Using deep learning to localize human eyes in images

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a) Outputs of the level 1 on BioID

b) Outputs of the level 4 on BioID

Credit: Liu et al.

A team of researchers at China University of Geosciences and Wuhan WXYZ Technologies in China has recently proposed a new machine learning-based technique to locate people's eyes in images of their faces. This technique, presented in a paper published in Elsevier's journal

Neurocomputing, could have several useful applications. For example, it could be used to detect drowsiness in people who are driving a car or performing tasks that require a certain degree of alertness and attention.

Drowsiness can greatly impair people's decision-making skills, as well as their attention and memory. Drowsiness while driving or completing an important task can lead to a significant decline in efficiency, and in some cases, even cause life-threatening accidents.

One of the most effective ways to estimate levels of drowsiness in humans is by looking at their eyes, which in drowsy people are typically more closed or fatigued. Automatically analyzing people's eyes using computational methods, however, first of all entails locating them in real-time images or videos.

"Our recent work is one part of our research on drowsiness estimation," the researchers who carried out the study told TechXplore via email. "In our previous works, we proposed an initiative service model for service robot that is different from passive service (i.e., the robot needs to wait for a user's instruction when providing service). What's more, we selected a drinking service robot as an example to verify the effectiveness of the initiative service model."

Initially, the researchers set out to develop a technique for drowsiness estimation that could improve the practicality of a robotic platform that serves drinks to humans. The first step in this direction was creating an automatic method to locate people's eyes in real time by analyzing images of their faces.
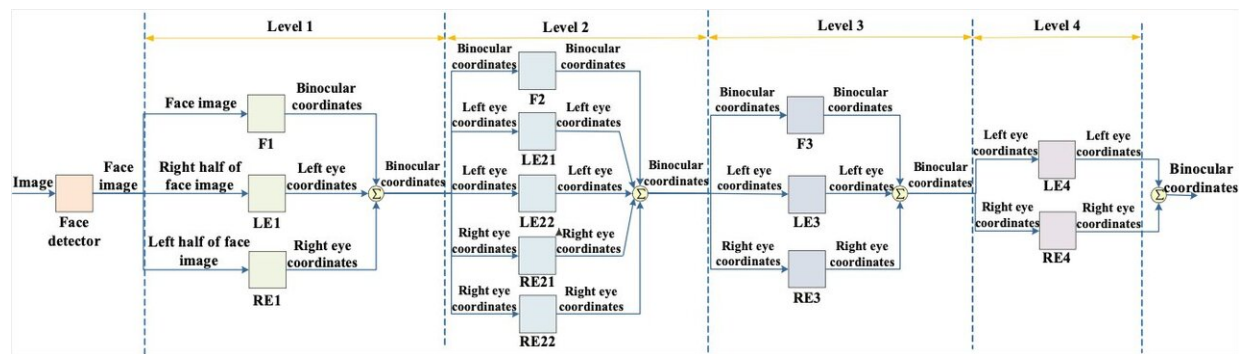
Overall structure of WBCCNN for eye localization. Credit: Liu et al.

The eye localization method proposed by the researchers is based on a machine learning technique known as weight binarization cascade convolutional neural network (WBCCNN). The WBCCNN they developed predicts the position of people's eyes from coarse to fine, which improves the performance of the model. In addition, the binary component of the network helps to reduce the model's storage size and speed up its operations.

The researchers evaluated their WBCCNN model for eye localization in a series of experiments using images from the Labeled Faces in the Wild (LFW), BioID and Labeled Face Parts in the Wild (LFPW) datasets. Their method achieved remarkable results and outperformed other techniques for eye localization, achieving an average detection error of 0.66 percent in localizing left eyes and 0.71 percent right eyes.

According to the researchers, the most meaningful achievement of their study was the development of a WBCCNN in which the weight is constrained by binarization. This unique design characteristic enables savings in the model's storage capacity, while also reducing its computational costs. In the future, the new WBCCNN model could aid

the development of effective tools to estimate people's drowsiness, as well as other emotions or states that can be detected by analyzing people's eyes.

"Reliable eye localization is necessary for drowsiness estimation, thus, we will now try to apply the proposed eye localization method to initiative service of robots for drowsiness estimation, designed to help increase people's work efficiency," the researchers said.

More information: Zhen-Tao Liu et al. Eye Localization Based on Weight Binarization Cascade Convolution Neural Network, *Neurocomputing* (2019). DOI: 10.1016/j.neucom.2019.10.048

Man Hao et al. Proposal of initiative service model for service robot, *CAAI Transactions on Intelligence Technology* (2019). DOI: 10.1049/trit.2017.0021

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