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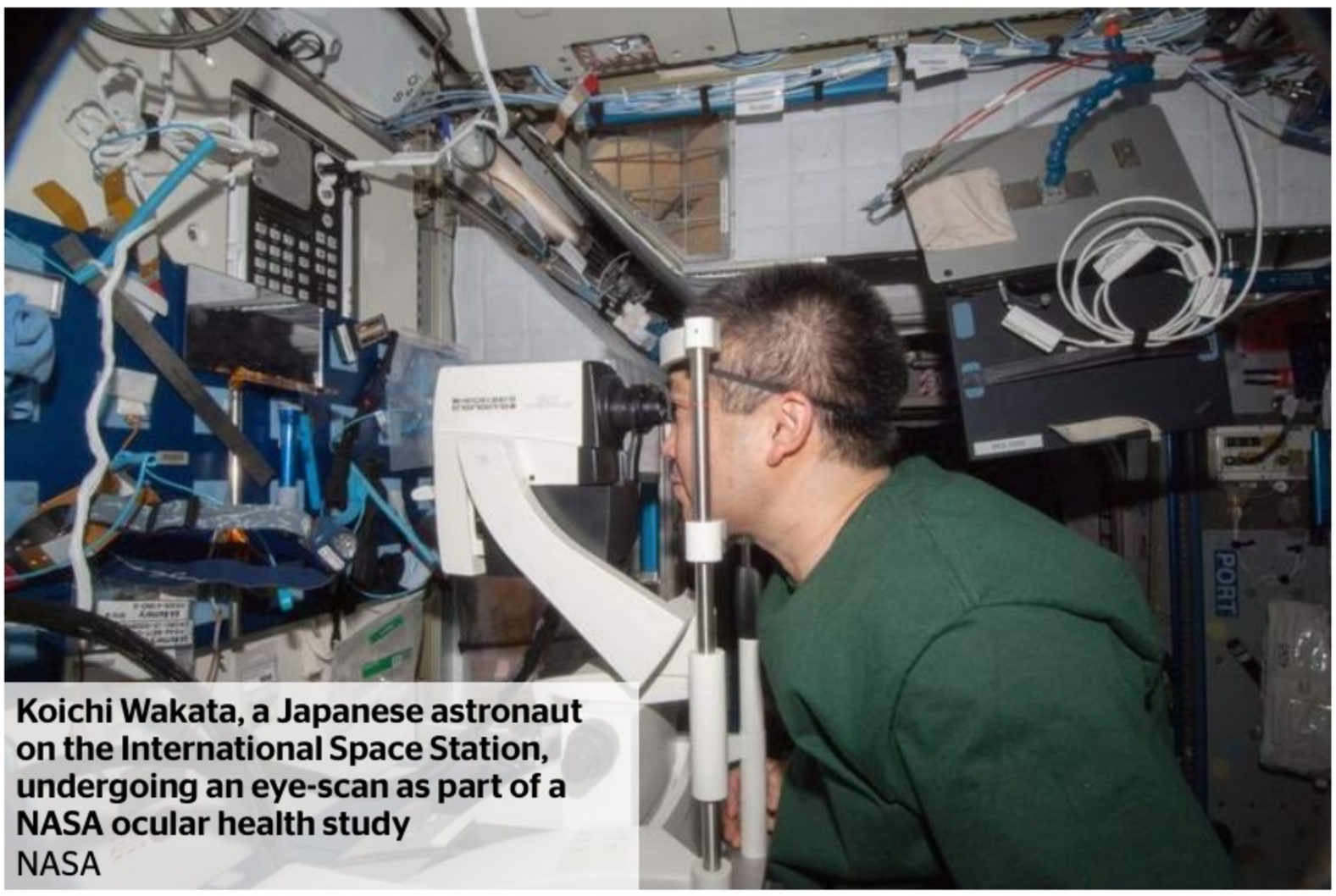
Eye-tech that turns science fiction into fact

Bionics and biology are giving new hope to people with declining sight, writes Mark Frary



Koichi Wakata, a Japanese astronaut on the International Space Station, undergoing an eye-scan as part of a NASA ocular health study
NASA

It is now 40 years since the first episode of The Six Million Dollar Man, in which Steve Austin was given a bio-nic eye, was aired. The technology was pure fiction but four decades on, just how far have we come? One device that is being dubbed a "bionic eye" has recently become available in the UK for some sufferers of retinitis pigmentosa , a rare, hereditary disease that causes a progressive degeneration of the light-sensitive cells of the retina.

Second Sight's Argus II is an artificial retina, which works by converting video images captured by a miniature camera housed in the patient's glasses into small electrical pulses that are transmitted wirelessly to an array of electrodes on the surface of the retina. These pulses are intended to stimulate the retina's remaining cells, resulting in the corresponding perception of patterns of light in the brain. The patient then learns to interpret these visual patterns, thereby regaining some visual function.

The NHS's Prescribed Specialised Services Advisory Group has now recommended that Argus II be authorised for implantation into UK patients.

Bionic Vision Australia is also trialling its own version of the bionic eye with three patients. Its version uses a digital camera mounted on a pair of glasses. This sends an image to an array of electrodes implanted into the patient's eye, which stimulates the retina. The current prototype includes only 24 electrodes, but versions with more resolution are planned. In the prototype, a wire emerges from behind the patient's ear and is plugged into a backpack of electronics. The company is now working on a fully implantable version.

Israel's VisionCare has recently received approval from the US Food and Drug Administration for an implantable miniature telescope to treat end-stage agerelated macular degeneration, the main cause of loss of vision in the over-65s. The pea-sized device is implanted into the eye, enlarges images to about 2.5 times their normal size and projects them on to unaffected areas of the retina, reducing the blind spot.

One of the biggest eye-tech stories this year has been the release of Google Glass in the UK, but another optical project from Google is also making the news.

Earlier this year, the company ann-ounced that it was working on a smart contact lens to help people with diabetes to keep their condition under control.

The modified contact lens includes a tiny wireless chip and miniaturised glucose sensor embedded between two layers of soft contact lens material. It is looking at whether embedded LEDs could light up to indicate that glucose levels have crossed above or below certain thresholds. In July, Novartis said it would license Google's contact

lens technology and look to extend it to people with presbyopia.

A more biological approach is also proving promising in the treatment of retinitis pigmentosa. Scientists at Columbia University Medical Center (CUMC) in the US are using induced pluripotent stem cell (iPSC) technology to transform adult skin cells into retinal cells. A team led by Dr Stephen Tsang has used these transformed stem cells to show that a form of retinitis pigmentosa is caused by mutation to the membrane-type frizzled-related protein gene, which can be treated by personalised gene therapy.

Using iPSCs is an effective shortcut, since harvesting retinal cells is fraught with danger and it avoids the controversy surrounding the use of human embryonic stem cells (hESCs).

Biotech company Advanced Cell Technology has seen encouraging results from using hESCs in the treatment of dry age-related macular degeneration. In one of the company's trials, a patient was implanted with retinal pigment epithelial cells derived from hESCs and his vision has improved from 20/400 (profound low vision) to 20/40 (the level at which you are allowed to drive in the US).

Some of this research will take a long time to become commonplace. Yet even the corrective laser surgery that tens of thousands of people have in the UK each year is moving forward. A new version of the common Lasik procedure is being offered by the London Eye Hospital. Lasik Xtra adds another stage to the treatment, in which riboflavin eyedrops are used and bombarded with ultraviolet light, strengthening the collagen fibres that make up the framework of the cornea.

Astronauts on the International Space Station are also doing their part. NASA is running an ocular health study, which tracks the effects of zero gravity on eyesight. The astronauts' eyes are scanned with a device called Spectralis, which uses optical coherence tomography. The scanner has a feature that allows all scans to be captured in the same position, making for easier comparison. The scans will determine whether there are any threats to eyesight on long-duration missions. ■