# Decoding the signals of the heart

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Tim Schäck (on the left) and Michael Muma. Credit: Claus Völker

There are currently an estimated 1.8 million people in Germany who have atrial fibrillation but do not know it. Now a Dutch company has developed an app with which a smartphone can be used to detect this dangerous cardiac arrhythmia. Scientists at the TU Darmstadt are

helping to ensure the recorded data is interpreted correctly and efficiently.

Atrial fibrillation means that the heart loses its rhythm and is unable to perform its essential pumping function as it should. Some patients realise this is happening if their heart starts to beat very fast (palpitations), their pulse starts to race and becomes irregular, or if they feel exhausted after exertion. However, the pernicious thing about it is that lots of people are not aware that they have a problem with their heart. Atrial fibrillation causes the blood to flow irregularly. It pools in the atria, may clump and form clots. If the clots then travel into the brain in the bloodstream, there is a very real risk of blockages and stroke.

Atrial fibrillation must be diagnosed by a doctor. The Dutch company Happitech is now working on an app that can be used on a normal smartphone to identify arrhythmia and provide apparently healthy people with unmistakable advice: Go and see a doctor without further delay.

The technology used is photoplethysmography (PPG). The user places a finger on the phone's camera. The smartphone light illuminates the blood vessels, and the camera takes a diffuse reddish picture. As the blood flow pulsates, the red colour changes slightly. Specific irregularities that would indicate atrial fibrillation also leave their traces. This is where the co-operation between the scientists in the Signal Processing Group of the Department of Electrical Engineering and Information Technology at the TU Darmstadt and the experts at Happitech starts.

Together, they first of all optimised a method which uses the pictures taken with the camera of the mobile phone to produce a one-dimensional signal. This is then processed and classified by algorithms, which were also jointly developed by the TU and Happitech: the technology can distinguish between atrial fibrillation, a normal sinus rhythm and artefacts caused, for instance, by moving the finger around too much on

the camera. "How can we extract the cleanest possible, conclusive signal, and with what means can we then classify these signals?" sums up Dipl.-Ing. Tim Schäck, who conducted the research and development at the TU together with his colleague, Dr.-Ing. Michael Muma.

The algorithms are subject to a test and development process. They have already examined and classified many thousands of heart signals, parallel to the evaluation, undertaken by cardiologists. Using a data set recorded under optimum conditions in hospitals, they have already achieved a success rate of almost 100 percent. "However, the algorithms have to be trained and tested on as large an amount of data as possible in order to then be able to work on a medically accurate app that is suitable for large-scale use," says Tim Schäck.

This contribution towards the detection of atrial fibrillation is a step forward in the field of biomedical engineering that is one of the areas to which the Signal Processing Group is committed: the processing of photoplethysmographic signals. They are obtained by screening perfused tissue and the photoelectric registration of blood flows.

In the past, the scientists at Darmstadt have worked on estimating the heart rate at the wrist during physical exercise, and they are currently working on methods to determine the blood pressure and to diagnose arterial stiffness. "We are well-positioned in PPG processing," says Michael Muma.

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