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# eNAI: ELECTRONIC NATAL ASSISTIVE INTERVENTION

**John Eddie R. Ayson, Nathaniel D. Cruz, Maria Angela A. Edora and Luis G. Sison**
*College of Engineering, University of the Philippines Diliman*

## ABSTRACT

*Maternal mortality is a perennial problem in the Philippines due to inaccessible quality maternal care. Many cases of maternal deaths could have been averted if essential obstetric care was readily available. Ideally, at least one obstetrician should be present in every health center. This is not the case, however, given the low number of medical professionals working in rural areas. Against this backdrop, the researchers came up with eNAI: Electronic Natal Assistive Intervention. This is a compact and portable device that combines maternal and fetal health monitoring with telemetry and current technologies to bring obstetric care to expectant mothers even when obstetricians are physically absent.*

*eNAI has four biomedical modules: a fetal doppler, a toco transducer, a sphygmomanometer, and a pulse oximeter. These were tested, calibrated and benchmarked against their medical-grade equivalents, and finally interfaced to the processing units. A telemetry functionality was added to facilitate communication between the midwife and an expert. Moreover, the system can retrieve patient data by accessing CHITS, an electronic medical record system.*

*From discussions with midwives and ob-gyns, the group established that the modules are necessary for fetal and maternal health monitoring. In addition, telemetry was perceived as a useful functionality, and overall, the eNAI was welcomed as very helpful in assisting with labor.*

## 1. RATIONALE AND SIGNIFICANCE

Though generally at par with other countries in medical technology, the Philippines still lacks dissemination of quality healthcare services, especially in rural areas where they are greatly needed. In response to this, the National Telehealth Service Program (NTSP) teamed up with the Electrical and Electronics Engineering Institute (EEEI) to produce a telemedicine appliance for remote consultation and diagnostics named RxBox. However, one of the most important healthcare services was overlooked in the development of RxBox – a maternal and fetal health monitoring system.

Maternal mortality rate in the Philippines is relatively high. This raises the need for a maternal and fetal health monitoring system for the rural health centers and lying-in clinics. eNAI was developed as a solution to this problem. eNAI is a compact and portable Android-based fetal and maternal health monitoring device with telemedicine capabilities. This device aims to assist doctors-to-the-barrios, barangay health workers and midwives during maternal labor, and to provide them with easy access to an electronic medical record system.

Correspondence to: Electrical & Electronics Engineering Institute, University of the Philippines, Diliman.
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## 2. OBJECTIVES

eNAI aims to provide assistance to doctors-to-the-barrios and midwives in communities that lack quality maternal healthcare services. The implemented system would provide them with a compact device that could be used to monitor the progress of maternal labor, access an electronic medical record system, and facilitate communication with experts not within their community. It is also the researchers' objective that the designed system be suited to the current practices of midwives.

## 3. PROBLEM STATEMENT AND DESCRIPTION

About 230 Filipino women die for every 100,000 live births. Other Asian countries register much smaller mortality like Thailand with 110 deaths, Malaysia with 62 and Singapore with only 14. These data show that the Philippines has a relatively high mortality rate compared with its neighboring countries. Around 11 women die in the Philippines alone due to births and miscarriages. Many of these cases could have been averted if only all known interventions were applied appropriately and access to essential obstetric care was provided. These facts raise the need to provide maternal and fetal monitoring systems in underserved communities.

Currently, midwives use the doppler ultrasound and sphygmomanometer to monitor fetal heart rate and maternal blood pressure, respectively. As for the pulse rate and uterine contraction, manual assessment is still done. At present, only hospitals have fetal monitors. Lying-in clinics and health centers are unable to acquire the said device due to its high cost. In addition, the archipelagic nature of the country and the concentration of doctors in urban areas, have inhibited access to quality maternal care in the poorest and most rural places in the country.

A device capable of automatically recording all essential medical data will greatly improve the monitoring of maternal labor. Furthermore, adding an easy access to medical records in the system will boost its efficiency. The problem of cost is also taken into account. Thus, the envisioned device must be cost-effective.

The problem of access to essential obstetric care may also be addressed by providing telemetry capability. In this manner, midwives will be able to communicate with experts in cases when assessment of an obstetrician is needed.

## 4. METHODOLOGY

This project covered the integration of a functional maternal and fetal health monitoring modules and telemedicine capabilities to an Android device.

The essential biomedical parameters, namely the fetal heart rate (FHR), uterine contraction (UC), blood pressure (BP), and pulse rate and oxygen saturation (SpO2) were collected using the biomedical acquisition modules. The microcontroller acted as the primary signal processing device for the data gathered from the modules. Furthermore, the Android device served as the user interface and the local data storage for the biomedical parameters obtained by the microcontroller. Patient data, and previous maternal visits, if any, were fetched from a remote server through CHITS (Community Health Information Tracking System) [2]. After the labor, the data was compiled and saved to the local database. Video conferencing was also integrated to the system for telemetry purposes.

 

Providing a new technology might be maladaptive since the midwives were already used to specific practices. This was addressed by continually gathering feedback from the medical practitioners and clinics during the project development. Hence, the system was also designed to be user-ready based on these feedbacks.

The overall Graphical User Interface (GUI) resembled the Partograph [3] – a tool midwives use to record the details of a delivery. It was shown to them and to ob-gyns to gather reactions on the look and feel of the application. Revisions were made based on the gathered data. The fetal heart rate monitoring adapted the beat-to-beat detection algorithm [4] and was tested on synthetic audio heart data and real fetal heart data. As for the uterine contraction monitoring [5], simulated pressure data were used to calibrate the implemented instrument. Both BP and Pulse Oximeter readings were gathered from a number of volunteers, and were calibrated against a commercial module.

## 5. RESULTS AND RECOMMENDATION

A system for monitoring the progress of labor and automatically recording necessary biomedical signals was developed. For its central processing units, the researchers used an Android tablet and a Seeduino ADK main board. The biomedical acquisition modules – Fetal Doppler, Blood Pressure meter, Tocometer and Pulse Oximeter – can all feed data simultaneously to the processing units. The overall GUI was designed to be user-ready to improve the recording without making a lot of adjustments from the current practices. The system is also capable of retrieving data from an electronic medical record system called CHITS. In addition, it has the ability to connect the user (midwife) to experts from further areas through a video call running under VoIP.

Each sensor was calibrated and tested under lab setting. The implemented fetal heart rate algorithm was accurate and noise-tolerant. Furthermore, the toco transducer was operational and five times more cost-effective than its commercial counterparts. Both the blood pressure and pulse oximeter modules reached the same accuracy attained by the RxBox [6].

eNAI has provided a compact, portable device that could be used to monitor the progress of maternal labor, access an electronic medical record system, and facilitate communication with experts. However, further calibrations of the interfaced biomedical modules and the approval of health experts are necessary before testing on actual patients may start.

Doctors and staff from health centers recommend a packaging adapted to the health center's room setting and an additional temperature monitoring module.

The researchers also recommend the addition of other modules such as eLearning modules, newborn hearing screening and prenatal and postpartum check-up modules.

**Figures**

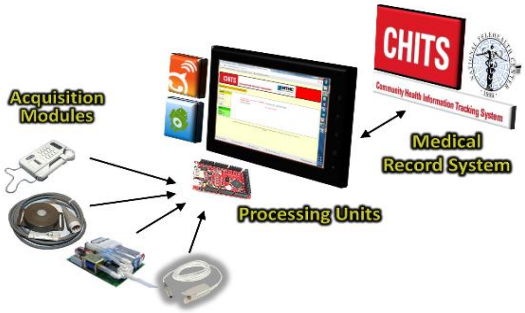


**Figure 1** System Overview

 


**Figure 2** Packaged eNAI Device


**Figure 3** eNAI Graphical User Interface

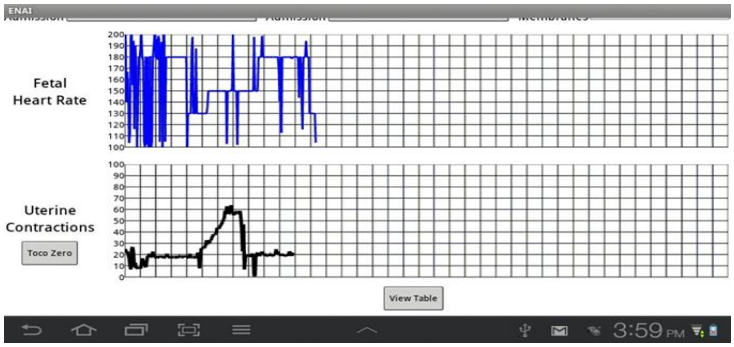


**Figure 4** Real time fetal heart rate and uterine activity plot

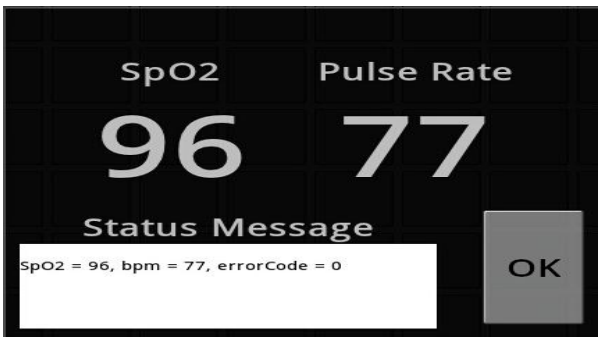


**Figure 5** Pulse rate and oxygen saturation monitoring user interface

 

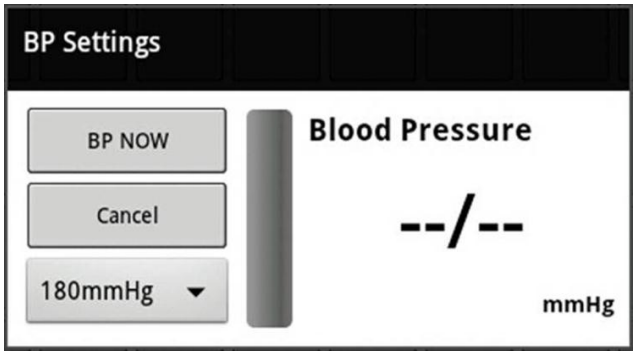


**Figure 6** Blood pressure monitoring user interface

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