Face recognition system 'K-Eye'

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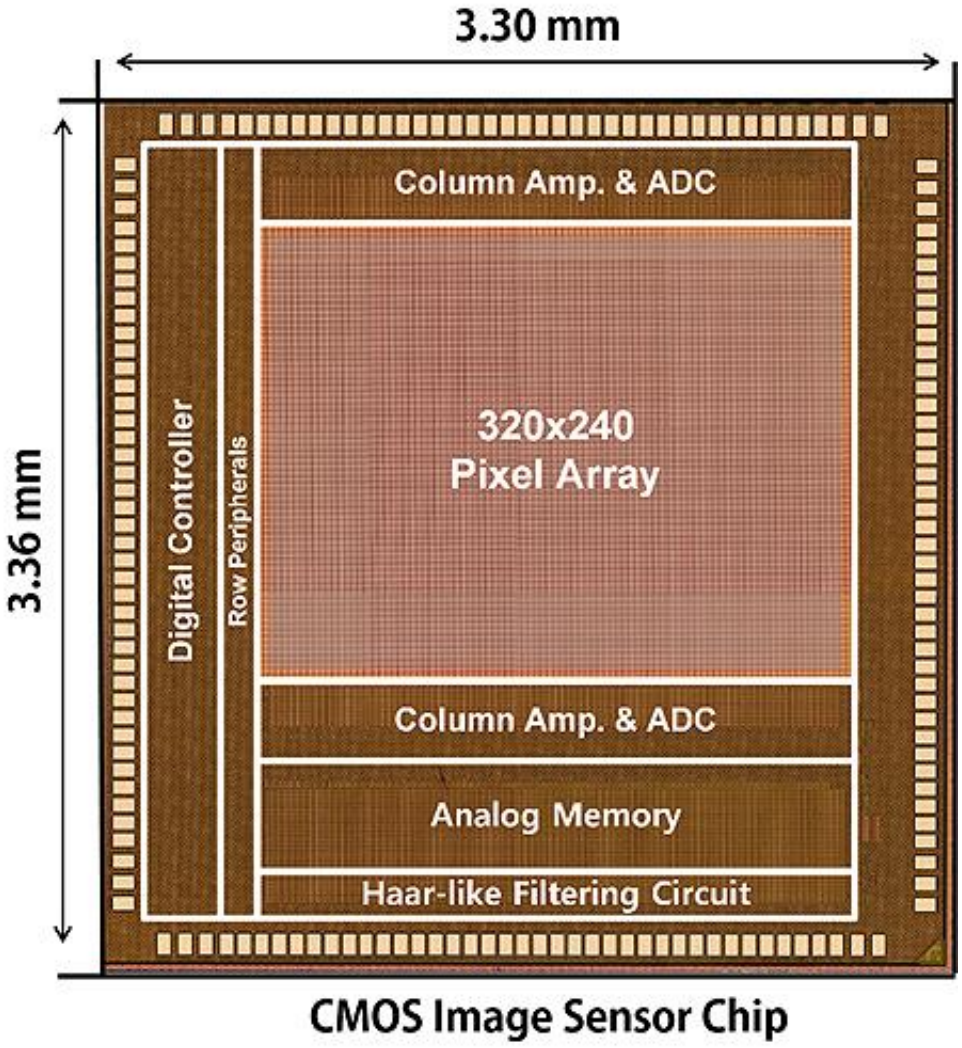

CMOS image sensor chip. Credit: KAIST

Artificial intelligence (AI) is one of the key emerging technologies.

Global IT companies are competitively launching the newest technologies and competition is heating up more than ever. However, most AI technologies focus on software and their operating speeds are low, making them a poor fit for mobile devices. Therefore, many big companies are investing to develop semiconductor chips for running AI programs with low power requirements but at high speeds.

A research team led by Professor Hoi-Jun Yoo of the Department of Electrical Engineering has developed a semiconductor chip, CNNP (CNN Processor), that runs AI algorithms with ultra-low power, and K-Eye, a face recognition system using CNNP. The system was made in collaboration with a start-up company, UX Factory Co.

The K-Eye series consists of two types: a wearable type and a dongle type. The wearable type device can be used with a smartphone via Bluetooth, and it can operate for more than 24 hours with its internal battery. Users hanging K-Eye around their necks can conveniently check information about people by using their smartphone or smart watch, which connects K-Eye and allows users to access a database via their smart devices. A smartphone with K-EyeQ, the dongle type device, can recognize and share information about users at any time.

When recognizing that an authorized user is looking at its screen, the smartphone automatically turns on without a passcode, fingerprint, or iris authentication. Since it can distinguish whether an input face is coming from a saved photograph versus a real person, the smartphone cannot be tricked by the user's photograph.

The K-Eye series carries other distinct features. It can detect a face at first and then recognize it, and it is possible to maintain "Always-on" status with low power consumption of less than 1mW. To accomplish this, the research team proposed two key technologies: an image sensor with "Always-on" face detection and the CNNP face recognition chip.

The first key technology, the "Always-on" image sensor, can determine if there is a face in its camera range. Then, it can capture frames and set the device to operate only when a face exists, reducing the standby power significantly. The face detection sensor combines analog and digital processing to reduce power consumption. With this approach, the analog processor, combined with the CMOS Image Sensor array, distinguishes the background area from the area likely to include a face, and the digital processor then detects the face only in the selected area. Hence, it becomes effective in terms of frame capture, face detection processing, and memory usage.

The second key technology, CNNP, achieved incredibly low power consumption by optimizing a convolutional neural network (CNN) in the areas of circuitry, architecture, and algorithms. First, the on-chip memory integrated in CNNP is specially designed to enable data to be read in a vertical direction as well as in a horizontal direction. Second, it has immense computational power with 1024 multipliers and accumulators operating in parallel and is capable of directly transferring the temporal results to each other without accessing to the external memory or on-chip communication network. Third, convolution calculations with a two-dimensional filter in the CNN algorithm are approximated into two sequential calculations of one-dimensional filters to achieve higher speeds and lower power consumption.

With these new technologies, CNNP achieved 97% high accuracy but consumed only 1/5000 power of the GPU. Face recognition can be performed with only 0.62mW of power consumption, and the chip can show higher performance than the GPU by using more power.

These chips were developed by Kyeongryeol Bong, a Ph. D. student under Professor Yoo and presented at the International Solid-State Circuit Conference (ISSCC) held in San Francisco in February. CNNP, which has the lowest reported power consumption in the world, has

achieved a great deal of attention and has led to the development of the present K-Eye series for face recognition.

Professor Yoo said "AI - processors will lead the era of the Fourth Industrial Revolution. With the development of this AI chip, we expect Korea to take the lead in global AI technology."

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