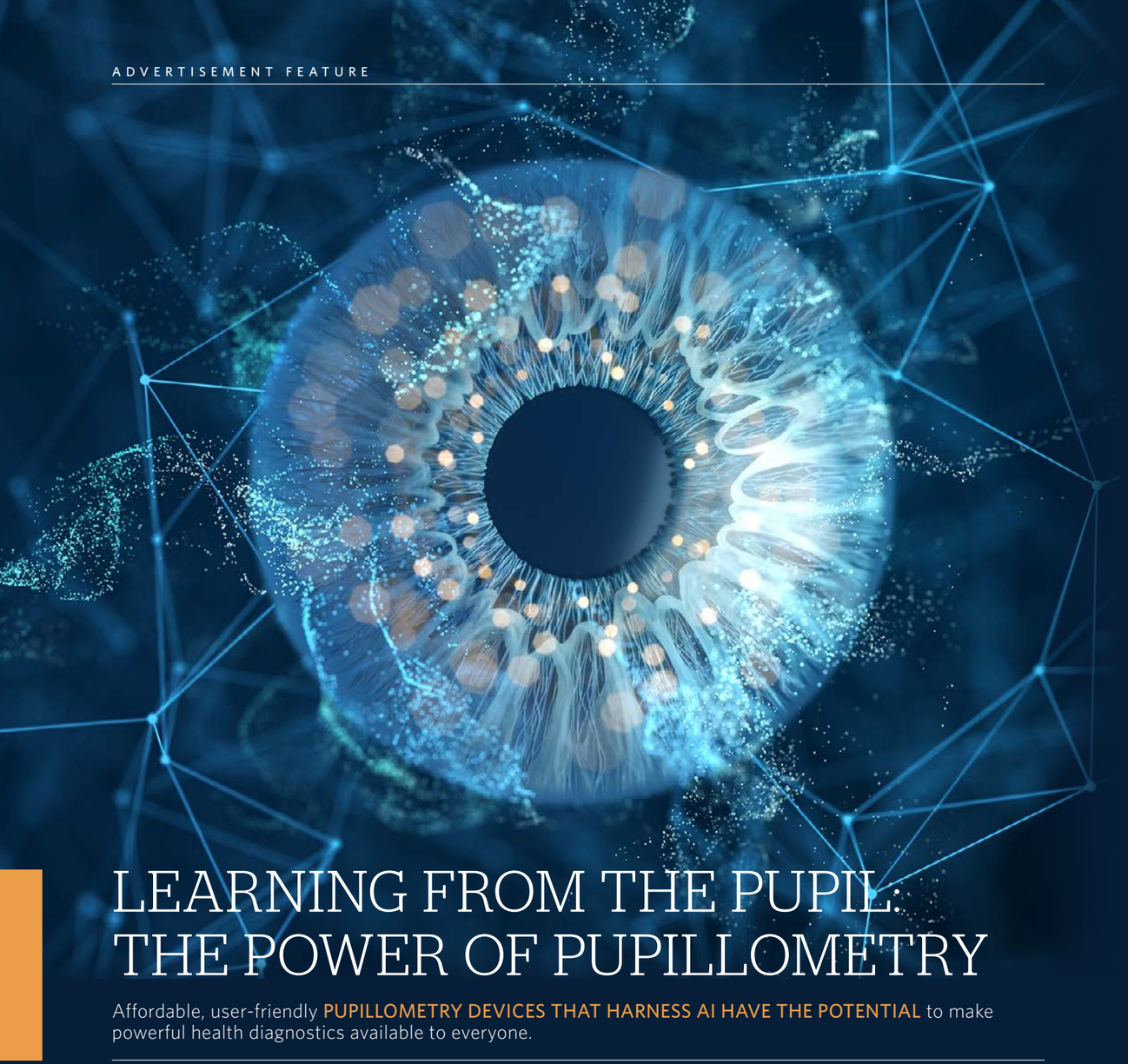

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LEARNING FROM THE PUPIL: THE POWER OF PUPILLOMETRY

Affordable, user-friendly **PUPILLOMETRY DEVICES THAT HARNESS AI HAVE THE POTENTIAL** to make powerful health diagnostics available to everyone.

The science of pupillometry takes a common intuition — that you can tell a lot about someone when you look them in the eye — and makes it concrete, measurable, and extraordinarily useful. By combining pupillometry with artificial intelligence (AI), companies such as AIMS Inc., from Tokyo, Japan, are hoping to make it more accessible.

Pupillometry measures the size and reactivity of the pupil, the dark circle at the eye's centre through which light enters. Typically, the pupil contracts and dilates depending on the amount of light entering the eye. Neurologists shine light into the eyes of trauma and stroke patients to gauge their light reflex[1], and ophthalmologists use it to check on the optic nerve. But it isn't only light that affects its behaviour. Since the 1960s, cognitive scientists and psychologists have found much of interest there, too.

MODERN PUPILLOMETRY

In 1957, Otto Lowenstein a professor at Columbia University in the United States, developed one of the world's first pupillometry devices, using infrared to measure the pupil's diameter. Soon after, two US-based scientists, Eckhard Hess and James Polt, demonstrated that the size of the pupil changed when visual stimuli was more or less interesting, indicating a relationship between the pupil's movement and cognitive state[2]. Many studies since then have shown that the pupil can reflect changes in mental states, the intensity of cognition, and the nature of attention[3].

"Over the last two decades, researchers in Japan have focused on how pupillometry can be used in diagnostics and preventative medicine," says Hiromi Kawamata, CEO of AIMS Inc. Building on this research, the healthcare startup is now investigating the relationships between pupil size and certain medical conditions that affect the nervous system.

Two factors, in particular, could reveal a person's inner state: the length of time it takes the pupil to dilate in response to a flash of light and how the pupil transitions from dilation to contraction, namely whether it is progressive and smooth or halting and jagged.

For example, when a pupil does not return to its original size within six seconds after a flash of light, or it does not return to more than 63% of its original size, a depressive state is indicated[4].

Likewise, an uneven progression from contraction to dilation could indicate pain, and a rapidly alternating progression indicates the impact of medication. A post-flash dilation that exceeds the original size of the pupil can indicate excitement or nervousness.

PORTABLE PUPILLOMETRY

Despite its potential, pupillometry is not yet part of routine medical care. Until recently, pupillometric devices cost tens of thousands of dollars and were available to few clinicians. Now, such devices are more affordable to produce and easy to transport and use.

With easier access to pupillometry, the technology could find its way into new applications. For example, AIMS is investigating the use of pupillometry as an objective measure of pain. Even the simplest discussion about pain between a patient and medical professional can be complex.

Children, in particular, may not have the words to describe what they are feeling, and adults may not be able to successfully communicate the intensity of pain to their doctor. In some cases, they may describe their pain, but not be believed. With a pupillometry device, a doctor can take a rapid and reliable measure of pain, leading to earlier, more effective treatment and reducing impact and cost.

Pupillometry might be used to enhance athletic performance. Coaches can objectively measure an athlete's stress or pain levels and customize a training programme. Pupillometry devices could also be useful for tracking interest and excitement in online shopping.

PUPILLOMETRY IS A QUICK AND NON-INVASIVE WINDOW TO THE AUTONOMIC NERVOUS SYSTEM.

AIMS Inc. is exploring the security applications of pupillometry. Several studies have shown that the pupils of people who are lying tend to dilate more than people who are telling the truth[5]. Used alongside other measures, they say that a pupillometry device could help detect people with criminal intentions at airports and similar public spaces that require high security.

BRINGING AI TO THE EYE

Measuring how the pupil reacts is the first step, the next crucial one is analysing the readings. To that end, AIMS has a team of five physicians and 15 AI engineers and data analysts who are validating the intended applications of the company's proprietary hardware, a miniaturized pupillometer that is operated with the press of a button.

An AI-powered pupillometry device offers many advantages over other diagnostic tools, Kawamata says. Blood and salivary tests are invasive, and in most health systems, pathology takes days to complete. Heart monitoring can provide a continuous, real-time measure of internal state but it requires that the subject be perfectly still, and it takes significant time.

▲ **A pupillometry device developed by AIMS Inc. in Japan.**

Pupillometry, in contrast, is a quick and non-invasive window to the autonomic nervous system. With easy-to-use AI-powered pupillometry devices, everyone can have the chance to look through that window.

To date, AIMS has received a 700-million-yen medical innovation grant from the Japanese government and applied for Pharmaceuticals and Medical Devices Agency approval for their AI-powered pupillometry device.

"Our goal," says Kawamata, "is a society where people use simple devices like ours to better know themselves." ■

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