot provide 3D position information. According to Han et al. [3], the lack of z-dimensional information may lead 2D-based systems to inaccurate positioning. 2D RFID positioning has potential errors by nurse in identifying the baby when drop from bed. Doctor still has potential errors for identifying the baby. Another risk using 2D RFID is the mother cannot track the baby in real time. 2D RFID system will dramatically create some mistake when too many babies in one room and too many movement.

4.2 3D RFID position system

According to Mark Roberti, Ultra-Wideband (UWB) RFID systems offer the highest resolution. These systems can usually pinpoint a tagged item to within about 10 inches in three dimensions. This is largely due to the fact that UWB systems do not have the same issues with multipath distortions that other RFID systems often have. Multipath is when a tag signal bounces of ceilings, floors, walls and objects before being received by an interrogator. These signal reflections make it difficult to determine a tag's precise location.

There are active ultrahigh-frequency (UHF) real-time location systems (RTLS) that can also locate an object in three dimensions, usually to within approximately three feet. Most other systems do not provide 3D positioning.

In order to solve the problem of 2D position system we give the new improvement with 3D position system which mean we improve in direction of tracking, not only "X, Y" direction but also we give "Z" coordinate as a modernization. The requirement based on GUPS technology [11] at least we need 4 node readers in one room to enhance accurate of positioning system.

We can see in **Figure 1:** the architecture of RFID positioning system there are 4 components such as switch/Wi-Fi, database/client, node reader and tag. Node reader can connect not only with switch, but also with Wi-Fi in order to save data in a database. The communication between node reader and tags uses UHF band which is no need closer with tags to get that data.

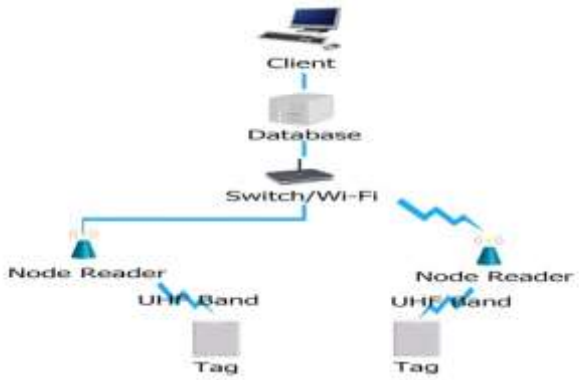

Figure 1: RFID Positioning System Architecture

4.3 Components 3D RFID

There are three important components of 3D positioning such as tags, node reader, and G-sensor.

4.3.1 Tag

In **Figure 2:** the specifications of tags are: frequency of tags is 3-7 GHz, speed 110K/850K/6.8Mbps.

Figure 2: Active tags

4.3.2 Node reader

In **Figure 3:** the left side is outdoor node reader and the right side is indoor node reader. The specifications of that node reader are: UWB: -41dBm/MHz, speed 110K/ 850K/ 6.8Mbps, Wi-Fi: 300Mbps.

Figure 3: Node reader

4.3.3 G-Sensor

G-sensor is a motion sensor that can measure linear acceleration of an object. That sensor can improve accuracy of 3D RFID positioning system. We can see in **Figure 4:** the function of that sensor is detected if baby falling down from the bed or detect the bottle if falling down from the baby.

Figure 4: G-Sensor

4.4 Other application from advance hospital

4.4.1 Indoor GPS

We can see in **Figure 5:** which is connected to the existing old hospital, which will be connected to the new hospital, and it's probably a mile from one end to the other. Other function is to get families and patients from one facility to the other.

Figure 5: Indoor GPS

4.4.2 Smart door technology

The system can detect the clinicians and providers to be able to access right devices in the patient room, in **Figure 6**. That door can give the alarm if not authorize person take out the baby from baby room.

Figure 6: Smart door technologies

4.4.3 Smart cabinet

The main function of that cabinet are for identifying the milk or drugs from each babies, so no wrong identification, time consuming, and never nearing expiration are expressed in **Figure 7**.

Figure 7: Smart Cabinet

5. BABY CARE CURRENT CONDITION

5.1 Previous Application in Baby Care

Healthcare providers (i.e., hospitals) traditionally use a paper-based 'flow chart' to capture patient information during registration time, which is updated by the on duty nurse and handed over to the incoming staff at the end of each shift. Although, the nurses spent large amount of time on updating the paperwork at the bedside of the patient, it is not always accurate, because this is handwritten.

The nurses play a vital role at the Hospital system in the success of both inpatient and outpatient care. They also play a very important role in bridging to execute clinical orders or to communicate information between the hospital and the patient that motivates to evaluate the potential of RFID (Radio Frequency Identification) technology, and to reinforce the critical job of information handover.

5.2 RFID for Baby Care in Current Condition

RFID is one of the emerging technologies offering a solution, which can facilitate automating and streamlining safe and accurate patient identification, tracking, and processing important health related information in health care sector such as hospitals said by Landmark [12].

RFID is expected to help boost baby care safety, improve security, cut down on theft and counterfeiting, enhance baby control, etc. However, RFID is not a single, simple technology. It consists of tags, readers, computer networks, and systems including middleware, databases, and so forth.

According to Yeo et al. [13], active RFID are built into a water-proof plastic ankle strap and given to all new born infants. Information such as the infant's mother, date of birth, medical data such are premature status will be stored securely on the database.

Improve the Speed and Quality of healthcare deliveries: Infant Protection Application can increase the quality of service of the hospital by increasing the confidence level of the parents that their infants are in the best care and are monitored, said Yeo et al. [13].

6. SMART 3D RFID IN BABY CARE

6.1 Explanation of 3D RFID positioning in baby care

3D RFID positioning system in baby care is one kind of improvement from exiting positioning system which is development of mapping technique with 3D space coordinates (x, y, and z).

The main reason to use 3D RFID positioning system is to make baby more safety from inside factor (wrong identification by nurse) and outside factor (snatcher baby).

In 3D RFID positioning system also can possible to multi tracking and accurate adjustment so it help nurses to identify each baby in baby room.

6.2 The Benefits of 3D RFID Baby Care

There are some benefits using 3D RFID for baby care such as:

6.2.1 See if the Child is Lying Down or Falling

There are several advantages of using 3D RFID positioning system with G sensor. To be modernizing is the main function use advance technology. The first advantages can detect straightforward and efficient infant monitoring system to reduce the potential risks of the theft, misuse hold and can tell if the baby fell out of bed.

While every nurse has some effort in order to know whether the baby is still lying down or drop to floor. It is crucial activities for nurse to keep the baby safe in the bed and sleep well.

With 3D RFID positioning system the nurse can protect the baby with real time, because that system can detect if the baby drop to the floor. The alarm will active if the system detect baby drop from the bed and the nurse will immediately come to pick the baby and take it back to bed.

6.2.2 Accurate Tracking

Sometimes restless baby toss and turn without crying. 3D RFID shows nurse what's going on even when the child is not crying, which is essential to keeping track of exactly how much sleep a child is really getting.

Using 3D RFID will improve accurate tracking for real time positioning and you can determine if an object is moving uphill, whether it will fall over if it tilts any more, or whether it's flying horizontally or angling downward, by tracking positioning quiet tossing and turning, nurse can more accurately track their baby's sleep in order to make sure they get all the sleep they need. 3D RFID positioning system is possible to tracking inside and outside and more accuracy.

6.2.3 More Secure

3D RFID positioning system provides extra security both inside and outside the crib. Babies often pull up to standing positions, then fall and bump their heads; a video baby monitor helps nurse either prevent these little injuries or at least be aware of them as common causes of crying. Furthermore, baby often get out of bed during the night without permission the alerts will active and the nurse will come immediately.

6.2.4 Nervous behavior alarm

According to Vimaliz [14], nervous behavior detection alarm that will be activated when a sound is detected, while the filter in baby cry sensor will try to detect only the baby's cries. Moreover, the alarm will be in a portable device; thus parents do not have to be in bed to notice that an alarm was triggered. This alarm will be activated when a sound in the frequency 900 Hz- 1200 Hz is detected, which corresponds to the infant cries in hyper phonation mode.

Furthermore, if baby defecation or urination in the bed, the baby will feel nervous and not comfortable. It can make the baby move to the right and to the left because of that situation. Using 3D RFID positioning system can be able to monitoring of that movement and will give the alarm to the nurse.

On the other hand, false alarms could happen when an external sound with the same frequency is detected, a vibration in the abovementioned frequency is detected and sensor is damaged.

7. CONCLUSION AND FUTURE WORK

In conclusion, this paper shows in a very memorable way the potential of RFID in the future and the way how the baby care system will be evolved in the next years. In 3D RFID positioning system can read and track the baby information in the monitoring areas and reports any susceptible behaviors. The advantages of the 3D RFID position system can detect straightforward and efficient baby monitoring system to reduce the potential risks of the theft, misuse hold and can tell if the baby fell out of bed.

We believe that, our suggestion can help doctor and nurse in DCMH for facilitate automating and streamlining safe and accurate patient identification, tracking, and processing important health records. Our future work will focus on the implementation of proposed systems in more real RFID applications.

8. REFERENCES

[1] Wang, Kaiyan; Lin, Niyang; Liu, Chunhua, "Infant Management System Based on RFID and Internet Technologies", In: Information Science and Engineering (ICISE), 1st International Conference on. IEEE. pp. 3665-3668, 2009.

[2] Want, Roy, "An Introduction to RFID Technology", Pervasive Computing, IEEE, vol. 5, no.1, pp. 25-33, 2006.

[3] Han, J., Zhao, Y., Cheng, Y. S., Wong, T. L., & Wong, C. H., "Improving Accuracy For 3D RFID Localization", International Journal of Distributed Sensor Networks, 2012.

[4] Cheng, Shou-Hsiung; Huang, Jui-Chen; Lin, Chun-jung, "A Real-Time Location and Infant Monitoring System Based on Active RFID", In: Machine Learning and Cybernetics (ICMLC), International Conference on. IEEE, pp. 1844-1849, 2012.

[5] Hassan, Taimur; Chatterjee, Samir, "A Taxonomy for RFID", In: System Sciences. HICSS'06. Proceedings of the 39th Annual Hawaii International Conference on. IEEE, pp. 184b-184b, 2006.
[6] Cangialosi, Andrea; Monaly Jr, Joseph E.; Yang, Samuel C., "Leveraging RFID in Hospitals: Patient Life Cycle and Mobility Perspectives", Communications Magazine, IEEE, vol. 45, no.9, pp. 18-23, 2007.
[7] Mautz, Rainer, "Indoor Positioning Technologies", PhD Thesis, Habilitationsschrift ETH Zurich, 2012.
[8] Chon, H. D., Jun, S., Jung, H., & An, S. W., "Using RFID for Accurate Positioning", Positioning, Science Research, 1(08), 2004.
[9] Wicks, A. M., Visich, J. K., & Li, S., "Radio Frequency Identification Applications in Hospital Environments". Hospital topics, vol. 84, no.3, pp. 3-9, 2006.
[10] Roberti, Mark, "How Can RFID Be Used With 3D Positioning?", RFID Journal, 05 October, 2010.
[11] GUPS Technology, https://mg.mail.yahoo.com/neo/launch?.rand=3mkmj5vtj6lev#6495391443, 2016.
[12] Landmarc, "Integrated Sensor Radio Frequency Identification (ISRFID)", Georgia Tech Research Institute Electro-Optics, Environment, and Materials Laboratory - GTRI Baker Building - Room 328 Atlanta, GA 30332-0834, 2002.
[13] Yeo, Melissa, Chaihirunkarn, Chalalai, Ren, Yifeng, Xie, Yang, Zhao, Ziwei, Vemuru, Vinod, "Innovative RFID Application for University of Pittsburgh Medical Center (UPMC)", Global Expert Engineering Knowledge Solutions (Greeks), 2016.
[14] Mendez, V. M., Acevedo, M. C., and Vélez, M. A., "Baby Care System", Electrical and Computer Engineering Department, University of Puerto Rico, 2010.