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Smart chip makes low-powered, wireless neural implants a possibility

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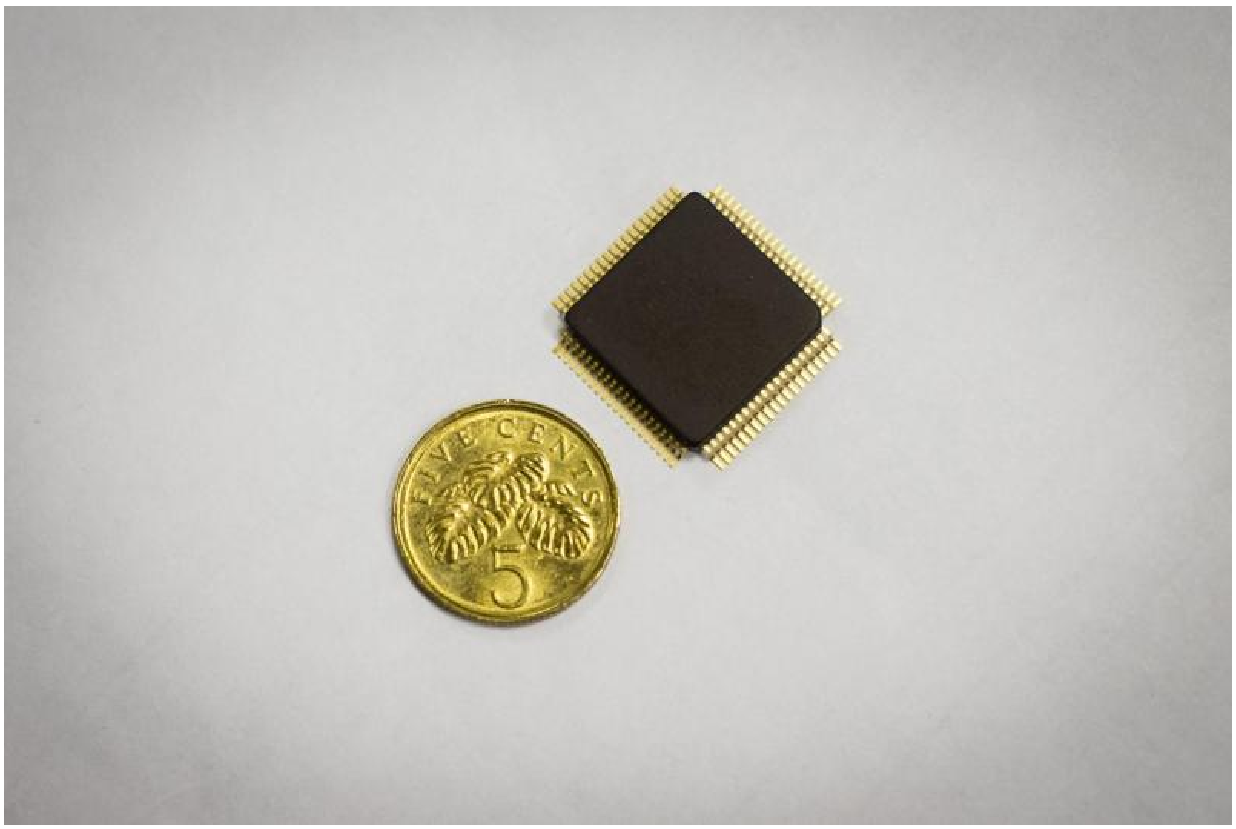


NTU's low powered smart chip which recognises patterns and is the size of a Singapore 5 cent coin

Scientists at Nanyang Technological University, Singapore (NTU Singapore) have developed a small smart chip that can be paired with neural implants for efficient wireless transmission of brain signals.

Neural implants when embedded in the brain can alleviate the debilitating symptoms of Parkinson's disease or give paraplegic people the ability to move their prosthetic limbs.

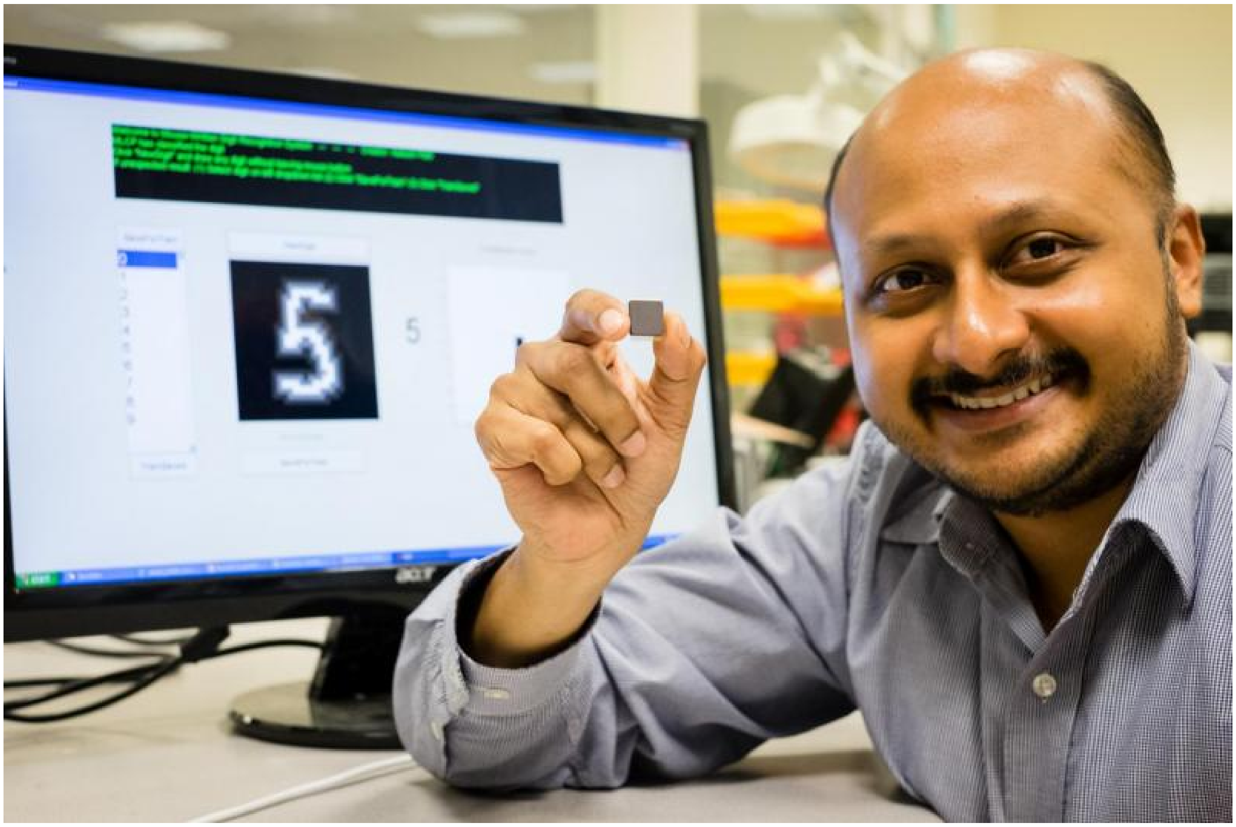
However, they need to be connected by wires to an external device outside the body. For a prosthetic patient, the neural implant is connected to a computer that decodes the brain signals so the artificial limb can move.

These external wires are not only cumbersome but the permanent openings which allow the wires into the brain increases the risk of infections.

The new chip by NTU scientists can allow the transmission of brain data wirelessly and with high accuracy.

Assistant Professor Arindam Basu from NTU's School of Electrical and Electronic Engineering said the research team have tested the chip on data recorded from animal models, which showed that it could decode the brain's signal to the hand and fingers with 95 per cent accuracy.

"What we have developed is a very versatile smart chip that can process data, analyse patterns and spot the difference," explained Prof Basu.



NTU Asst Prof Arindam Basu holding his low-powered smart chip

"It is about a hundred times more efficient than current processing chips on the market. It will lead to more compact medical wearable devices, such as portable ECG monitoring devices and neural implants, since we no longer need large batteries to power them."

Different from other wireless implants

To achieve high accuracy in decoding brain signals, implants require thousands of channels of raw data. To wirelessly transmit this large amount of data, more power is also needed which means either bigger batteries or more frequent recharging.

This is not feasible as there is limited space in the brain for implants while frequent recharging means the implants cannot be used for long-term recording of signals.

Current wireless implant prototypes thus suffer from a lack of accuracy as they lack the bandwidth to send out thousands of channels of raw data.

Instead of enlarging the power source to support the transmission of raw data, Asst Prof Basu tried to reduce the amount of data that needs to be transmitted.

Designed to be extremely power-efficient, NTU's patented smart chip will analyse and decode the thousands of signals from the neural implants in the brain, before compressing the results and sending it wirelessly to a small external receiver.

This invention and its findings were published last month in the prestigious journal, IEEE Transactions on Biomedical Circuits & Systems, by the Institute of Electrical and Electronics Engineers, the world's largest professional association for the advancement of technology.

Its underlying science was also featured in three international engineering conferences (two in Atlanta, USA and one in China) over the last three months.

Versatile smart chip with multiple uses

This new smart chip is designed to analyse data patterns and spot any abnormal or unusual patterns.

For example, in a remote video camera, the chip can be programmed to send a video back to the servers only when a specific type of car or something out of the ordinary is detected, such as an intruder.

This would be extremely beneficial for the Internet of Things (IOT), where every electrical and electronic device is connected to the Internet through a smart chip.

With a report by marketing research firm Gartner Inc predicting that 6.4 billion smart devices and appliances will be connected to the Internet by 2016, and will rise to 20.8 billion devices by 2020, reducing network traffic will be a priority for most companies.

Using NTU's new chip, the devices can process and analyse the data on site, before sending back important details in a compressed package, instead of sending the whole data stream. This will reduce data usage by over a thousand times.

Asst Prof Basu is now in talks with Singapore Technologies Electronics Limited to adapt his smart chip that can significantly reduce power consumption and the amount of data transmitted by battery-operated remote sensors, such as video cameras.

The team is also looking to expand the applications of the chip into commercial products, such as to customise it for smart home sensor networks, in collaboration with a local electronics company.

The chip, measuring 5mm by 5mm can now be licensed by companies from NTU's commercialisation arm, NTUitive.

Developed over the past two years by a team of four at NTU's VIRTUS IC Design Centre of Excellence, the project has since received over S$850,000 in research funding.

More information: Yi Chen et al. A 128-Channel Extreme Learning Machine-Based Neural Decoder for Brain Machine Interfaces, *IEEE Transactions on Biomedical Circuits and Systems* (2015). DOI: 10.1109/TBCAS.2015.2483618

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