Course of unborn baby's heart by Wireless Baby Tracking System

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Abstract

The most important problem for pregnant and gynecologist is tracking of unborn baby. An important part of infant deaths occur in the last months of pregnancy. For this reason, by using an external fetal monitor non-stress test (NST) measurements are done for gathering information about the baby’s condition. This method is a procedure that requires specialist from a medical center. The proposed study aims wirelessly transmission of NST measurement results to the specialist or health center. Thus, in case of any particular problems by giving notice to the patient, it is intended to provide her being shipped to the nearest medical facility.

1. Introduction

In 1960s, death rate after 20th week in the womb was 11out of 1000, today this number has decreased to 5 out of 1000 babies. Approximately 90% of infant deaths reason is understood by autopsy after stillbirth[1]. Nowadays, the reason decrease in the rate of death is directly proportional to the technology. Infant deaths have decreased with the use of NST device.

The purpose of NST is to determine increase in heart beat rate together with the baby's movements. Factors such as age of pregnancy, baby in asleep, affects NST. To get the best results, testing should be done after 2 hours from meal. The measurement is done using two probes connected to the mother's abdomen. One of them monitors the hardness of the uterus and the other writes heart rate on the paper. During this process, the mother pushes a button with every movement of baby.

Routine application of NST will be useful for the following cases: Diabetes, Hypertension, Growth retardation, Heart diseases, Threat of premature birth, history of stillbirth, Anemia, Decrease in Fetal movements and other situations where the mother's womb may lead to death. There is no risk in monitoring NST.

Many studies have been already carried out on NST and provide extraction of data about the infant development and mother. [2-5] Because of the benefits brought by the fetal monitor, many different models has been developed and even some models has been modified to be carried out by patients. In later, version monitoring is done at home and data is carried to medical center. [6]

In this work we propose a more controlled and safe birth by using mobile NST system.

2. System Architecture and Implementation

Fig. 1 demonstrates the architecture of the proposed system, comprising from hearth beat and uterus cramp probes, NST sensing unit (SU), wireless communication unit (WCU), data storage and internet interface (DSII). The flow chart of process can be seen in Fig.2. Each step and/or unit is described below.

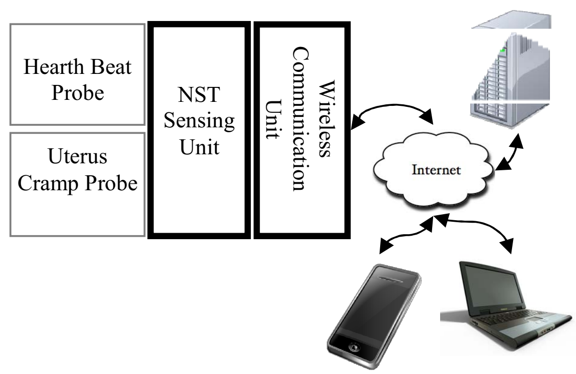

Fig. 1. System architecture of proposed wireless baby tracking system

2.1. Heart Beat and Uterus Cramp Probes

These are standard parts of a Fetal monitoring system. They are composed of Doppler heartbeat sensor used for tracking baby’s heart beat and a tocodynamometer (toco) pressure sensor used for detecting uterus cramps. The probes connected to SU with well insulated and high quality coaxial cables for low noise and electrical interference. The cables can extend up-to 3m to separate SU from fetus and pregnant mother to reduce exposure of RF radiation of Bluetooth module in the system.

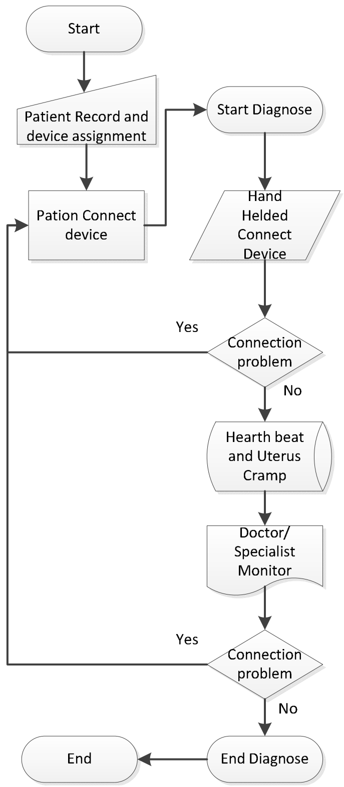

Fig. 2. Flowchart of designed system

2.2. NST Sensing Unit

This unit is responsible for gathering data from the probes. A 16 bit Microcontroller is used for system to convert the signals from analog to digital conversion. The comparison test to measure prototype data against a standard NST is under progress, the result demonstrates close matching between two monitoring devices. This unit is operated with both battery and electricity. The sensor circuit prototype was assembled by a firm.

Fig. 3. Sensing Unit

The photograph of prototype is shown in Fig. 3. It is equipped with a speaker to hear hearth beats. There is battery unit is also under the circuit with power of 4800MAh. In use of battery, the unit can operate about 6 to 8 hours. The unit contains a Bluetooth module configured to Serial Port Profile for transferring monitored data to WCU. The module is compatible with FCC Class 2 type communication devices. The FCC does not require Bluetooth devices to be certified with an SAR level, as cellphones are, because Bluetooth devices are considered to be “low-power, non-licensed radiofrequency devices.”[7]. The Bluetooth module can communicate with WCU up to 8 to 10 meters. Thus, the SAR level can be reduced by two orders of magnitude, separating module and probes reduce the undesired RF emission exposure to the fetus and mother significantly. This unit gets the commands via Bluetooth from WCU for start/stop monitoring and configuring communication interface. The circuitry diagram for the SU and Bluetooth module is shown in Fig. 4.

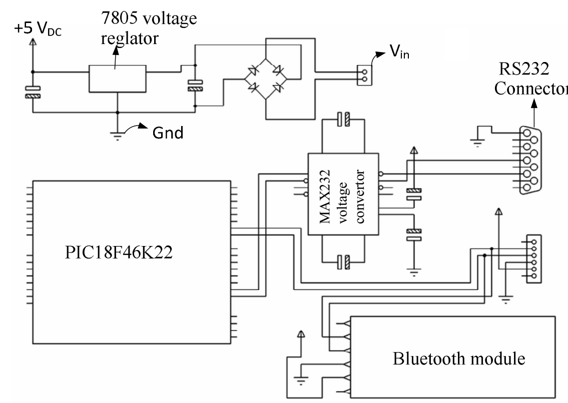

Fig. 4. Sensing Unit implemented circuitry

2.3. Wireless Communication Unit

This is an almost GPRS and Wi-Fi operated smartphone tailored for transferring data from NST Sensing unit to DSII. This unit is based on Google’s Android operating system. The unit communicates and controls the NST sensing unit via Bluetooth. By using Bluetooth, the module can be place far away from fetus and mother for undesired RF emission of WCU. The software on WCU registers the patient on device and informs DSII. The data is stored in DSII for observation of baby’s development history, clinical purposes and forensic cases like infant’s death.

The unit has self-storage incase of communication lost with the DSII. Due to GSM/GPRS network stability problems, connection can be lost for short time of periods, when connection lost the monitoring continues to save data to the self-storage with notifying user until the connection re-established. The WEB interface of the system also notifies the doctor for the connection lost. The network failures are logged for especially forensic cases. The stored data can be seen by pressing a button on the user panel of WCU as shown in Fig. 5. On the user panel, patient can monitor instantaneous hearth beats of fetus, which is shown in right-bottom of Fig. 6. The status of the Bluetooth connection is also show in left-bottom of same figure with green/red led image. The control panel is designed for easy use of patient.

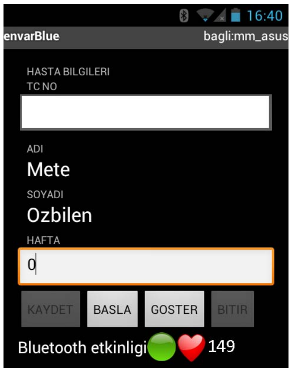

Fig. 5. Screen shot of control panel on WCU implemented on an Android

2.4. Data Storage and Internet Interface

This unit is combination of data-storage and a WEB server for registered doctors to monitor their patients in real-time with periodic updates. With the help of WEB interface the patient can be monitored from various devices like personal computer, tablets and smart phones.

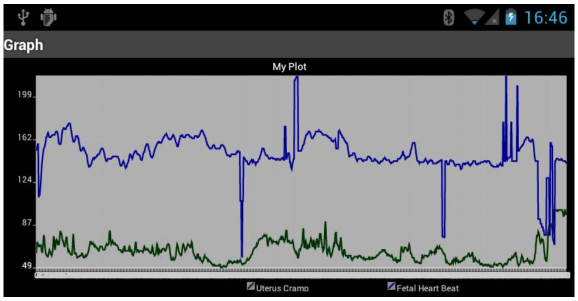

Fig. 6. Screen shot of stored-data on WCU implemented on an Android

3. DSII WEB Services

The DSII is cloud based server that stays in the middle of monitoring operation. The WCU unit periodically sends hearth beat and uterus cramp data. The periods can be 15, 30, 45, 60 seconds. To minimize the transaction time, data is compressed and during the active monitoring only raw data is sent to the DSII.

At the beginning of the monitoring WCU unit sends patient identification and active monitoring information to the DSII. This causes an update in doctor's active patient list. From the patient list, which is shown in Fig. 7, doctors can choose a patient for viewing her tracking history.

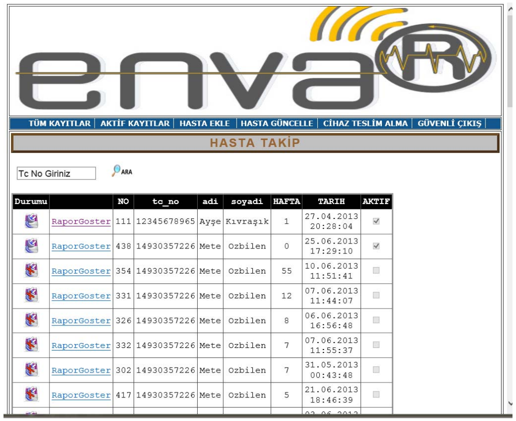

Fig. 7. Screen shot of implemented DSII WEB service

In the list "active" columns denotes whether patient is online or not. There is also a filter for quick accessing to active patient list of a doctor. The monitoring screen is shown in Fig. 8. The graph ranged to 20 minutes in horizontal axis. During the monitoring when the DSII lost connection to the WCU unit. A highlighted visual notification is showed embedded to graph for warning doctor. The DSII interface is also arranged to be fit on many mobile version of internet browsing software. The mobile version of DSII monitoring screen can be seen in Fig. 9. The image is also refreshed in real-time in mobile version of DSII monitoring.

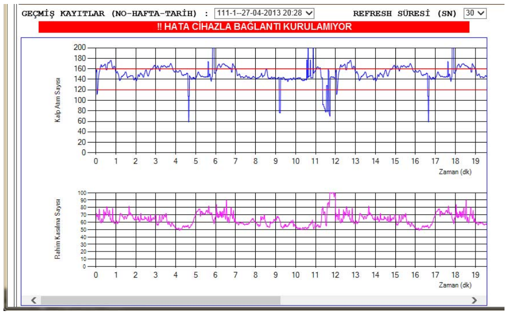

Fig. 8. Screen shot of monitoring DSII WEB service

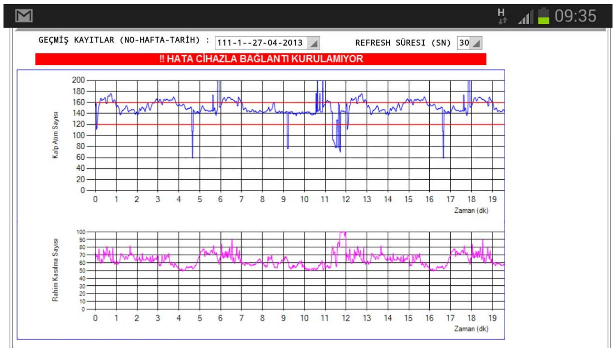

Fig. 9. Screen shot of monitoring DSII WEB service on Android Browser

The DSII also give doctor to manage his/her patients. With the help of DSII WEB interface a doctor can easily add, update and delete from his/her patient list. The DSII is secured with user name and MD5 type password for unauthorized accesses. There is a session time-out for security purposes in case of 2 minute inactivity. WEB Interface is designed easy and clearly to understand and use.

3. Future work

In the future study, we subject to develop a sensing unit with more accurate data and capable of detecting twins hearth beat. The DSII is planned to re-engineer to minimize the delays for data update. WCU will be developed to display real-time graph. Various client versions of DSII will be implemented for wider mobile support such as IOS, Android and Windows Phone. A messaging system will be integrated to DSII for messaging between doctor and patient, and warning doctor when a patient of him/her becomes online or offline. The DSII data structure will become compatible with ministry of Health databases.

4. Conclusions

The present NST monitoring technology is both wired and constrained to health centers. As a result the health center and patient have to be physically located, in time and place, in order to collect the measurements, provide diagnosis, and care. The proposed system is both wireless and mobile introducing a new prototype for care. The measurement can be done as close to the mother's location as possible while the data is viewable from any device like smartphone, tablet, or personal computer.

The proposed wireless tracking system uses of sensors, short range radios (Bluetooth), Wi-Fi and cellular data communication network and internet for remote monitoring and reduces the size and cost of the device, without negotiating the quality of measurement.

The system that is described in this paper is a patent-pending engineering investigational prototype and is not available for commercial distribution or professional use. The full system has been implemented and tested and is in the process of undertaking feasibility trials in suitable clinical settings.

Acknowledgment

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7. References

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