Mobile Health

PhysioNet

The PhysioNet Challenge
Improving ECGs collected using mobile phones

According to the World Health Organization, cardiovascular diseases (CVD) are the number one cause of death worldwide. Of these deaths, 82% take place in low- and middle-income countries. Yet often the people affected with such diseases, particularly rural populations, live very far away from physicians with the expertise needed to diagnose CVD.

The pervasiveness of mobile phones, and their computing power, present a great opportunity for improving the delivery of quality health care. One of the most exciting applications of mobile health is the ability to extend the reach of doctors. In the developing world, there is a significant shortage of trained doctors and specialists; in the developed world patients with chronic conditions often need to see a doctor regularly. By enabling remote diagnostics and monitoring, mobile technology allows doctors to treat patients across a much wider geographical area.

This mobile health opportunity, combined with the public health need created by cardiovascular diseases, has led to a joint collaboration between Narayana Hrudayalaya, one of India's leading health-care providers, and Sana, an open-source, student-managed, mobile telemedicine group at MIT. Their objective is to enable an inexperienced nurse or paramedic to collect and transmit electrocardiograms (ECGs) from rural patients to cardiologists at a city hospital for remote analysis.

ECGs can now be obtained using inexpensive, battery-powered, handheld instruments. Sana has successfully developed open-source software for mobile phones to receive these ECGs via Bluetooth, display and archive them on the phone, and forward them via mobile phone networks to a cardiologist. But a significant obstacle remains: when an inexperienced person records ECGs from a mobile device, problems can occur that render them not usable for diagnostic interpretation. Common problems include misplaced electrodes, poor skin-electrode contact, external electrical interference, or electrical noise resulting from patient motion. Remote ECG diagnosis is practical only if these problems can be identified and corrected at the source, while the patient is still present so that another ECG can be taken if needed.

To stimulate research aimed at making this goal a reality, PhysioNet, a website which provides free access to collections of recorded physiologic signals and open-source software, is running an open engineering competition in partnership with Sana, sponsored by the GSMA. The challenge is to develop an efficient algorithm able to run in near real-time on a mobile phone, that can provide useful feedback to a layperson in the process of acquiring a diagnostically useful ECG recording. The software should be able to indicate within a few seconds, while the patient is still present, if the ECG is of adequate quality for interpretation, or if another recording should be made. Ideally, the software should identify common problems and either compensate for these deficiencies or provide guidance for correcting them.

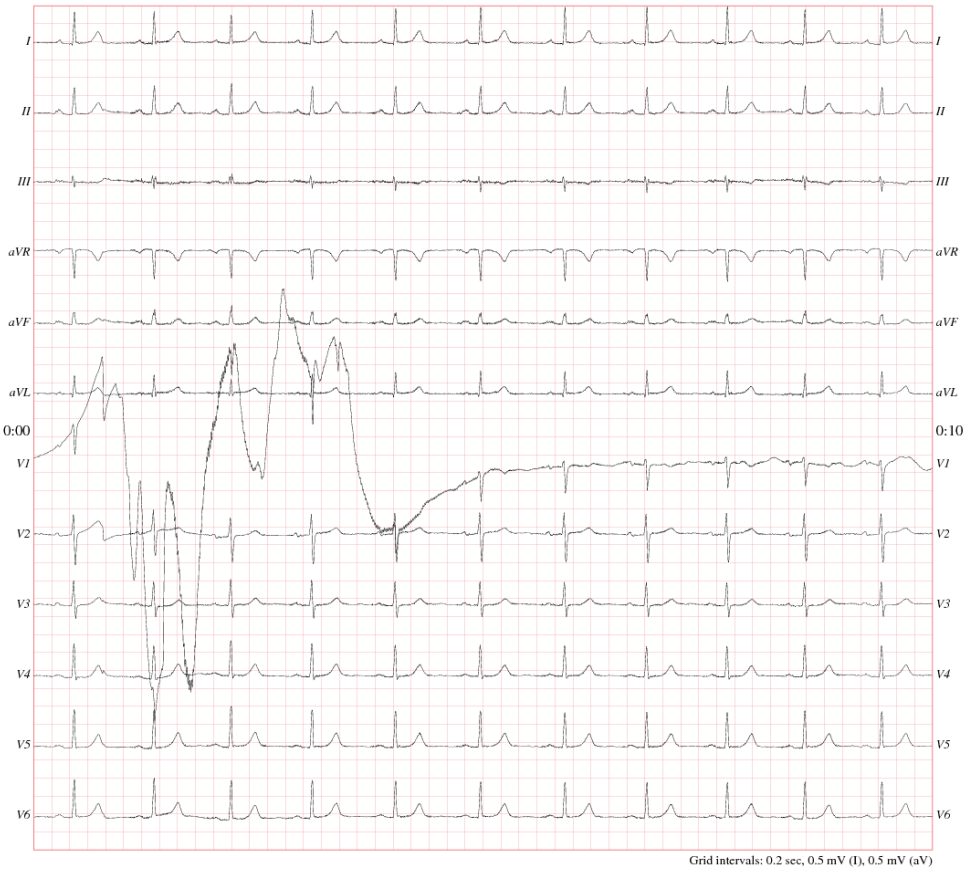
For further information visit: www.physionet.org and www.cinc.org

For this year's PhysioNet/CinC Challenge, 55 teams and individuals from at least 15 nations are participating in the Challenge. In the first Challenge event, the goal was to identify automatically which of a set of 500 ECGs are good enough to enable a doctor to make a diagnosis about a patient's cardiac health. The results show that roughly 85-93% classification accuracy can be obtained using a wide variety of computational methods.
In the second event, participants developed and submitted mobile phone implementations of their algorithms that were tested for accuracy against the data sets they have already seen.

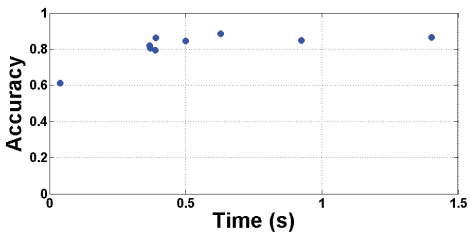
The third event was the most demanding part of the challenge, and the most rigorous criteria of the algorithms that participants have developed. The algorithms were tested for accuracy and speed using a data set that they have not seen before, so any fine tuning of the test data was not possible. The idea was to replicate exactly the circumstances in which the algorithm should function in real life: it has to judge whether an ECG taken by a community health worker is good enough to be sent to a cardiologist for diagnosis, or whether they have to take the ECG reading again. The quicker the algorithm works, the more useful a tool it will prove when deployed for real diagnostic work.

Participants discussed their work at the September 2011 annual conference of Computing in Cardiology in China. Overall the results showed [Fig 1] that it is possible to obtain a fast (less than a second) and accurate (above 80%) ECG quality control test on a mobile phone. The open-source Java code will be available at PhysioNet for those interested in improving or implementing the algorithms.

Sana expects to incorporate the most successful methods in its open-source telemedicine software, and to give Narayana Hrudayalaya and other healthcare providers the technology they need to make remote ECG diagnostic services a reality in their regions.



ECG Noise - An example of a ECG recording in which it is not clear for a layperson if the ECG is still clinically useful or sufficiently corrupted by noise.



Final Result - Overall the results show that it is possible to obtain above 80% average accuracy in less than half a second on average per record being processed a cell phone.