Title	I'd like to obtain useful information from visual images and use it to benefit society : Understanding contexts from human, object and spatial information
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Featured in this issue is Associate Professor Yoshimitsu Aoki, who pursues research into image information sensing for application to a wide range of fields.

I'd like to obtain useful information from visual images and use it to benefit society

Understanding contexts from human, object and spatial information

Our modern daily lives are brimming with all kinds of visual images and image information thanks to the spread of digital cameras, security cameras and the like. To put it another way, these visual images and information are serving as our vital sensors on understanding society. Associate Professor Yoshimitsu Aoki focuses his energy on the effective use of leading-edge image sensing technology to develop systems beneficial to society. We asked Dr. Aoki about a variety of advanced technologies he is working on at his lab.

A desire to develop a "quick-witted" artificial intelligence system based on image sensing technology

Dr. Aoki of the Department of Electronics and Electrical Engineering is currently engaged in an attempt to apply visual images from digital cameras and video cameras for sensing. He says he is interested in developing a system that allows meaningful pieces of information to be extracted automatically, which he wants to use for the benefit of society.

For example, functions such as extracting a particular individual's facial features to automatically focus on them and functions for recognizing one's own child and bringing the camera into focus on the child have already been put into practical use with digital cameras and video cameras. Furthermore and steps ahead, he aims to enable the computer to understand a move a subject is going to make, a given situation and even the meaning or import of a whole particular scene.

"I'm targeting not only humans but also recognition of colors and shapes of objects as well as spatial and environmental recognition. In other words, I'm trying to understand the whole of a given scene by using images to recognize the three – human, object and spatial – elements. By combining multiple pieces of information, I think it'll be possible to understand the context of what's going on there. Suppose there is a person who is extending his hand. Context understanding in this case means distinguishing whether he is going to shake hands with someone else or is trying to get hold of something," remarks Dr. Aoki.

Almost everyone carries a smart phone or a tablet device now, casually taking snapshots and videos and uploading them on the Internet. Out on the streets, security cameras are installed everywhere, replacing human eyes. Sensing these images and using them to develop an intelligent sensing system with human-like senses, sensitivity and thinking, something that can comprehend complex matters and make forecasts . . . this was Dr. Aoki's motive to take up this research theme.

But why images . . . ? He explains as follows: "The primary merit of using images lies in that images allow us to conduct simultaneous, wide-range measurement of more than one person. Another advantage is that, unlike common sensors, images do not have to be carried by the persons concerned, thus placing no restrictions on their actions.

On the other hand, the use of images can involve privacy problems. Images are also useless unless the target can be captured by camera due to blind spots and so on. Furthermore, it is difficult to process moving images in real-time because of their large volume of information. In this age of overflowing image information, why can't we make full, more effective use of images? . . . This is the ever-stronger voice from the real

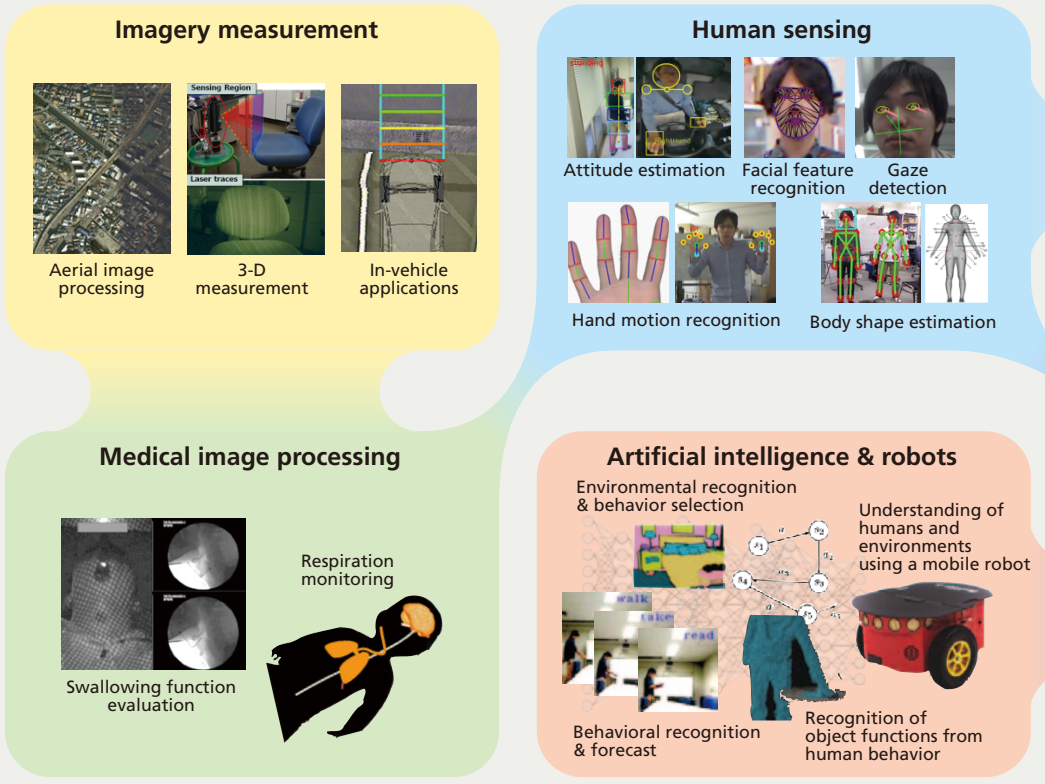


Fig.1 Image sensing technologies from Aoki lab
Aoki lab's core technologies cover: a variety of sensing technologies targeting humans for measurement and recognition; and imagery measurement and recognition technologies targeting objects and spaces. Results of sensing thus obtained are applied for automatic image analysis, scene understanding, extraction of sensitivity information, and medical diagnosis support systems, among others.

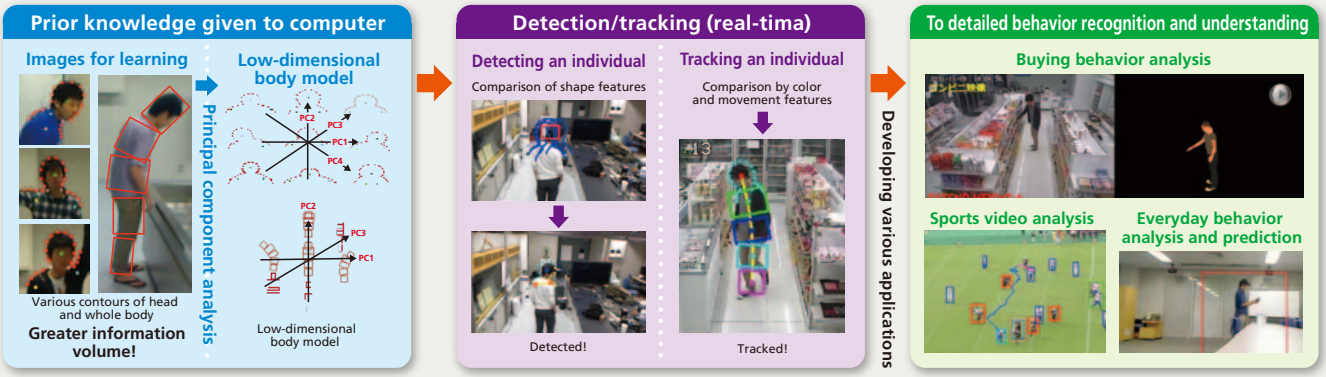


Fig.2 Flow of human behavior recognition from image information
This process begins with modeling of an individual's features based on a limited amount of information. The modeled features are given to computer as prior knowledge and are compared stochastically with features obtained from visual images. This enables detection and tracking of a target that has human-like features. Expectations are high for applying this technology for a wide range of fields, such as analysis of buying behavior at shops, analysis of sports tactics, recognition of everyday behavior, and even the prediction of next actions to be taken.

world."

Recognizing and understanding individuals under various situations by detecting and tracking their behavior

Above all, Dr. Aoki focuses on a technology with the ability to detect and track a particular individual in images. "By applying this technology to security cameras, it will become possible to identify a suspicious person or detect a lost person. If used with security cameras at convenience stores, for example, it will recognize what product items customers are interested in – an application for marketing research."

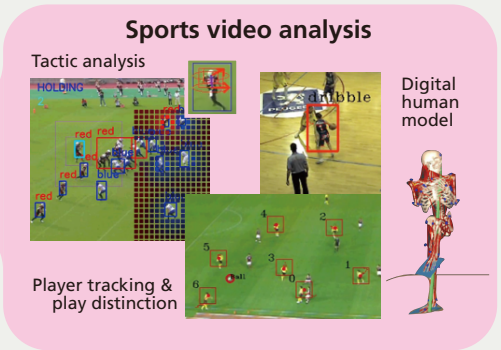
Dr. Aoki is also tackling a more challenging theme in relation to sports events such as soccer or American football games, where players of each team wear the same uniforms with different numbers. The challenge here is to detect movements and/or positions of a particular player (or the ball) from among many players, relying on his number only. These technologies can be applied for the understanding of tactics and prediction of plays. In fact, Dr. Aoki is receiving business inquiries from pro sports teams, TV stations, game software makers and so on.

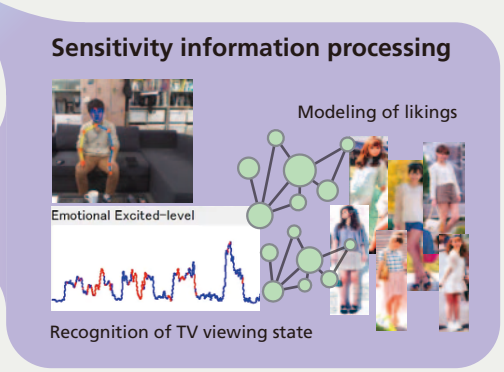
"For this technology, we employ a method based on modeled human postures, which allows the computer to learn beforehand information about how positions of a person's body parts, e.g. from the head to shoulders, will change. In doing so, we compress the information volume significantly by using a technique known as 'principal component analysis,' which is the secret," continues Dr. Aoki.

Principal component analysis is a mathematical technique to show in a limited number of indices the features of given multidimensional data without destroying important information. By using this technique, it becomes possible to express an individual's body shape features from a limited volume of information. Furthermore, by establishing a link model for a human body from the upper to the lower halves, it is also possible to track an individual's movements and postures in real-time and robustly.

"Thanks to this technology, I can now obtain more detailed information about human postures, such as determining to what product on a shelf a person is trying to extend his/her hand. In addition, by applying this knowledge I could successfully develop an innovative technology capable of instantaneously restoring one's three-dimensional body shape from only two pieces of image showing his/her front and side," he says.

In this manner, the excellence of Dr. Aoki-initiated technologies lies in that they can speedily process highly complex movements and shapes using an extremely limited volume of information, which can be applied to actual systems.





Aiming to put the technologies into practical use in entertainment, fashion and medical fields

The essence of Dr. Aoki's research initiatives can be described as pursuit of real-time processing of information using minimal volume of information. What lies beyond? . . . It should be practical application of the research results. What he has in mind as application outlets for his research results are fields, such as sports, entertainment, apparel, medical and social welfare.

Examples of potential medical application are measurement systems for the detection of babies' respiratory failures and for the swallowing ability of the elderly. For the former, the system is intended to measure subtle up-and-down movements of the chest, and for the latter it will measure movements of the Adam's apple. The greatest advantage is that both of these measurement systems will have no invasiveness.

Another feature of the Aoki lab is that it engages in research into a sensitivity information processing system designed to measure human sensitivity. For example, suppose one accesses an EC (electronic commerce) web site. In this case, the system will estimate the user's personal taste for clothing and recommend a product most suited for his/her sense or liking.

"At my lab, 60 to 70 percent of the research activities are joint projects with businesses. This means expectations are high among businesses for our image sensing technologies," concludes Dr. Aoki. Being close to our everyday life, it seems only natural that expectations continue to grow for practical application of these technologies.

(Reporter & text writer : Madoka Tainaka)