GSMA Mobile Health

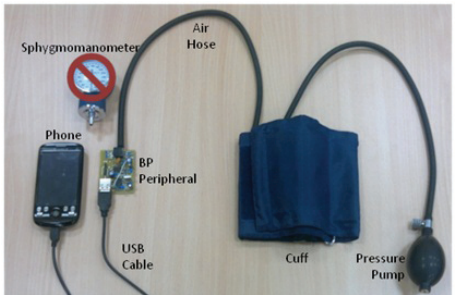
UNIVERSITY OF OXFORD

Mobile Health from the Intelligent Patient Monitoring Group

The Intelligent Patient Monitoring Group (IPMG) at Oxford University, led by Dr Gari Clifford, are working on a diverse selection of health issues: chronic disease management, maternal and child health, Intensive Care Unit decision support and AI4D (Artificial Intelligence for Development). But they are united by a common methodology: teaching machines to diagnose patients.

More and more health solutions are emerging that harness mobile technology, but they mostly use mobile phones to replicate existing health care processes. By contrast Dr Clifford and his group are working to make existing processes more intelligent, with the help of mobile phones. Their basic paradigm is to collect vital sign data – such as ECGs or blood oxygen levels – and associated demographic or behaviour data, from many different individuals and have experts annotate this data. The annotations range from a diagnosis, or an instruction to refer the patient for further testing, to a warning that the data is flawed and the reading ought to be repeated. Using this annotated data set, machine learning algorithms are then developed that can make diagnoses from new data. Currently, when a doctor makes a diagnosis based on a patient's data, that analysis is only used once and then often forgotten or noted in a way that is difficult to use except by the individual who noted the issue. Dr Clifford's vision is a world in which that valuable human computation is stored and used to inform future decisions, suggested mostly by algorithms. In a world where the patient to doctor ratio can be as low as 50,000:1, automated diagnostics is a necessity.

But can algorithms ever really replicate doctors? In fact, for certain tasks algorithms can successfully step in for humans in the vast majority of cases, leaving doctors free for the exceptional difficult cases. In some ways an algorithm is actually better than an average individual. Humans agree on annotations only about 80% of the time, due to inconsistent behaviour, lapses in concentration or simple mistakes, whereas an algorithm is totally consistent and when it fails, it generally fails in known ways. Algorithms, unlike humans, can also accurately tell you how confident they are about their diagnosis. Drawing on the raw data from previous diagnoses, algorithms can use statistical methods to give a confidence rating on their conclusions for a particular patient, allowing a user to decide on how much to trust the diagnosis. Humans tend to be worse in general at giving an accurate estimate of their confidence, particularly when they are looking at a number of different indicators for one patient. Cases with low confidence can be referred to experts to provide a diagnosis and then be used to improve the automated algorithm, allowing a continual evolution over time. Conversely, the untrained user can be guided by the algorithm to understand why a diagnosis was made in a certain way, and later, when they begin to recognise patterns themselves, refer anomalous behaviour back to clinical experts. In this way a crowd-sourcing of medical diagnosis can take place, integrating humans and automated algorithms, learning together. We are all familiar with the concept of a second (and



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third) opinion, and this reflects scientific evidence – in general multiple non-colluding experts can produce a better diagnosis than a single expert. This is also true of algorithms. Dr Clifford simply wants to combine multiple algorithms and multiple experts to help improve each other's performances to provide more accurate diagnoses.

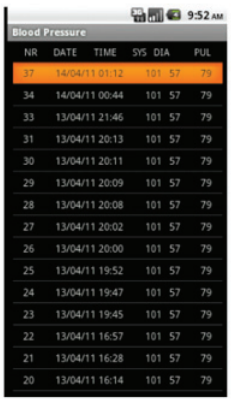
Mobile phones are the ideal device on which to run these algorithms because of their pervasiveness and increasing complexity (in terms of both sensors and computing power). Consequently the IPMG focuses on developing algorithms and low-cost sensors that can be used with, or integrated into mobile phones. They see mobile phones as an opportunity to leverage existing infrastructure and supply channels in order to minimize the cost and environmental impact of improving health systems. Most people in the world have access to a mobile phone, and people are also personally invested in maintaining them, whereas purpose-built medical devices in the developing world often fall into disrepair for lack of parts or specialised knowledge to repair them.

One of the mobile health projects within the IPMG, the blood pressure project, has just won the first prize in the annual Engineering World Health Design Competition. They have designed a device that uses a smartphone, a low-cost standard arm cuff and low-cost electronics to process good quality blood pressure measurements. The blood pressure changes are transmitted via USB to the phone, where they are analysed, stored and uploaded to personal or central medical records. Since the device costs just £5.00, it could make a big difference for people living in resource-poor areas. It is hoped that it will help healthcare workers in developing countries accurately track medical information over long periods of time to address epidemic chronic problems such as hypertension.

Another project in the IPMG group is a sleep analysis system. Sleep is a crucial but often overlooked component of health. Over time, people who sleep poorly are more likely to develop a chronic disease, such as chronic heart failure or hypertension. In a vicious cycle, those with fractured sleep also show worse compliance levels for treating disease and lead to exacerbated chronic conditions. Furthermore, a breakdown in sleep patterns is often an early warning sign of mental illnesses and depression. But people are often unaware of their sleep patterns, which prevents any effective intervention to improve matters. Although currently doctors can advise a home sleep study, it is fairly expensive, involves bulky monitoring equipment, and can only be conducted for a short period of time. As a solution to this problem, the IPMG are developing a low-cost sleep monitoring device which works through mobile phones, and would allow people to continually monitor their sleep. Unlike current phone apps which only appear to reflect a user's overnight activity, their software is being rigorously tested to provide a scientific evidence base for interpreting its feedback.

Many of the projects are already being tested in hospitals or clinical settings around the world and will be scaled if successful. Soon patients and clinicians can look forward to a more intelligent and accessible kind of healthcare, which will run on their mobile phones.

Main page



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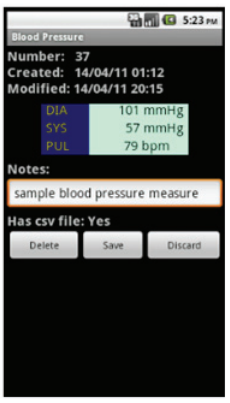
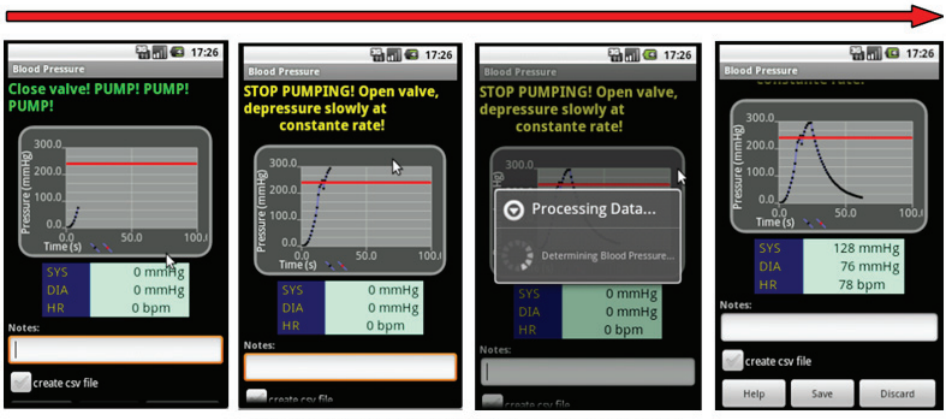


Measure view page



Real time blood pressure measurement page