Birth Record Communicator: A Pathway to Automated Health Data Acquisition System

Ali Shihab Sabbir¹, M Omar Rahman¹, Khosru Md. Salim¹, Md. Raihan Bin Rafique¹, Md. Mustafizur Rahman², Md. Hasanuzzaman Bhuiyan⁷, Hasan Shahid Ferdous², Syed Ishtiaque Ahmed²

¹Department of CSE, Independent University, Dhaka, Bangladesh
²Department of CSE, Bangladesh University of Eng. & Tech., Dhaka, Bangladesh

Abstract-

The problem of child malnutrition remains persistently high in the developing world particularly among the ultra-poor in the South Asia. Bangladesh, like most other countries in this region, does not have any database for birth records. Most of child births are still taking place at home with the help of a midwife and consequently no systematic records related to birth are maintained. The two most significant factors contributing to childhood malnutrition are low birth weight and premature delivery. In order to have a good understanding of the problem and develop appropriate intervention mechanisms we need a comprehensive database of birth records containing birth weights and gestation ages of the newborns. An application domain that makes use of wireless sensor network technology can be found in the area of above discussed medical monitoring. This field ranges from monitoring patients in the hospital using wireless technology in order to remove the constraints of tethering patients to big bulky, wired monitoring devices to monitoring people in their everyday lives to provide early detection and intervention for various types of disease. This paper discusses how can we automate the process of getting child birth weight from the remote with the help of wireless technology and modern microcontroller technology.

Introduction

Low birth weight has been defined by the World Health Organization (WHO) as weight at birth of less than 2,500 grams (5.5 pounds). This is based on epidemiological observations that infants weighing less than 2,500 grams are approximately 20 times more likely to die than the other babies. It is more common in the undeveloped and developing countries than the developed ones and it contributes to a range of poor health outcomes.

Reducing the low birth weight incidence by at least one third by the year 2010 was one of the major goals in ‘A World Fit for Children’ program, the declaration and plan of action adopted by the United Nations General Assembly Special Session on Children in 2002. The reduction of low birth weight also forms an important contribution to the Millennium Development Goal (MDG) for reducing child mortality. Activities towards the achievement of the MDGs will need to ensure a healthy start in life for children by making certain that women commence pregnancy healthy and well nourished, and go through pregnancy and childbirth safely. Low birth weight is therefore an important indicator for monitoring progress towards these internationally agreed-upon goals.

One of the major challenges in measuring the incidence of low birth weight is the fact that more than half of infants in the developing world are not weighed. In the past, most estimates of low birth weight for developing countries were based on the data compiled from health facilities. However, these estimates are biased for most developing countries because the majority of newborns are not delivered in facilities, and those who are present there only a selected sample of all births. More importantly, they may form the portion of the society who is more aware or conscious about the child and mother’s health than the people who have this delivery at home. So these study may be biased and not reflect the actual scenario. To address these issues effectively, we are suggesting here a very low cost automated system which will help us to gather real birth weight of the infants.

Related Works

Large field surveys are a common feature of the health research landscape. In low and middle income countries where capacity and administrative problems with the collection of health data are common, surveys are often the only way to collect reliable data.¹² Paper based data collection has been the standard method for decades but errors are frequent, storage costs are prohibitive, and the costs of double data entry are high. Electronic methods of data collection have been developed in order to merge the process of data collection and data entry. Handheld devices such as personal digital assistants (PDAs) are increasingly being used instead of paper and pencil methods of data collection.¹³ PDAs are not without problems of their own, however, including the challenges associated with having to download data (often to expensive laptops in the field). In addition, data can be corrupted if PDAs are damaged, or data can be lost if PDAs are misplaced or stolen.
Wireless and mobile phone technologies have the potential to overcome some of these limitations. Moreover, they can be adapted for use in field research settings. Low and middle-income countries lack the infrastructure in many research field settings to accommodate adequate fixed line internet access, whereas wireless networks allow access to telecommunications in a region where fixed lines remain limited. In Africa, mobile users account for 83 per cent of telephone subscribers, a higher proportion than any other region in the world. South Africa leads the continent in mobile penetration with 36.4 mobile phones per 100 population. Use of mobile phones is widespread even in remote areas of rural South Africa.

The use of mobile technology as a research instrument is in its infancy, however. Studies conducted in developed country settings have investigated the use of cell phones on the patient end to generate feedback for improved chronic illness care and monitoring, increased medication compliance and smoking cessation, or reduced missed clinic visits. Additionally, other studies have investigated the use of cell phones on the provider end to transmit images for documentation or diagnostic purposes. However, few studies have investigated the use of mobile phones as a data collection tool in low income countries. One demonstration project in Peru showed that a cell phone-based system could be used to collect real-time data on adverse events occurring during the course of a randomized trial. The Millennium Villages Project has also begun efforts to use mobile phones to monitor livestock health, facilitate the timely transfer of patients to appropriate health facilities, and support community health workers in the field. Finally, there are numerous reports, but few published studies exist.

In the context of poor research infrastructure and of increasing demands for large scale health surveys, the affordability and availability of mobile phones and wireless networks make them a viable alternative to traditional paper and pencil methods and even PDAs. In this paper we report on the use of mobile phones technologies in Bangladesh using health workers to collect birth weight data of infants. We investigated the feasibility, the ease of implementation, and the extent to which health workers with little experience in electronic data collection could be trained and successfully supervised to collect data using mobile phones in a large health survey.

Our system - Birth Record Communicator

The ‘Birth Record Communicator’ that we have devised is essentially a weighing machine embedded with a communication device. Additionally the module will have provisions for accepting two external inputs: Sex and Gestation age. For Male/Female we propose having two separate buttons rather than a single toggle, effectively eliminating the problem associated with default bias. For gestation age we will have 4 buttons (suggesting months of pregnancy) marked 6, 7, 8 and 9+, instead of providing a numeric keypad. For the communication module we have used a GPRS modem ($50) (giving us future capabilities to upload the gathered data to a web-server instead of depending on text messages). The different inputs: weight, sex, gestation age will be collected and transmitted to the mobile phone with the help of a micro-controller (we used PIC16). Our module also has a small LCD display that will show the information for verification. Once verified, pressing a ‘Send’ button will form a text message and send the message. The message will be captured by another mobile phone connected to the remote server hosting the database. The information, gathered manually, is prone to errors due to inadequate data entry skills and possible recall bias of the midwives. The acquired data is subsequently subjected to deliberate or inadvertent corruption. We believe, empowering the midwives with adequate technology to

a) Record the essential information related to a birth, e.g., date, sex, gestation period (months) and most importantly, the birth weight, accurately and reliably and
b) Communicate the information to a central repository
will contribute greatly in the development of a birth record database. This may be a major step towards appreciating the nature and extent of the malnutrition problem. So, the project involves development of the followings:

(a) A Web based Information system for monitoring the birth weight of each region.
(b) SMS interface for integrating SMS messages from the midwife using either 2nd Generation mobile systems (GSM/CDMA) or GSM Modem with the Information system.
(c) The Microcontroller based weight machine which will help the midwife to collect the weight and other relevant information and send it to the central Information system i.e. SMS server.
It is quite obvious that the data collection starts from the remote site with the help of our weight machine.

a) **Weight Machine**

The weight machine includes the following modules.
1. A flat comfortable bowl to place the infants.
2. On board interface to communicate with midwives.
3. A small LCD display.
4. A transducer for collecting the weight.
5. A Microcontroller for two-way communications
   a. One end for transducer and communication with the user
   b. Another end for sending information to the SMS server

Now we will discuss each part of the machine in detail.

b) **A flat comfortable bowl to place the infants**

Since we have to place the infants somewhere to measure their weight, our weight machine must have a comfortable bowl to place the infants there.

c) **On Board interface to communicate with midwives**

As our main concern is to remove the assumption that our midwife are quite learned to send text messages, we have to design an interface that is at the same time quick and successful to send all the necessary data and also have a minimum number of buttons to press. Our interface board consists of the following type of keys:
   a. **Keys for sex identification**
      We have two different keys named as M and F for male and female respectively. Two separate buttons rather than a single toggle, effectively eliminating the problem associated with default inputs.
   b. **Keys for gesture periods**
      For gestation age we have 4 buttons (suggesting months of pregnancy) marked 6, 7, 8 and 9+, instead of providing a numeric keypad.
   c. **Keys for clearing the screen**
      Once a data is sent to the server, the midwife can clear the previous data to collect the data for the new one by pressing the clear button.
   d. **Keys for sending SMS**
      Finally, a key for sending SMS to the remote site.

d) **A small LCD display**

To know whether the information is being correctly inserted, we have also provided a small LCD display containing the sex, gesture period and weight of the infants.
e) Microcontroller

The heart of our system is the microcontroller which is actually automating the process of collecting weight, communicating with the midwives and send SMS to the server. Microcontroller has two different tasks in our system as described below:

i) Transducer and user interface end:
Since the transducer gives the weight in a very weak analog signal, it is necessary to amplify the signal using OpAmp before converting it into the digital signal. After the amplification of analog signal we pass it on to the ADC (Analog to Digital Converter). After the weight is being displayed on the LCD display, the job of the microcontroller is to interact with the users i.e. midwives to receive the gestation period and sex information.

ii) Sending SMS end:
The SMS end of the server does the job of sending sms to the central server. We have use the AT Command set in the GSM Modem to do this part. The AT command and other microcode are burnt into the microcontroller for the purpose.

iii) Energy Source for the remote site
The energy need of our module will be satisfied through a rechargeable battery (9V), providing power to the microcontroller circuitry and the mobile phone. A separate charging dock for the device is planned that may be connected to either a conventional (AC) outlet or, in case that is not available, through a small (5 Watt) solar panel.

f) Base Server
The data, once received by the server will be extracted and entered in a database. Subsequently, the data is available through a web server for real-time global access and may be used for GIS mapping.
System Implementations

The proposed overview of this system is the direct implementation method. Here it is proposed that the gathering birth weight Information can be totally automated by the newly developed system. Health issues like birth weight are a serious issue and we tried to take every possible measure to ensure minimum chance of human intervention and error. This is to ensure adequate measurement of birth weight of infants as it excels current health care system into high and qualitative health care administration.

Conclusion

Providing midwives with a conventional weighing machine and a mobile phone, and also training them how to send the gathered information through a text message may solve the same problem with little less cost but depends heavily on the communication and technical skill of the midwives. This approach is also subjected to errors both at the data acquisition phase (taking weight reading) and the data entry phase (typing the text message). Having a machine that captures the birth weight automatically eliminates the human error associated with taking the reading. Moreover, for information other than weight, the well-marked buttons that only need to be pressed, effectively eliminate the need for the health workers to be able to read and write, as many of them, lacking conventional education, do not have adequate communication skills. In addition, a structured, button-driven input mechanism will limit the scope of making mistakes in gathering birth related data.

References