MOBILE EMR
FOR DEVELOPING COUNTRIES

ENGL 398
PROJECT PROPOSAL

BY BRYAN MARTY

TABLE OF CONTENTS

EXECUTIVE SUMMMARY

Many developing countries lack the infrastructure to provide efficient patient tracking and medical records, inhibiting a doctor's ability to quickly and effectively provide accurate diagnoses and treatment. I propose that a mobile application be developed and provided to single-practicing doctors in developing countries, and eventually integrated into existing hospital electronic medical record (EMR) systems. The application would be able to plug into many open-source EMR systems, allowing doctors to more easily identify patients, and prevent them from assuming a false identity. The patient history would be available so doctors could see previously purchased medicine, as well as prior treatment and surgery. Data on disease outbreaks would be collected and analyzed in real-time to provide faster relief, and prevent further sickness among the population. Finally, the application could be used to track shipments of medical drugs between clinical, reducing human error during transfer process.

Humanitarian organizations such as the World Health Organization and Doctors Without Borders would benefit from the application's ability to identify and locate patients, as well as retrieve important medical history. In countries that lack sufficient roads, the application can be used to track patients via global positioning satellites. As a junior undergraduate of Case Western Reserve University with past experience in managing a mobile application development team, I am confident in my abilities to develop and maintain an application that can improve healthcare and provide real-time updates on disease outbreaks.

PROJECT DESCRIPTION

Many developing countries lack the infrastructure to provide efficient patient tracking and medical records, a problem that could be solved by a smartphone application that uses the GPS and Internet to collaborate with doctors and hospitals in real-time. A mobile application should be developed and provided to single-practicing doctors in developing countries, and eventually integrated into existing hospital electronic medical record (EMR) systems. The application would be able to plug into many open-source EMR systems, allowing doctors to more easily identify patients, and prevent them from assuming a false identity. An up-to-date picture could be taken by the mobile device, and added to the patient profile, to prevent mistaken identity (see Figure 1). In addition, biomarkers such as weight, height, foot size, fingerprint, and tattoos would be recorded. Patients could also be provided with a health card, printed with a special QR code, which would identify them in healthcare system. The patient history would also be available, so doctors could see previously purchased medicine, as well as prior treatment and surgery. In order to accommodate any special circumstances, the application will also feature a "Notes" section

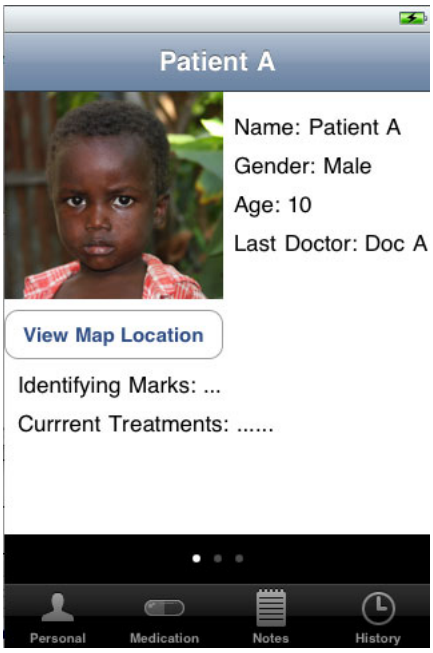

FIGURE 1: MOCKUP

(see Figure 1), where the doctor can write anything he or she wishes. These notes will be viewable to all other doctors, ensuring the ability for full communication and disclosure of vital information. Data on disease outbreaks would be collected and analyzed in real-time to provide faster relief, and prevent further sickness among the population. This data will be automatically plotted on maps, and a server will derive statistical information automatically. This data will be freely accessible via a special website, allowing for public, up-to-date information on the latest outbreaks.

BACKGROUND AND SIGNIFICANCE

Developing countries face many challenges regarding infrastructure for communication and travel. Africa is home to over a billion people, yet consumes only four percent of the world's electricity. Despite tough economic conditions, cell phones and mobile devices have become a key tool in communicating information and ideas.[1] There is very little electricity available in developing countries, but mobile devices are still feasible due to their low power consumption. Devices like cell phones and iPods, with GPS capabilities, provide the hardware needed to begin sharing information about patients and diseases with other doctors. While many people in developing countries cannot afford expensive smartphones, doctors could be furnished with smartphones to improve their patient tracking system.

PRECEDENTS

Dr. Steven Lane, Clinical Associate Professor of Medicine at Stanford University, assembled a group of volunteers to visit Haiti and provide relief to the thousands injured during an earthquake. The group piloted a new mobile application called iChart ($139.99, Figure 2[2]), with the goal of recording demographic data, diagnosis, and treatment for the local government and UN[3]. While the data they collected was useful, it lacked important location information. There are very few roads in Haiti, and many people do not have address. Dr. Steven Lane's team worked at local shelters, and thus was unable to provide accurate information on where patients lived. This information is important, because doctors need to be able to locate and contact patients about test results and important health information. GPS tracking would greatly benefit doctors and hospitals when locating patients, providing the exact coordinates of villages and settlements located in developing countries. Another issue with the iChart application was its inability to provide data in real-time for analysis, a task that is crucial for tracking disease outbreaks in real-

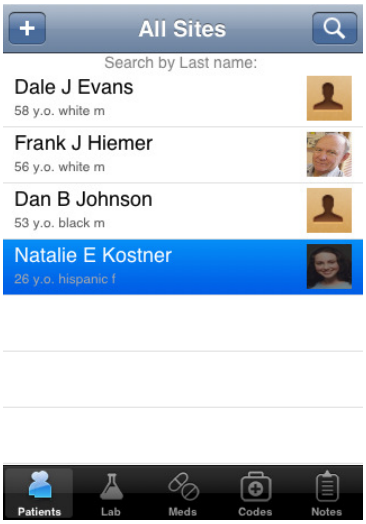

FIGURE 2: ICHARTS[2]

[1] Intelligent Life, "DIGITAL AFRICA" http://moreintelligentlife.com/content/ideas/jm-ledgard/digital-africa?page=full

[2] iCharts iTunes Preview, JPG, http://itunes.apple.com/app/ichart-emr/id284964162?mt=8

[3] David Callaway, "The Haiti Information Technology Rescue Project: Electronic Medical Record and Patient Tracking Assessment" 5.

time[4]. Dr. Lane's experience shows that mobile applications for EMR systems can be used in developing countries, even though electricity and communication infrastructure is sparse.

BENEFITS

There are many benefits to a location aware EMR application. Roads can be scarce in developing countries, and people do not always have permanent addresses. After a doctor finds the result of a test, such as a test for HIV or AIDS, it can be difficult to find or contact the patient to make him aware of the results. Additionally, single-practicing doctors record all their data in a journal, making the sharing of information difficult. If a patient goes to another doctor, that doctor may not know anything about the patient's medical history, allergies, treatments, or prior medical drug purchases. A mobile application would replace this journal, providing a searchable list of patients (see Figure 3) and allowing the doctors to view the patient's records. Many of these doctors can go out to villages, and can record the location of patients, or ask them to point on a map where they live if they go to the doctor's residence. The real-time use of this data would allow for real-time identification of disease trends and their source. For example, an outbreak of cholera could be easily tracked in real-time, and geographic data could help determine the source of the bacteria. Knowing this information would increase the efficiency of relief organizations providing medical aid to affected areas.

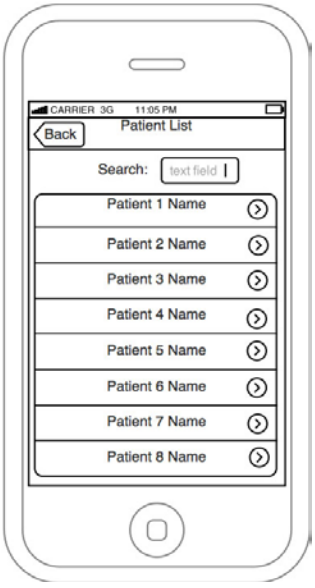

FIGURE 3: PATIENT LIST

According to Richard Arlow, a graduate student at Case Western Reserve University School of Medicine who visited Haiti in March 2011, there is a need to track shipments of medicine and medical devices between clinics and single-practicing doctors[5]. Currently, this exchange of goods is recorded and processed by hand, leading to many human errors during transfer. In countries such as Haiti, certain areas will mass purchase medicine and drugs, and will receive these goods by truck. As the truck driver goes from clinic to clinic, collecting these supplies, the driver must fill out many forms regarding his cargo. By implementing an automatic system within the EMR application, the driver would no longer need to fill out so many paper forms, reducing the possibility of human error, and saving valuable time and resources.

INTEGRATION

The current ecosystem of electronic medical record software is vast, and the addition of another EMR system would only add to the complexity of decision making when a hospital selects an EMR solution. Previous EMR systems have been developed, but due to their proprietary nature are expensive to upgrade and maintain. Hamish Fraser, an Assistant Professor at Indian University

[4] [4] David Callaway, "The Haiti Information Technology Rescue Project: Electronic Medical Record and Patient Tracking Assessment" 16.
[5] Richard Arlow, interview by Bryan Marty, March 27, 2011, CWRU Rockefeller 206.

School of Medicine, believes "collaborative development between projects using an open source model (even if the underlying operating system is not open) has great potential to improve quality of software and reduce costs".[6] Therefore, instead of creating an entirely new EMR system, the smartphone application would be integrated with existing systems (Figure 4). Such an application would allow for better communication between single-practicing doctor, clinics, and hospitals. In addition, the system would be extremely versatile, allowing it to be used in many developing countries at once, no matter what type of EMR system they use.

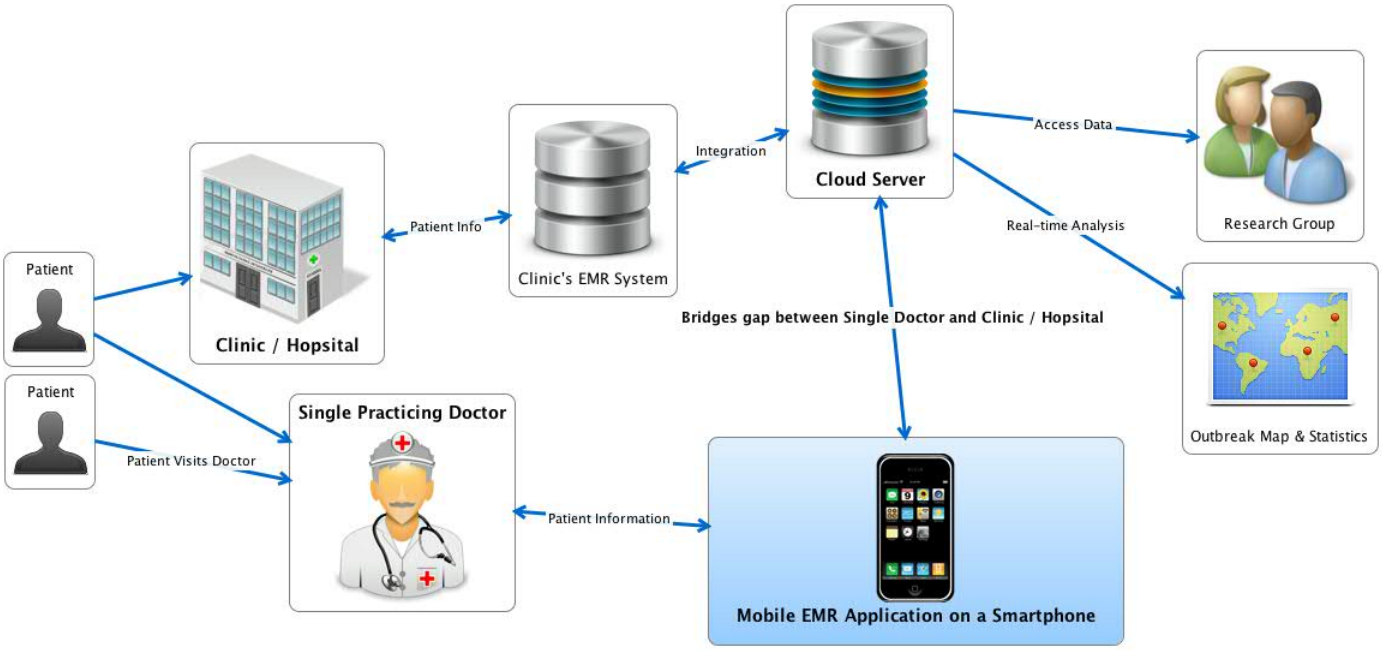

FIGURE 4: INTEGRATION WITH A CURRENT EMR SYSTEM

POTENTIAL INVESTORS

While beginning as a non-profit campaign, this project has a commercial application for researchers who need access to outbreak statistics. International medical humanitarian organizations, such as the World Health Organization and Doctors Without Borders, could fund the development and use of such technology. These organizations have a board of directors that would be responsible for green lighting the project, and propelling to multiple countries. These organizations are dedicated to saving life and improving patient care. The World Health Organization agenda outlines 6 objectives it uses to measure its performance[7]. Point numbers three and four, "Strengthening Health Systems" and "Harnessing research, information and evidence" are two examples of where this project meets the goals of humanitarian organizations. A smartphone application that improves

[6] Hamish Fraser, "Implementing electronic medical record systems in developing countries," 93.
[7] World Health Organization, "The WHO Agenda," http://www.who.int/about/agenda/en/index.html

collaboration between doctors, clinics, hospitals will improve the care a patient receives, especially in developing countries. Many of these organizations already have people located in developing countries, and once a working application is complete, can be supplied with a smartphone. The World Health Organization is governed by the World Health Assembly, which is comprised of delegates from 193 member states. The Director General, Dr. Margaret Chan, would have the authority to present any proposal to the assembly.

In addition to the World Health Organization, Doctors Without Borders would find the application extremely useful in their day-to-day work in developing countries. Doctors Without Borders sends doctors to various developing countries, who could be trained to use a mobile EMR system. Since the 2010 earthquake that hit Haiti, Doctors Without Borders has treated over 100,000 people for cholera. Now that the epidemic in Haiti has begun to subside since February 6, 2011, they are in need of an effective monitoring system to help prevent further devastating outbreaks. In their news release, they state, "close monitoring of the situation is still required because cholera is now endemic in Haiti and the rainy season will start soon, increasing the risks of a resurgence of the epidemic".[8] With an ability to track real-time disease outbreak, Doctors Without Borders will be able to detect and respond quickly to any disease outbreak that doctors may encounter. While the application itself falls under their humanitarian missions, research groups wishing to access non-identifying data could provide another source of income to help cover expenses.

QUALIFICATIONS OF THE RESEARCHER

I am a junior undergraduate of Case Western Reserve University, focusing on a Bachelor's degree in Computer Engineering. My high level coursework has focused on operation systems, mobile development, algorithms, and digital logic design. I led and managed a 9-person team to develop an Android based GPS game, which was reviewed by Electronic Arts (EA). The experience improved my skills in team management, deadline assignment, and project management. In addition to my academic studies, I am involved in a local nonprofit organization called GeoHealth, which aims to improve the quality of healthcare in Haiti though the use of mobile devices. I currently work for Information Technology Services at Case Western, maintaining custom web-based learning software used by professors who wish to provide a social learning experience in their classrooms. I am confident that I can successfully manage a team of programmers and artists to develop this application, while working closely with the medical graduate students in the CWRU School of Medicine.

ANTICIPATED OUTCOME

The goal of this project is to help single practicing doctors locate, identify, and make accurate diagnoses, despite the poor infrastructure seen in developing countries. I anticipate that this project will meet these projected goals, and will be adopted by many developing countries for use in their healthcare system. The application will allow doctors to more easily identify patients

[8] Doctors Without Borders, "Haiti: Cholera Cases Decline but Vigilance Still Needed," http://www.doctorswithoutborders.org/news/article.cfm?id=5051&cat=field-news

through the use of biomarkers, questions, or a health card. This will help to prevent misdiagnoses and treatment, should a doctor accidently retrieve the history of another patient and make important decisions based on irrelevant information. The ability to retrieve information about patients will allow clinics and hospitals to collaborate and verify personal information and medical records, preventing mistakes caused by incorrect or unknown information. Through the use of the GPS location, doctors will be able to easily track down patients, and easily interoperate disease outbreak information. Should and outbreak occur, the data is automatically plotted on a map, in order to help humanitarian organizations provide fast, effective relief. Should the need arise, this data could be accessed by research groups, in order to perform studies that could help further our understanding of infectious diseases. Such information is valuable in understanding, treating, and preventing disease outbreaks among all populations.

ANTICIPATED FACULTY INVOLVMENT

Bruce Terry, faculty and student mentor in the STEP program, has been working with GeoHealth and I to help define our goals and desired outcomes. He has gracious donated his time on Saturdays to meet with him, and discuss our progress, questions, and concerns. Together, we developed a Job Map, outlining the details of what type of job our application will do, in addition to the expected outcomes. In addition, Professor Marc Buchner of the Electrical Engineering and Computer Science Department at Case Western Reserve University will be providing crucial insight to the usability of such an application. Professor Buchner is in charge of application development, and has many resources at his disposal for testing, implementing, and advertising mobile applications. He will be providing feedback for the user interface, to ensure it is user-friendly. In addition to his valuable input, he is also allowing us to use of the EECS Virtual Worlds Gaming Laboratory for any development needs. This lab consists of powerful desktop computers, a sound recording studio, and various systems such as iPods to use in testing.

SCHEDULE

This project will be completed in eleven months, but because the needs of people and healthcare are constantly changing, this project will continue past the eleven-month period. Table 1: Schedule (below) outlines the initial schedule for the first eleven months, during the application will be developed, tested, and distributed. During Months 3-9, there will be weekly code-review meetings, where the developers will review current progress in relation to goals, make adjustments to code, and analyze each other's code to provide useful tips on improving quality and performance.

TABLE 1: SCHEDULE

Duration	Description
Month 1	Establish working environment, order necessary smartphones, computers, and equipment. Order the necessary servers and establish daily backup routines.
Month 2	Design mockups for the user interface and establish initial functionality goals. Determine how the application will interact with online servers through the appropriate API.

Month 3 – 5	Begin coding the smartphone application
Month 6	Program the necessary web server protocols for relaying, storing, and analyzing data.
Month 7	Write the necessary server code to integrate the application with current EMR systems, such as OpenMRS
Month 8	Build online web portal to allow for researchers and doctors to analyze and track disease outbreaks.
Month 9	Field-testing the application and web portal. Fix any issues or bugs that appear
Month 10	Travel to target countries (starting with Haiti), distribute mobile device to single-practicing doctors, and train them how to use the application. Work with existing medical clinics to integrate our application with their EMR system.
Month 11	Follow up with doctors, clinics, and hospitals. Send out a survey to gather feedback. Address any issues. Continue to provide support and upgrades.

BUDGET

The itemized breakdown below will cover a period of one year, and the distribution of 30 smartphones to single practicing doctors. Certain expenses such as server costs, developer salary, and cellphone access will need to be re-purchased every year. Income from research groups looking to gain access to advanced outbreak statistics will help to pay for these costs, in addition to donations and money from investors.

TABLE 2: BUDGET

Item	Description	Supplier	Cost
Developer Salary	$20 per hour		$210,000[9]
Computer Equipment	Apple iMacs and Macbook Pros	Apple	$21,000
Apple Developer Fee			$99
Android Marketplace Fee			$25
Cloud Server	Website and data integration	Rackspace	$1,788[10]
Smartphone	30 mobile devices with GPS [11]	Apple & Motorola	$6,000[12]
Cell Plan	Includes data charges	Digicell	$21,600[13]
Plane Tickets	Send group to distribute devices and train doctors	US Airways	$1,116[14]
		Total Cost:	**$261,628**

[9] Assumes 40 hours per week, $20 per hour, with a team of six developers.
[10] Cloud Server cost per year. This is a yearly expense.
[11] Apple iPhone or a Motorola Android device.
[12] Estimated purchase of 30 phones, each costing $200.
[13] Estimated at $60 per month, per phone, for a period of one year. This is a yearly expense.
[14] Priced for a group of two people, round trip ticket costing $558 per person. Round trip from Cleveland to Port-au-Prince, Haiti.

CONCLUSION

The sharing of patient data between doctors in developing countries is a problem that could easily be remedied by a mobile electronic medical record application with GPS technology. By facilitating collaboration and information sharing between doctors and clinics, doctors can ensure their diagnoses are as accurate as possible. If the patient needs to be contacted immediately, a doctor can quickly and easily find out where they live, and contact them as soon as possible. The data can be used to track disease outbreaks in real-time, providing faster relief and preventing further sickness among the populations. This valuable information will allow relief organizations to provide targeted relief to the areas that need it most, and allow volunteers to warn others in the area of an outbreak. The data could have commercial use in research groups, provided that patient privacy is maintained, leading to a better knowledge of how certain disease are spread through a population. Groups such as the World Health Organization and Doctors Without Borders have volunteers in developing countries, and could help to green light this project, as it is synchronous with their goals of improving health systems and providing research and information during outbreaks. As a junior undergraduate of Case Western Reserve University with past experience in managing a mobile application development team, I am confident in my abilities to manage and maintain an application that can better healthcare and provide real-time updates on disease outbreaks.

BIBLIOGRAPHY

"DIGITAL AFRICA." Intelligent Life. http://moreintelligentlife.com/content/ideas/jm-ledgard/digital-africa?page=full (accessed March 19, 2011).

"Haiti: Cholera Cases Decline but Vigilance Still Needed." Doctors Without Borders. http://www.doctorswithoutborders.org/news/article.cfm?id=5051&cat=field-news (accessed April 6, 2011).

iCharts. From iTunes Preview. JPG, http://itunes.apple.com/app/ichart-emr/id284964162?mt=8 (accessed April 12).

"Volunteers Pilot EMR use in Haiti using iPhones." Palo Alto Medical Foundation. http://newsroom.pamf.org/2010/06/haiti-emr/ (accessed March 5, 2011).

"The WHO Agenda." World Health Organization. http://www.who.int/about/agenda/en/index.html (accessed March 6, 2011).

Arlow, Richard. Interview by Bryan Marty. March 27, 2011. CWRU Rockefeller 206.

Callaway, David W. *The Haiti Information Technology Rescue Project: Electronic Medical Record and Patient Tracking Assessment*: The Operational Medicine Institute, 2010 (accessed March 21, 2011).

Fraser, Hamish S. F., Paul Biondich, Deshen Moodley, Sharon Choi, Burke W. Mamlin, and Peter Szolovits. "Implementing Electronic Medical Record Systems in Developing Countries." *Inform Prim Care* 13, no. 2 (2005, 2005): 83-95.

Lang, Trudie. "Advancing Global Health Research through Digital Technology and Sharing Data." *Science* 331, no. 6018 (FEB 11, 2011): 714-717.