Innovative app receives a Science Oscar

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The novel hearScreen mobile application (app), developed by the team of Prof De Wet Swanepoel and Dr Herman Myburgh, has received the 2013/14 National Science and Technology Forum (NSTF)-BHP Billiton Award for an outstanding contribution to science, engineering and technology through research leading to innovation in a corporate organisation or institution. These awards, known as the "Science Oscars", recognise the best and most influential researchers in South Africa.

Prof Swanepoel is associated with the Department of Speech-Language Pathology and Audiology in the Faculty of Humanities, and Dr Myburgh is attached to the Department of Electrical, Electronic and Computer Engineering in the Faculty of Engineering, Built Environment and Information Technology. While Prof Swanepoel is the audiology expert who had the idea, Dr Myburgh provided the technical expertise. This is an excellent example of the multidisciplinary research that is one of the strategic goals of the University of Pretoria.

The idea for the app came to Prof Swanepoel while he was looking for a solution to the unique problem of providing accessible audiology services to people in South Africa and Africa. The focus was on people in underserved rural areas, where health services are seldom available. Apart from the accessibility problem, hearing loss is a condition that can be easily alleviated and managed if detected early – in children and in adults.

Prof Swanepoel approached Dr Myburgh in March 2013 to assist him with creating a cellphone application that could perform hearing screening tests on children and adults. This was a new field for Dr Myburgh, but since modern-day smartphones have the same capabilities as a computer, he and David Howe (a final-year student in 2013) set about developing an Android app for the Samsung Galaxy Pocket Plus, an inexpensive phone with a retail price of approximately R900.

Numerous tests were done to determine suitable signal frequencies and hearing intensities, and to ensure that signals are correctly generated. Dr Myburgh was responsible for data analyses, and verified that the signals that were generated adhered to international hearing screening standards.

The phones are calibrated at 1, 2 and 4 kHz at different hearing intensities. In total, three tones are played in each ear, and if the person does not hear one of them, he or she is referred to a professional audiologist, who will perform further tests and implement interventions, if necessary. The phones' microphones are calibrated for a particular phone model, while each phone has to be calibrated with a unique headphone, due to slight variability in the output of the headphones.

The calibration did not, however, happen overnight. Dr Myburgh had to obtain some knowledge of audiology to understand the signals involved in hearing tests, and then had to ensure that the signals were generated correctly according to specifications. Initially, the phone could only be calibrated at intensities from 20 to 70 decibels in intervals of five. An easier way of calibration was sought, as existing audiometers are only calibrated at 70 decibels and a function is applied to automatically scale it down to lower intensities. Eventually, it was determined that the phones only had to be calibrated at 70 dB HL at 1, 2 and 4 kHz to render accurate dB increments up or down.

The research has shown that the phones are extremely consistent with regard to the calibration, which makes the calibration process uniform for a given phone model. Two more Samsung phones have been identified as potential phones for the app, and even if the app has

→ *Prof De Wet Swanepoel uses a cellphone to test the hearing of a toddler.*

→ *Prof De Wet Swanepoel (left) and Dr Herman Myburgh received the 2013/14 National Science and Technology Forum (NSTF)-BHP Billiton Award for the work of their team in developing this innovative app.*

to be upscaled to these devices, the calibration process stays consistent. The headsets, however, present less consistency when calibrated, but the problem is overcome by calibrating the phone and its particular headset together or as a pair. Furthermore, to ensure accuracy and adhere to calibration standards, the phone and headphones will have to be recalibrated annually.

Other than traditional equipment, the hearScreen product can detect background noise and indicate this to the person who is conducting the test. The test will then be taken at a later stage, or it can be taken in another venue. This feature was created by using narrowband noise at different intensities and adding the mathematical calculations to take this into account in the software.

A huge benefit and a novel development of the new technology is that the data of every screening can be uploaded to a central, secure database. The users, whether they are school nurses or community health workers, will each have an account on the database and will be able to access and monitor the data of their patients. It would also be useful for the Department of Health to have access to such a central database in order to identify specific regions where hearing problems occur. This database will have two options for users: a normal account and a premium account. The premium account will have more functionality than the normal account.

Background to the innovation

Recent statistics issued by the World Health Organisation (WHO) indicate that hearing loss is a significant healthcare burden worldwide. It is estimated that 360 million people across the globe, that is 5.3% of the global population, suffer from permanent disabling hearing loss. Included in this figure are 32 million children. As hearing loss is a condition that can be alleviated by various interventions, this burden of disease can be decreased if hearing loss is detected. The earlier it is detected, the better the outcome of the intervention, even in older people.

However, the impact of hearing loss may be the most devastating on children. They are at risk for delayed speech, language and cognitive skills, which lead to reduced literacy, academic and socio-emotional development, and higher risks of failure and fall-out in schools. In the end, these results can have a negative influence on a person's entire life and quality of life.

Prof Swanepoel has been involved in an advisory capacity with the Department of Education for quite some time. In his research and other work, he has always tried to improve access to health services, especially audiology services, for underserved communities. The Integrated School Health Policy, formulated by the national departments of Health, Basic Education and Social Development, and implemented in 2012, stipulates that all Grade 1 learners have to undergo a hearing screening test.

However, with an average of 1.1 million new Grade 1 learners every year, this is a mammoth task.

Another factor that decreases the probability that all these learners will be tested is the equipment needed for the screening. Traditionally, the machine that is used is heavy and has to be plugged into a power supply point to operate. Many schools in the underserved areas of the country do not have electricity. Furthermore, the equipment is expensive, and can cost up to R25 000 a unit. Another limiting factor is human subjectivity. The people operating the equipment are not necessarily trained in the same way and their interpretation of the results may differ. All these factors leave a fairly wide margin for error.

This probability of errors is almost completely eliminated by using smartphones and headphones that are each calibrated identically. The cellphone and set of headphones are also sold together, which further decreases the chances for error.

The largest selling point of this innovation is perhaps its price – it is estimated that the package of calibrated phone and headphones will be available for under R6 000.

The reason why a cellphone application was chosen is that there is a huge uptake of mobile devices in rural areas in South Africa, as well as the rest of Africa. In general, healthcare is increasingly moving towards the use of mobile health technologies (or m-health) to take healthcare to rural areas and to people who do not have access to more than perhaps primary healthcare facilities.

Outcomes and the way forward

A number of field trials and pilot projects are being launched to test and create awareness of hearScreen.

The University is involved in a field trial with the Department of Health, during which a planned pilot study of 80 phones will be rolled out to provincial school nurses to test learners over a period of a few months. Another research project will be conducted in Mamelodi in collaboration with the Department of Family Medicine in the University's Faculty of Health Sciences and the City of Tshwane Metropolitan Municipality. Community health workers will perform several electronic health assessments, including hearing screening, which will be uploaded on a number of phones to be issued. The aim is to do electronic health registrations and risk assessments. The inclusion of hearing tests will be the first time that a point-of-care health service like this will be delivered to people in their homes. Based on the findings, it is envisaged that these tests will later be upscaled and expanded to include the entire Tshwane area.

The first field trial on threshold tests – the next step in hearing testing – was to start in September 2014. This was to be done in collaboration with a Swedish colleague, Prof Claude Laurent, and a Swedish medical student from Umea University.

A huge boost for the research team is that the hearScreen product is set for commercialisation through Business Enterprises at University of Pretoria (BE at UP), the University's business entity. There is a strong possibility that venture capital will be provided to develop the product further.

The research needed to develop the product presents various research opportunities to final-year and postgraduate students in the fields of both computer engineering and audiology. Two PhD Audiology students are busy with studies in this regard for their theses.

Coupled with this, a few exciting developments and expansions of the mobile audiology product are set to follow. One of these is the adaptation of the product for use by the end-user; that is, for example, parents who would like to test their children's hearing.

Apart from the NSTF-BHP Billiton Award, hearScreen has also been shortlished for the South African Breweries Foundation (SAB) Social Innovation Awards.

The hearScreen product is the culmination of an ideal cross-faculty research project. True to the three pillars of a higher education institution, it involves learning, research and community engagement. This innovation, and what will follow on it, has the potential to have a profound socioeconomic effect and to improve the quality of life of many people.

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