Hailiang Mei

Managing biosignals for fast response

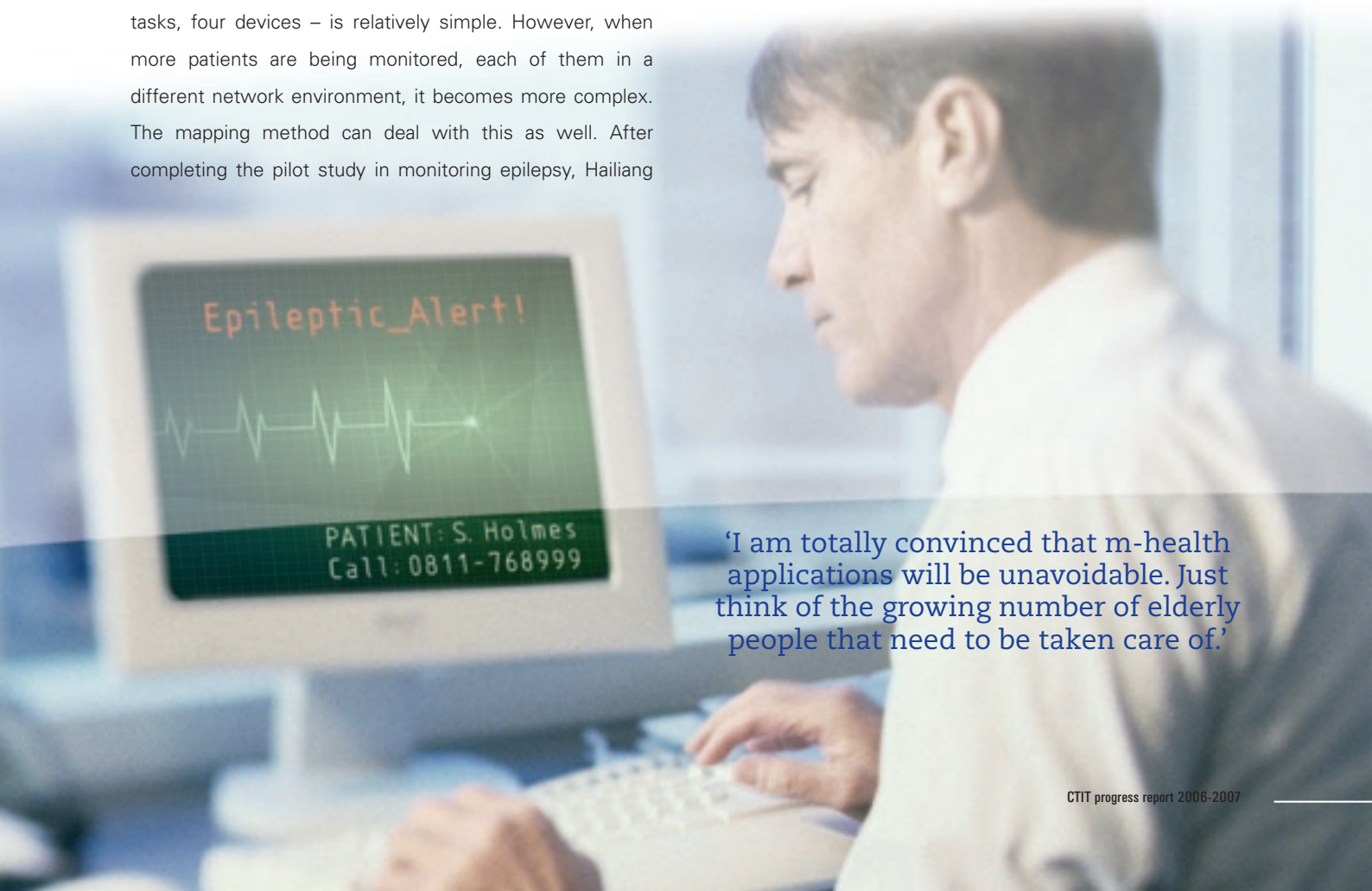
All too often telemonitoring in healthcare has to deal with limited resources. In order to rapidly convey patient information to the doctor, Hailiang Mei wants to distribute all essential tasks involved among all the system components available. In the end, the dynamic assignment of tasks to available computing power enables a doctor to act rapidly whenever it is necessary.

Epileptic patients monitored using mobile health systems can move about freely while their heart signals are constantly being analyzed. Patients need not feel insecure or avoid certain activities because they are in fear of having an epileptic seizure. The sensors on the patient's body register the ECG signals and send these, via Bluetooth, to a PDA he or she is carrying. The PDA communicates with a back-end server via the internet. On the other end of the line, the doctor receives seizure prediction alerts on his or her laptop. When the patient moves about, the context and available resources change constantly. While broadband WLAN is available at one moment, the next moment it may be UMTS or even GPRS. 'The system has to be working in such a way that the patient doesn't notice these changes at all. They won't have to take action themselves,' Hailiang explains. 'You have to be aware that conditions can change dramatically from one hour to the next. If you only have the GPRS connection and there is a lot of mobile phone traffic in the cell the patient currently is in, the available bandwidth will be very limited. If at the same time, the doctor must be alerted rapidly, we want to ensure reliability by distributing all of the necessary steps in the process to the computing power available in that specific context. And that is quite a challenge.'

'Before the doctor receives an alert predicting a seizure, six tasks are necessary to process the ECG sensors' raw data, including data filtering and heart signal analysis. A more straightforward choice might be to send the raw ECG to the doctor's server and do all the processing on that side. However, the signal could be very vulnerable if the patient has a bad connection. In some cases it is better to send processed signals.' In that case, the PDA takes over part of the calculations. In his research, Hailiang tries to optimally map all six steps onto the devices that are available – four in this case. He takes the communication and computational context into account as well as limited battery power. 'You could perform an exhaustive search to choose the best assignment, but if it takes an hour, you obviously won't. A smart alternative we selected is a mathematical, graph-based method to map one chain to another. The first chain describes the tasks involved in processing the patient's biosignals; the second consists of the available networked devices. This approach is much faster than an exhaustive search.' Keeping the biosignal processing delay as low as possible is top priority for Hailiang. However, optimizing the system in terms of life span is a little bit more complex.

The case described above – one patient, one doctor, six tasks, four devices – is relatively simple. However, when more patients are being monitored, each of them in a different network environment, it becomes more complex. The mapping method can deal with this as well. After completing the pilot study in monitoring epilepsy, Hailiang will also start applying the task assignment approach within monitoring chronic pain together with the Roessingh rehabilitation centre in Enschede. In this project, patients will also be able to receive feedback about their sitting position or activity patterns that may be harmful, for example.

'Introducing m-health is taking more time than we initially expected. The technology is available, but a company introducing it, takes quite a responsibility. Naturally, patients and doctors want to be sure that it works. That's why I think we'd better start by introducing these techniques in the less demanding world of sports. The signals monitored are basically the same. You can monitor heart signals, send alerts, compare training schemes with those of other athletes around you on the internet. Once technology has proven itself in this field, it can be introduced in applications with greater risk involved. However, I am totally convinced that m-health applications will be unavoidable. Just think of the growing number of elderly people that need to be taken care of. Personally, I think that if you really want to take this one step forward, you have to include automatic diagnosis and decision-making. Then you don't need a doctor all the time. But then, of course, the level of responsibility is even greater.'



'I am totally convinced that m-health applications will be unavoidable. Just think of the growing number of elderly people that need to be taken care of.'