UNIVERSITE DE BOURGOGNE
Laboratoire Électronique Informatique et image de Bourgogne

Computer vision based real-time micro-expression analysis

PhD Position

Speciality : INSTRUMENTATION AND IMAGE PROCESSING

Mots clé : Computer Vision, video analysis, micro-expressions classification, machine learning, approximate computing, real-time processing, affective computing, IA emotion.

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Scientific Background

In some circumstances, stress can be a positive and motivating force. However, chronic stress or anxiety can cause a variety of symptoms and affect the overall well-being and health. Affective computing (also called artificial emotional intelligence, or emotion AI) consists to conceive and develop systems that can recognize, interpret, process, and simulate human affects. This modern branch of computer science should analyze the human's emotional state and adapt the man-machine interface to give an appropriate response to those emotions.

Computer vision-based emotion assessment begins by capturing data about the user's physical state or behavior using passive sensors. For example, a video camera might capture facial expressions, body posture, and gestures, while other sensors detect emotional cues by directly measuring physiological data, such as skin temperature and galvanic resistance. Recognizing emotion requires firstly the extraction of meaningful pattern from the gathered data, then the processing of different modalities, such as facial expression, physiological parameter, using machine learning techniques to produce an emotional label. Real-time emotion analysis possesses many potential applications such as *e-learning*, *e-health, neuro-marketing, etc.* This research topic is relatively recent and very few results are published in the literature.

Description of the project

Based on computer vision techniques, the goal of this PhD thesis is to establish a real-time and remote emotion recognition system which respects multiple constraints of general public applications: robustness and flexibility, low cost, user-friendliness, and embedability with low energy consumption. Facial expressions of emotion are not culturally determined, but universal. Thus, we can categorize them in 6 basic emotions. Recently, these expressions are divided in two classes: macro- and micro-expressions. Micro-expressions occur within 1/4 -1/25 of a second. They are involuntary and expose a person’s true emotions. However, locating and analyzing these events from a video sequence is very difficult due to their short duration and low intensities.

In this PhD project, based on the bibliographic study, firstly we will use a fast camera (200 frames/s) to capture micro-expressions: a new video database will be created under real-world conditions. Then, existing macro-expression recognition algorithms will be tested and improved on optimal extracted images/video in order to generalize them on micro-expressions. Some specific new approaches for micro-expression analysis will be studied and proposed using machine learning techniques.

Secondly, we will work on approximate computing for real time emotion analysis and classification prototype implementation. The recent concept of “approximate computing” involves how computer systems can be made better “more energy efficient, faster, and less complex” by relaxing the requirement that they are exactly correct. In fact, many image processing applications are error-resilient, allowing for the introduction of approximations in the calculations. Therefore, adequate computing paradigm is emerged, in which the accuracy of computation results can be traded for, e.g., savings in energy, improvement in performance at runtime. In this project step, the algorithms will be reorganized in order to extract their parallelism. Intrinsic parallel calculations will be implemented on a specific GPU processor (or Field-Programmable Gate Array – FPGA circuits or hybrid architectures) to accelerate the processing speed. We will perform multiple optimizations at several levels using approximate computing.

Significant Publications

- **Quartile = JCR**

[1] Fan Yang and Michel Paindavoine, "*Implementation of a RBF neural network on embedded systems: real time face tracking and identity verification*", IEEE Trans. on Neural Networks, Vol.14 (5), pp. 1162-1175, September 2003 (Q1, IF=6.108).

[2] Dominique Ginhac, Jérome Dubois, Michel Paindavoine and Barthelemy Heyrma, "*A 10 000 fps CMOS sensor with massively parallel image processing*", IEEE Journal of Solid-State Circuits, Vol.43 (3), pp. 706-717, March 2008 (Q1, IF=4.181).

[3] Nicolas Farrugia, Franck Mamalet Sebastien Roux, Michel Paindavoine and Fan Yang, "*Fast and Robust Face Detection on a Parallel Optimized Architecture implemented on FPGA*", IEEE Trans. on Circuits and Systems for Video Technology, 19 (4), pp. 597-602, April 2009 (Q1, IF=3.599).

[4] Souleymane Balla-Arabé, Xinbo Gao, Bin Wang, Fan Yang and Vincent Brost, "*Multi-Kernel Implicit Curve Evolution for Selected Texture Regions Segmentation in VHR Satellite Images*", IEEE Trans. on Geoscience and Remote Sensing, Vol.52 (8), pp. 5183-5192, 2014 (Q1, IF=4.942).

[5] Souleymane Balla-Arabé, Xibao Gao, Dominique Ginhac, and Fan Yang, "*Shape-Constrained Level Set Segmentation for Hybrid CPU-GPU Computers*", Neurocomputing, 2016 (Q1, IF=3.317).

[6] Souleymane Balla-Arabé, Xibao Gao, Dominique Ginhac, Vincent Brost and Fan Yang, "*Architecture-Driven Level Set Optimization: From Clustering to Sub-Pixel Image Segmentation*", IEEE Transactions on Cybernetics, 2016 (Q1, IF=7.384).

[7] C. Li, S. Balla-Arabé, D. Ginhac and F. Yang, "*Embedded Implementation of VHR satellite image segmentation*", Journal of Sensors - MDPI, 16, 771, 2016 (Q1, IF=2.677).

[8] Chao LI, Yanjing BI, Yannick BENEZETH, Dominique GINHAC and Fan YANG, "High-level Synthesis for FPGAs: Code optimization strategies for real-time image processing", JRTIP Journal of Real-Time Image Processing, In press, 2018 (Q2, IF=2.010).

[9] Bobbia, S., Macwan, R., Benezeth, Y., Mansouri, A., & Dubois, J. (2018, in press). Unsupervised skin tissue segmentation for remote photoplethysmography. Pattern Recognition Letters – Elsevier, In press, 2018 (Q2, IF=1.995).

[10] Anastasia Pampouchidou, Panagiotis Simos, Kostas Marias, Fabrice Meriaudeau, Fan Yang, Matthew Pediaditis, and Manolis Tsiknakis, *"Automatic Assessment of Depression Based on Visual Cues: A Systematic Review"*, IEEE Trans. on Affective Computing, In press, 2018 (Q1, IF=3.149).