SKIN DEEP

Researchers in the UAE have made a breakthrough with the development of a non-invasive wearable tech device that uses optics to track hydration and dehydration levels of the skin. The device could play a vital role in providing early information to detect cardiovascular diseases, diabetes and cancer.

Whether it's following an illness, or when the sun is beating down and your temperature is soaring, or directly following physical activity, nothing can deliver the instant relief and tonic that water provides.

It is difficult to overstate how vital water is, not only to our own lives but for all life. Humans, animals and plants would all perish without access to water. Simply put – without water there would be no life on Earth.

Although we can't independently see it, water in the body is essential for its proper function. A body's cells, organs and tissues use water to regulate its temperature and keep everything working as it should be. It lubricates our joints and protects the brain, spinal cord and our eyes, and the digestive system relies on water to help deliver nutrients and to remove waste.

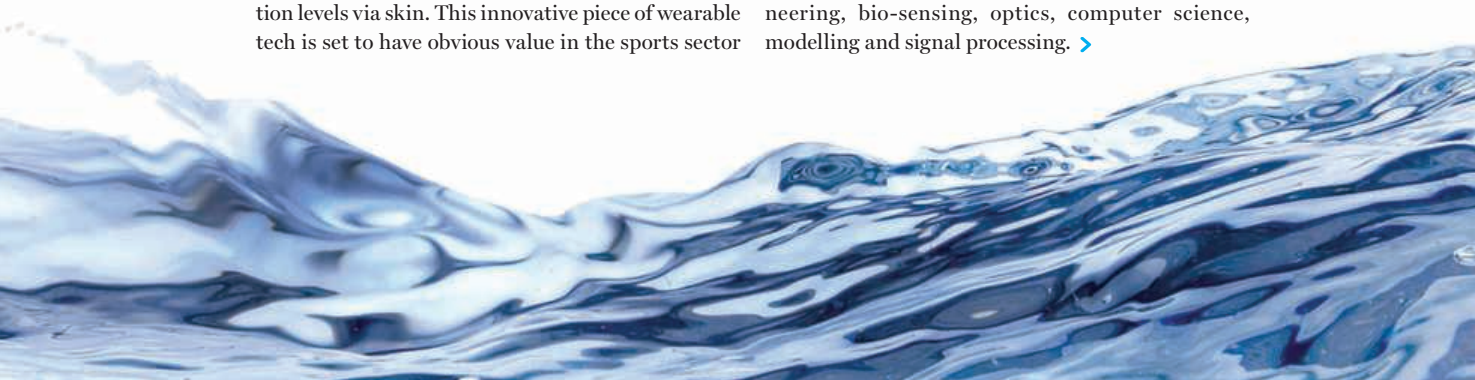
Approximately 60% of a person's body weight is water and problems of all kinds begin if we don't get enough of it. Through activity, digestion, sweating and simply breathing we lose water, so rehydration is paramount.

A team of researchers at the United Arab Emirates University (UAEU) is developing a groundbreaking wearable device to monitor hydration and dehydration levels via skin. This innovative piece of wearable tech is set to have obvious value in the sports sector but will primarily be a major advancement in the medical field, as cardiovascular disease, diabetes and cancer can be detected in early stages through skin dehydration levels.

The device will be a significant improvement on current methods of measuring water content in the body, which involve radioactive substances being injected into the body before x-rays are taken and the images analysed for an estimation of water content. Body impedance is another alternative technique that measures the electrical resistivity of the human body but this also only offers a rough estimate.

The new non-invasive optical wearable technology being developed by UAEU uses optical sensors and LED. Different wavelengths of light are transmitted into the body and the reflected rays are measured to determine the water content of the skin layers.

With nine world-class research centres, the UAEU is the leading university in the United Arab Emirates and is ranked fifth in the Arab world. Alongside experts from Glasgow University in Scotland and Queen Mary University in London, the UAEU has led a multidisciplinary team with backgrounds in electrical engineering, medicine, biomedical engineering, bio-sensing, optics, computer science, modelling and signal processing. ›



Right: Dr Najah Abu-Ali, Associate Professor of Network Engineering at the UAEU's College of Information Technology

Speaking exclusively to *Flashes*, Dr Najah Abu-Ali, Associate Professor of Network Engineering at the UAEU's College of Information Technology, explained that the device will be worn as a rubber band or integrated into a smartwatch to track a person's physical health through the condition of the skin tissue.

Elaborating on how this new method of measuring water content is a notable progression from current practices, Dr Abu-Ali said: "Our method is more accurate, continuous and in real time and, most importantly, non-invasive. Current methods have to be done in medical labs following procedures similar to the ECG test, and yet their accuracy is not similar to our work. Additionally, the result of the test provides the water level. Our method is more comprehensive and provides more detailed data about any slight changes in skin layer due to the amount of the water intake or to diseases that affect the hydration level."

The elasticity of the skin and its ability to change and return to its normal shape, known as skin turgor, can be an indicator of dehydration. It can also reveal fluid gain, known as edema, which is a serious condition particularly for elderly people and children. As the new device will work continuously in real time, it will capture any fluctuations in skin turgor.

"We aim to measure hydration levels at a constant rate and with high accuracy due to the use of optical frequencies combined with the research team's knowledge of the skin tissue electromagnetic properties," Dr Abu-Ali explained, adding: "We'll be able to have an in-depth understanding of the slight changes in the skin, not only the ones related to water content but also any biological variations due to the variations in hydration level."

The research and testing has to be carried ou with artificial skin before it can be approved for widespread use with human skin across various industries. Commenting on the experience with artificial skin that preceded this innovation, Dr Abu-Ali said: "The research team has previous knowledge in nano sensors implanted in skin and analysis of collected data for monitoring skin changes and early diagnostics of cancerous cells. Most of the work was on cancerous cells from the education hospital associated with Queen Mary of London University and artificial skin."

While the innovation is extremely promising, there is a range of challenges and considerations before there will be a transition from testing on artificial to real skin. Dr Abu-Ali said: "Currently, the team is working on preliminary testing and skin tissue characterization on the specified frequencies to ensure that the electromagnetic and electric properties are behaving as theoretically predicted and to ensure safe operation and reliable testing of intended devices. To have a smooth transition to real skin, we will test our results on real skin samples in the lab to finetune the findings of electromagnetic and electrical properties before implementing the prototype of the device."

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WHAT DOES WATER DO FOR YOU?

- Needed by brain to manufacture hormones and neurotransmitters
- Forms saliva (Digestion)
- Keeps mucosal membranes moist
- Regulates body temperature (sweating and respiration)
- Acts as a shock absorber for brain and spinal cord
- Allows body cells to grow, reproduce and survive
- Converts food to components needed for survival-digestion
- Flushes body waste, mainly in urine
- Lubricates joints
- Helps deliver oxygen all over the body
- Water is the major component of most body parts

When worn as a standalone wristband, or integrated with a smartwatch, smartphone or similar digital device, this piece of wearable tech is likely to have major applications in medicine and health sciences. It will ensure you're not placing yourself at risk of dehydration when engaging in sports activities, help to detect a range of diseases including diabetes and cancer, and also have a new use in childcare.

"It can be used with babies as well," Dr Abu-Ali explained. "Since the infants cannot express their need for water, the device will continuously monitor the hydration level and will collect the data and initially analyse it, then send it to the parent's smartphone, where a more comprehensive analysis is carried out. If the hydration level is below the safe threshold, the app will notify the parent of the amount of water needed to be provided to the baby."

The device will also be capable of detecting disorders that are not directly related to water content and hydration, working with high accuracy to track any slight change in the skin. These biological variations can be the early warning flags to signal the need for further prevention technologies for diseases such as skin cancer and diabetes.

The two primary objectives for the project include the final prototype and development of the optical-based wearable device for monitoring tissue hydration, and developing realistic in-vitro artificial and tissue-based skin phantoms to test the hardware and software.

Dr Abu-Ali expects the project to be delivered by January 2020 and concluded by summarising the innovation as a "commercial device that's easy to wear – its main operation is for data collection and initial processing. Most data will be then treated offline through the cloud system for more thorough analysis. The cloud system may be associated, for example, with a hospital, sports institute or a nursery".

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