Medical Diagnosis:
The Next Generation

When somebody tells you that you look a bit ill, it's usually just a friendly concern. Not so in the Diagnostic Development Unit at the Leicester Royal Infirmary, where researchers aim to turn this phrase into an actual medical diagnosis. Here your appearance may indicate what's wrong with you. Through the application of state-of-the-art technology and established medical knowledge, article author **Károly Keresztes** explains how the DDU team may be able to remove the 'fiction' from 'science fiction' with producing in the longer term the iconic medical diagnosis tool: the Star Trek tricorder.

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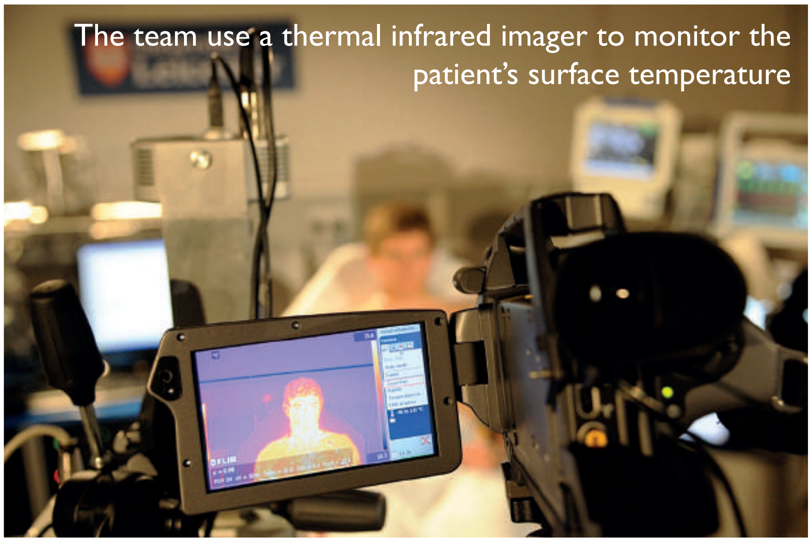
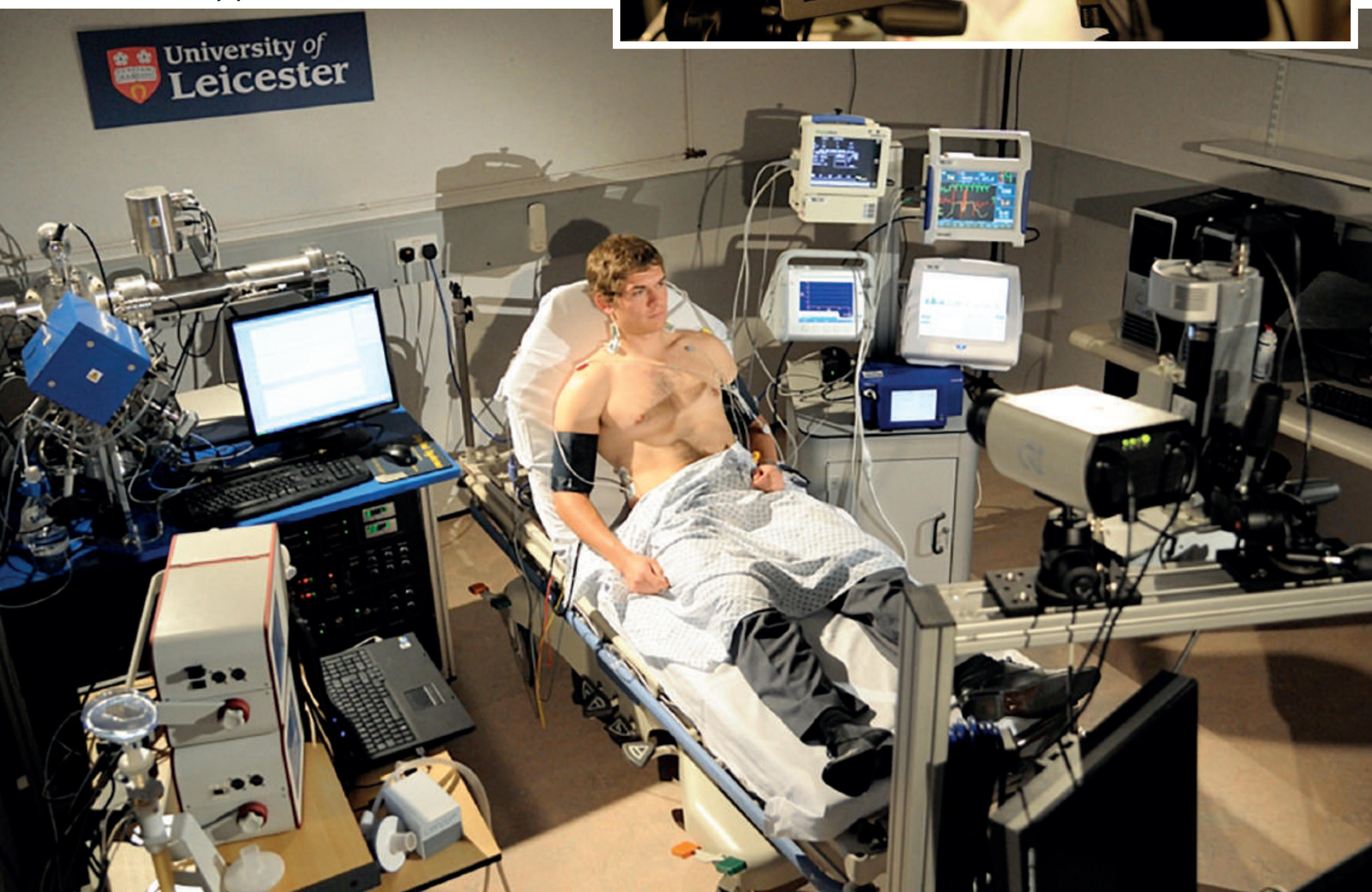

The team use a thermal infrared imager to monitor the patient's surface temperature

Medical student and volunteer Tom Geliot is surrounded by technology aimed at measuring his vital body processes in real time



Technological advancements are occurring at an impressive pace, but progress in the field of medical diagnostics has been far slower. In general, diagnosis still relies on invasive testing, often causing discomfort and leading to complications such as infection. Finding ways to circumvent these invasive procedures could thus save a lot of money, time and inconvenience to everybody involved. How can we use recent technological developments to aid in medical diagnosis?

Where no diagnosis has gone before

Over the past few years, Timothy Coats (Professor of Emergency Medicine, NHS and Department of Cardiovascular Sciences), Paul Monks (Professor of Atmospheric Chemistry, Department of Chemistry) and Professor Mark Sims (Professor of Astrobiology and Space Instrumentation, Space Research Centre, Department of Physics and Astronomy), have been developing non-invasive methods of medical diagnosis. This work has resulted in the creation of the Diagnostic Development Unit (DDU) at the Leicester Royal Infirmary.

The techniques build on the same principles used in medicine for hundreds of years, where physicians use their sense of sight, touch and smell to obtain a diagnosis. At the DDU we try to emulate these techniques with state-of-the-art equipment and sensitivity beyond human capability.

> “These tools may allow us to measure the properties of blood without using a needle”

Looking peaky

As a PhD student, I worked on the imaging aspect of the project. One component of this project is the thermal infrared imager. This imager builds a temperature map of the body, so it can be used to detect fever, infections and cardiovascular response to disease and treatment. We also utilised a visual wavelength Hyperspectral imager and spectrometry to analyse visible and near-infrared light. These tools may allow us to measure the properties of blood and physiology using skin pigments without using a needle! Hence, it could enable the rapid diagnosis of kidney and liver disease and possibly even cancer via subtle colour changes in reflected light.

A gas sampling instrument ‘smells’ how well the respiratory system’s running

> “Each patient will generate a vast amount of varied data that needs analysing and interpreting”

The development of instruments mimicking touch and smell is also underway. Body state and cardiovascular monitors replace the sense of touch. The monitors measure the heart and blood vessels’ response to your current health state. Smell is emulated with a mass spectrometer, spirometer, nitric oxide analyser and a carbon dioxide capnograph. These instruments determine the composition of exhaled air and provide an analysis of other bodily substances such as sweat and urine. The investigation of large datasets could help to identify and quantify a number of different disease markers.

An enterprising study

Currently we are working on our pilot study, where we are collecting data from over five hundred patients. These data will be used to determine the parameters for patients with common accident and emergency complaints in comparison to those of a normal population. There are three main challenges to contend with. The first is to populate our database with a large multivariate dataset including both imaging and spectral information. Given the size and complexity of the dataset, this is a key challenge in itself. The second challenge is the analysis of these data. Each patient will generate a vast amount of varied data that needs analysing and interpreting. Hence the DDU has assembled a team of experts from various fields to help with this interdisciplinary task. The final challenge after the data have been captured, organised and interpreted is the automation of the data analysis and interpretation process.

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Live long and prosper

Once the above issues have been addressed, DDU will start to move towards a fully-integrated system that could resemble the technologies used in science fiction programs. Our current set-up looks very much like the famous medical bay in Star Trek. In the future we hope to miniaturise this technology into the well-known ‘tricorder’ or a range of such equipment for different medical needs.

Imagine the day when a patient is need of immediate medical attention. The medical team arrives, give the appropriate diagnosis *in situ* and are ready to provide treatment within minutes. It sounds incredible, but this may no longer be something out of science fiction. The research in the DDU still has a long way to go, but the work we have done so far looks promising and, in combination with other diagnostic technologies, may enable this vision to occur given sufficient funding and time.

Károly Keresztes is finalising his PhD and is currently a Teaching Fellow at the University of Leicester