4.12. miCROWDscopy

Project	miCROWDscopy: Video games and mobile microscopes for collective telediagnosis of global health diseases
Organisation	MalariaSpot – Biomedical Image Technologies – Technical University of Madrid
Research location	Madrid, Spain
Cooperation partners	Ashoka, National Centre of Microbiology, Clinical Hospital San Carlos, Global Health Institute of Barcelona, Health Investigation Centre of Manhiça (Mozambique), National Institute for Communicable Diseases (South Africa), Technical University of Cataluña and University of Gothenburg (Sweden)
Team	The founder, two full-time researchers (software developer and communications manager), three Master's student internships and collaborators
Funding sources	National research grants and donations
Website	http://malariaspot.org and two smartphone apps

ORGANISATIONAL BACKGROUND

This project develops collective tele-diagnosis systems to empower citizens to collaborate in solving global health challenges. It is based on a crowd-computing platform, which analyses medical images taken by a microscope embedded in a smartphone connected to the internet, using image processing and human crowdsourcing through online video games. This system will provide remote, rapid, ubiquitous and accurate diagnosis of global health diseases such as malaria or tuberculosis, which are responsible for the deaths of millions of people. At the moment, it is a functional prototype that has been tested in Africa on a number of real digitalised blood samples. In the future it should work in real time in medical diagnosis. The aim is to functionally make use of collective wisdom/intelligence in society in an engaging way, using big data science to contribute to global health. In short, the idea is to develop an app embedded in the medical system.

The multidisciplinary nature of the project at the crossroads of medicine, video games, artificial intelligence and education involves a diverse range of stakeholders. The research team has several target groups and all of them are essential: medical specialists, players, developers and makers. Following the diverse stakeholders, the researchers can address the specific sensitivities due to the multicultural nature of the project, tailoring the message to each discipline and cultural context.

The underlying idea of the model is to translate medical protocols into digital micro-tasks that can be packaged into video games and performed by citizens around the world. MalariaSpot has been recognised worldwide as a pioneer and has already been the inspiration to other experiments such as screening for ocular pathologies and gamifying radiotherapy for cancer. All in all, the team relies on the belief that learning through games can be revolutionary in democratising access to universal health coverage: digital collaboration is a precious cognitive resource for solving humanity's challenges.

FUNDING

Over the past four years a number of research grants and donations have been obtained, allowing the maintenance of a staff of two, internships, travel and software/hardware resources. At present, however, the team is struggling to find sustainable funding. Many collaborators also contribute voluntarily and/or as part of their job.

PROBLEM BEING ADDRESSED

This project intends to initiate the era of crowd diagnostics by connecting a global network of mobile microscopes and citizen diagnosers. The research team is designing open-source crowd-computing tools for image analysis and an open 3D-printed microscope-in-a-smartphone, which are extremely portable and low-cost, tailored to different global health pathologies. The practical implementation of the project is to develop a low-cost solution which is able to provide rapid and accurate diagnosis of malaria and tuberculosis, leveraging crowd computing, mobile microscopy and the efforts of global citizen diagnosers: non-medical specialists connected to the internet contributing to the diagnosis while playing a game. Such a solution can help to provide access to a diagnosis in rural areas where appropriate facilities and capacities are not available, uncovering the burden of the disease and permitting optimisation of treatments and eradication programs. Players of all ages will learn and become part of a global task force of disease hunters.

The idea behind the project was initiated in 2012, starting from the combined perspectives of global health problems, the potential of big data and the fact that everyone has a mobile device (i.e. the collective power of society using the device) to help diagnose diseases (initially malaria and now also tuberculosis). At first the project team started with a pilot game (shooting malaria parasites in pictures) using images of real blood samples. With the idea of collaborative intelligence, a team of doctors and medical specialists from South Africa and programmers in Spain were involved in developing the prototype. Very quickly 10,000 people began playing it in over hundred countries. Interestingly, the gamers were as good at spotting malaria as professional microscopy specialists.

RESEARCH DESIGN AND SOLUTION

The principal idea behind the project is that small diseases that fly under the radar, in terms of scientific interest, can be investigated using public effort (e.g. in games), as can diseases that exist on a mass scale. It relies on mass image processing supported by the public. In future, e.g. in 2020, the majority of Africa will probably be connected to the Internet, allowing for fast diagnosis. In future this should work as follows: a blood sample is taken in a health clinic and transformed locally into an image, which is uploaded, checked very quickly through the game by a large community of gamers (minutes-hours), and then reported. This target should be achievable in 2020. The mobile microscope is not yet available, but it probably will be within three years from now. The team expects the system to allow diagnosis in rural locations where appropriate facilities and capacities do not exist, permitting optimisation of treatments and eradication programs. The premise is that only a small percentage of the time people spend playing video games can already greatly contribute to providing access to diagnosis anywhere in the world. At the same time, gamers will learn about global health, and become part of a global task force of 'disease hunters'.

Research so far has shown that based on information from some twenty non-expert players, it is possible to conduct a malaria image analysis as well as an expert microscopist. The same methodology is currently also being used for tuberculosis. A few months ago, a prototype of the real time technology was tested and a field test was carried out in Mozambique. Support from the virtual community is key, not only to achieve the first real-time collective telediagnosis in history, but also to provide feedback that has been used to adapt and improve the system.

GRAND CHALLENGE BEING ADDRESSED

The main challenge concerns global health. Each year, over half a million deaths and more than 200 million new cases of malaria are identified, and about 1.5 million deaths and 9 million new cases of tuberculosis. This is despite the fact that both are curable diseases. According to the WHO, 40% of suspected malaria cases and 48% of TB cases are not diagnosed by any method. Access to diagnosis is key to the eradication of global diseases which cause millions of deaths each year and has a huge impact on development in low-income countries. However, the new generations that have grown up in the digital era are not fully aware of this problem – we spend millions of hours playing video games with poor social and learning value. We need to find a way to leverage this potential to turn a problem into a solution. The team believes diagnosis could be democratised, while at the same time facilitating learning through games can be a revolution to achieve universal health coverage. Both mass-scale and rare diseases can be collectively diagnosed with the help of citizens, freeing medical specialists to spend more time on patient treatment, conducting research or other critical tasks.

RESPONSIBLE RESEARCH AND INNOVATION

The main aim is to develop a medical diagnosis protocol that can be digitalised and which makes use of the collective intelligence and capabilities of the public. Digital literacy is increasing exponentially and represents a precious cognitive resource for solving humanity's challenges – multiplying the workforce devoted to image diagnosis – and, perhaps even helping to create new digital jobs as "telediagnosers".

The rationale behind the games is based on an open-source platform (instead of patenting the ideas) to enable collaboration with different parties. The team believes in providing open tools so anyone can adapt them to solve new problems. The outcome of the research is not patented, because one of the aims is make the knowledge available to be replicated by other teams, in other countries and in other fields. The mobile microscope design is also open source.

RRI concepts are the pillars of the project. For example, the team aims to democratise access to health diagnostics. This is part of the mission of the team, i.e. to create a benefit for society. The same is true for openness and inclusion work is not done in isolation but openly (mobilising society and scientists) and in an open source, multidisciplinary, inclusive format. Stakeholders in the areas of AI, the medical community, civil society, education and institutions can all contribute.

Partners are engaged in various ways:

- Through extensive community management: online newsletters, public lectures, other outreach in (social) media. Different layers of engagement (remotely interested vs. very engaged). Initiative also comes from the other partners, and the team is always open to ideas from others. Sometimes more offers are provided than the team can handle.
- Hackathons: competition between hackers is good to motivate good people to test the safety and possibilities of the system on an AI level. These are people who are good at software engineering outside the academic sphere. The aim is to help the research team to look for better software and hardware.
- The game is also given to high schools, which can create for example a competitive championship. In this way, citizens are learning to diagnose and become aware of global health problems.

The team uses a dynamic, iterative development process where each iteration (e.g. a new version of the game, a new digitisation protocol or a citizen engagement strategy) is evaluated by the different stakeholders, allowing to adapt and change practices in response to their feedback. From the medical perspective, the project is focused on strengthening individual, organisational and institutional capacities so that people can use innovative ICTs to address global health needs. For that purpose, the project also includes the participation of relevant African stakeholders in innovation and end-user community representatives to ensure its clinical validation.

EVALUATION AND DISSEMINATION

The research team has developed a multidisciplinary project at the crossroads of medicine, video games, artificial intelligence and education. It is well embedded with a large and diverse range of stakeholders, some of whom are contributing voluntarily. So far more than 100,000 people from 130 countries have contributed to the project. Clinical validation of the system and creation of a sustainable business model is expected by 2018. Reports have been published in various peer-reviewed publications, but also in media output, social media, newspapers etc. The research team has given public lectures in Spain and received invitations from around the world (US, France, etc.). At the moment there are two games, which make up different parts of the diagnosis protocol for malaria identification. These games address micro parts of the diagnosis system, that can be played and carried out by the gamers, and they can be accessed and downloaded via the website.