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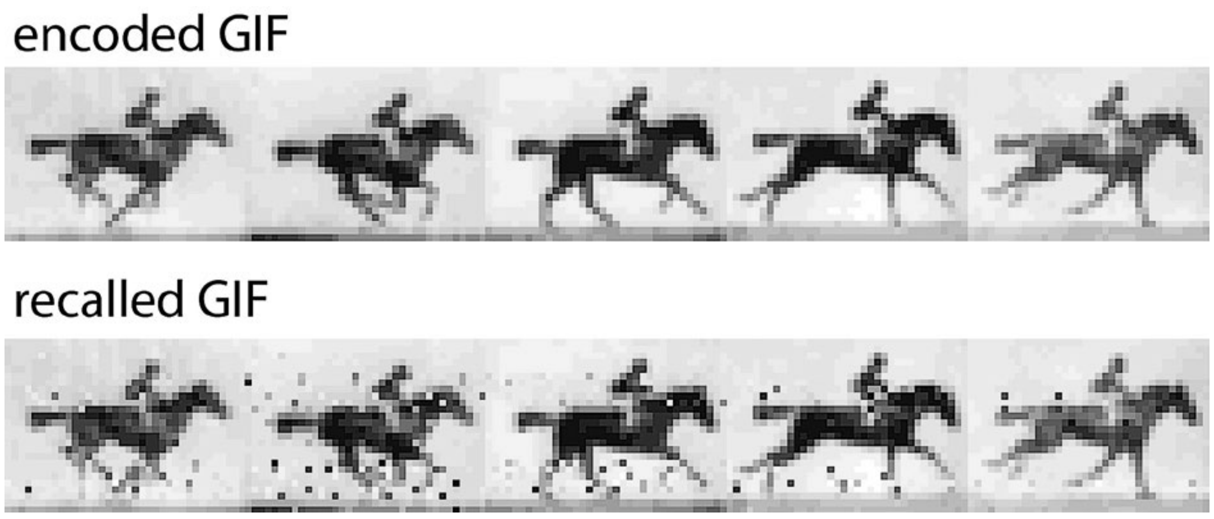
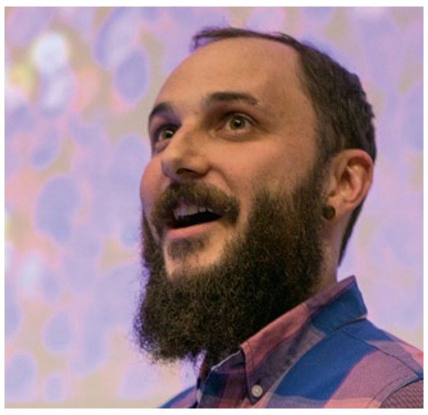


CRISPR system embeds images in DNA

19th century horse gallops through bacterial DNA



Seth Shipman PhD is a neuroscientist and postdoctoral fellow in Genetics at Harvard Medical School and a member of a team at the Wyss Institute for Biologically Inspired Engineering.
Shipman gained his doctorate through his focus on Neuroscience, at the University of California, San Francisco. His key interests lie in genetics and the advancing understanding of brain function.

Report: By Mark Nicholls

A research team in the United States has developed a revolutionary technique that has encoded an image and short film in living cells.

Scientists at the Wyss Institute for Biologically Inspired Engineering and Harvard Medical School (HMS) used CRISPR gene editing to encode the image and film in DNA, using this as a medium to store information and produce a code that relates to the individual pixels of each image. The team hopes to use the technique to create 'molecular recorders', an approach ultimately to lead to better methods to generate cells for regenerative therapy, disease modelling and drug testing.

For the research, the HMS group inserted a gif – five frames of a horse galloping - into the DNA of bacteria and then sequenced the bacterial DNA to retrieve the gif and the image, verifying that the microbes had incorporated the data as intended. The images chosen were of a human hand (because it has the type of intricate data the researchers hope to use in future experiments) and a galloping horse by 19th century British photography pioneer Eadweard Muybridge, because it has a timing component that could help to understand better how a cell and its environment may change over time.

The bacteria acquired data frame by frame

The team used still and moving images because they represent constrained and clearly defined data sets. The film also gave the bacteria a chance to acquire information frame by frame. The breakthrough follows work in 2016 when the HMS team built the first molecular recorder based on the CRISPR system.

The recorder allows cells to acquire elements of chronologically provided, DNA-encoded information that generate a memory in a bacterium's genome. The information is stored as an array of sequences in the CRISPR locus and can be recalled and used to reconstruct a timeline of events.

The latest breakthrough confirmed the scientists' ability to engineer CRISPR system-based technology that enables the chronological recording of digital information in living bacteria. The CRISPR system helps bacteria develop immunity against viruses in their environments.

Capturing viral DNA molecules

Dr Seth Shipman, a postdoctoral fellow in Genetics at HMS, explained that, as a memory of survived infections, it captures viral DNA molecules and generates short 'spacer' sequences from them, which it then adds as new elements upstream of previous elements in a growing array located in the bacterial genomes' CRISPR locus.

The CRISPR-Cas9 protein – a widely used genome-engineering tool – uses this memory to destroy the same viruses when they return, but other parts of the CRISPR system have not so far been much exploited.

In this study, the scientists showed that two proteins of the CRISPR system, Cas1 and Cas2, which they had engineered into a molecular recording tool, together with new understanding of the sequence requirements for optimal spacers, enables a significantly scaled-up potential for acquiring memories and depositing them in the genome as information.

'We designed strategies that essentially translate the digital information contained in each pixel of an image or frame into a DNA code that, with additional sequences, is incorporated into spacers,' Shipman explained. 'Each frame thus becomes a collection of spacers. We then provided spacer collections for consecutive frames chronologically to a population of bacteria, which, using Cas1/Cas2 activity, added them to the CRISPR arrays in their genomes. After retrieving all arrays again from the bacterial population by DNA sequencing, we finally could reconstruct all frames of the galloping horse movie and the order in which they appeared.'

Effectively, to read the information back, the researchers sequenced the bacterial DNA and used a computer code to unscramble the genetic information. 'We took on this research because we see the potential for cells to gather information about their own biology and their environment,' Shipman said. 'For that to happen, we need a way to capture and store information within a cell while it's still alive – that's what we are testing.'

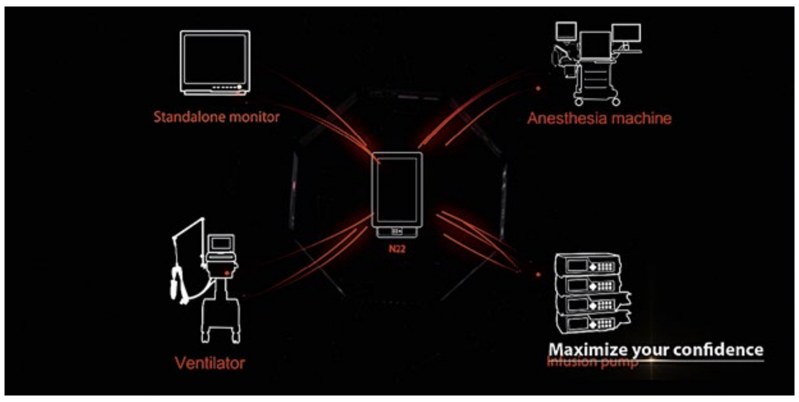
It took researchers three to four years to go from the idea of cells encoding information using the CRISPR-Cas adaptation system to this latest work and it took several days to do the recordings.

'Going forward,' Shipman continued, 'we'd like to see this work used as the basis for building living biological recording devices that might function as a research or medical diagnostic tool.'

Envisioning the future of patient monitoring

The distance is within reach

30 years ago, monitoring in most intensive care environments was via an ECG display with a numeric value for heart rate combined with intermittent manual measurements of blood pressure. Advances in technology have greatly increased monitoring parameters. Eight, for example, are included in the current minimum standards for monitoring under anaesthesia but more than ten further sensors are routinely available. * Mindray, which specialises in patient monitoring & life support, in-vitro diagnostics, and imaging systems, is headquartered in Shenzhen, China, and employs nearly 7,600 people internationally. Here, the company looks at present and future technological developments for intensive care.



The BeneLink Interfacing Module integrates monitored data from other bedside devices

All technological advances come with paradoxes. Patient monitoring is a multifarious process involving the contex-tual acquisition and interpretation of patient-related data as well as the performance of diagnostic tasks. While the exponential growth in the number of parameters provides clinicians with more patient information to base their diagnosis on, it also makes decision-making a more complex process. Clinicians must hunt for the most relevant pieces out of a vast amount of data that often comes unprocessed and unorganised.

The question is: how to reconcile this paradox? The clinical setting is in urgent need of decision support. Especially when the acuity of today's clinical environment frequently necessitates real-time decision-making, prompt response to life-threatening events, and handling of a variety of medical devices. In this sense, patient monitoring might become a valuable tool, if it can reduce the cognitive workload of the stressed clinician and ease the decision-making process. We need, in a word, a monitoring system that liberates clinical expertise. With BeneVision N Series Patient Monitor, Mindray is envisioning the future of patient monitoring with a humble yet ambitious start.

BeneVision's interoperability platform builds bridges between stand-alone devices and data sources

Centralised data management

Current monitoring systems do not lack data. What is lacking is the ability to convert that data into intelligence—intelligence that enhances clinical expertise with a complete and accurate view of patient conditions. Combining physiological data extracted by a patient monitor with information located in computerised records of medical history, drug therapy, laboratory and radiological testing, integrated patient information can provide early warning of health concerns and optimised management of diseases. In this way, clinicians can spend more time with patients and less time hunting and gathering information.

BeneVision's originated interoperability platform works exactly this way. It builds bridges between stand-alone devices and data sources to enable more informed decision-making and seamless informatics flow. With a powerful iView medical PC inside, BeneVision runs applications independently to bring all patient information on the same screen such as medical imaging and laboratory records.

Besides, the BeneLink Interfacing Module integrates monitored data from other bedside devices, and further transmits to external system by HL7.

Mindray is at Medica
Hall 9 / Stand A74-A78

Seamless informatics flow

BeneVision's powerful data integration capacity also allows it to be the centre of the seamless informatics workflow complemented by the T1 transport solution. The compact T1 monitor follows the patient continuously and seamlessly anywhere, anytime. T1 combines the MPM module and transport monitor together, with plug and play capability with BeneVision N Series host monitors. Together they constitute a data network that streamlines workflow, enhances patient safety and optimises resources for clinicians.

Another improvement to clinical workflow BeneVision offers is the SmartPager technology. With SmartPager, clinicians can receive real-time patient conditions on mobile devices such as mobile phones and tablets. This way patient data is constantly monitored and readily available to clinicians wherever they are.

Intelligent decision support

What if monitoring systems can be more intelligent? What if their assistance goes beyond raw information to software entities enriched with decision support? BeneVision envisions more possibilities of patient monitoring with powerful decision support tools such as ST Graphic, HemoSight, SepsisSight, BoA Dashboard and EWS scoring. These tools summarise complex clinical measurements such as rSO2, ICG, PiCCO, AG, RM, BIS, NMT, etc. and translate it into visualised graphic display, so that clinicians can grasp patient conditions at a glance.

For example, HemoSight helps clinicians make decisions through sets of hemodynamic assistance applications, with visualisation and infographics of hemodynamic parameters. ST Graphic and real-time QT/QTc analysis help clinicians recognise subtle cardiac changes and make early diagnosis and treatment.

Mindray believes the best way to predict the future is to create it. The revolutionary BeneVision N Series is designed to liberate clinical expertise with maximum decision support throughout the entire patient monitoring process, from data acquisition, interpretation to its application in decision-making.

* Source: American Society of Anesthesiologist; Recommendations for Standards of Monitoring during Anesthesia and Recovery

Shadowless, clear and homogeneous

A light that's just right

Generating a shadowless, clear and homogeneous light assures clarity of the surgical site. Thanks to next generation LEDs, the Italian firm Acem reports that its 'Starled5 NX produces a perfect illumination under every condition generating an IR-free light, an excellent colour temperature and a practically endless life cycle at low consumptions.

'The 43 LEDs in the system are circularly positioned and divided into five reflectors (with seven LEDs each) and another eight LEDs are radially placed around the handle. The lamp produces in this way a high illumination level of 130.000 lux (160.000 lux optional) for a steady life cycle of about 50.000 hours.

'Acris is the extraordinary and innovative system realised by Acem that ensures, due to the use of a microprocessor, the control of electrical curves typical of LEDs to remain unaltered over time but maintaining a long life cycle. The colour rendering index of Starled5 NX is 95 and its colour temperature 4.500 °K. (Optional: Variable colour temperature from 3.700 °K to 4.700 °K continuous). '

Focused and ambient

To achieve a correct illumination according to different surgical needs the lamp can produce focused and ambient light. Due to its special optics, the light field focusing system adjusts the lightspot diameter accurately, assuring an excellent sharpness of details in the operating area, the firm reports. Ambient light is managed by the Endo function. 'This technology allows visual comfort as well as correct exposure of the surrounding environment thanks to its particular light beam coming from the upper part of the lamp.'

This model is particularly suitable for minimally invasive surgery and ideal for preparation and surgical operations plus patient monitoring.

The lamp is also easy to move with the lateral handles assuring stability and constant illumination even during movement, the manufacturer adds. 'Its ergonomic and practical design takes into consideration sanitary requirements essential for the operating room. For this reason Starled5 NX has been manufactured with a smooth and resistant material that makes cleaning quick, easy and complete. Its removable and sterilisable central handle can house a video camera, on demand, shooting surgical operations accurately (alternatively the video camera can be placed on a separate arm).

'The lamp shape assures visual comfort and is particularly suitable for laminar flows in the operating room. All the functions of this model are managed by the handy, digital and easy-to-read I – SENSE control panel on the cardanic structure.'

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43 LEDs are circularly positioned and divided into five reflectors