

Physio-Vision with ATHEMOS

Colin Puri, Pradeep Buddharaju, Nanfei Sun, and Ioannis Pavlidis
Computational Physiology Lab
University of Houston
Houston, TX 77204-3010

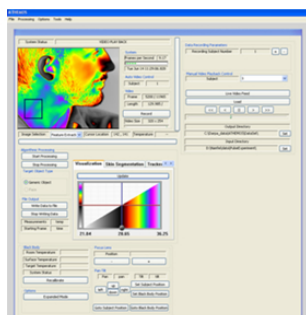
Email: {Colin.Puri,Pradeep.Buddharaju,Nanfei.Sun}@mail.uh.edu, ipavli@central.uh.edu

I. ABSTRACT

Our research focuses on physiological measurements using computer vision methodologies and has found applications in biomedicine, psychology, and biometrics. The measurements are extracted by processing emitted thermal radiation signals from facial tissue. Therefore, we use as a sensing device a mid-wave infrared camera, which is incorporated into a custom hardware and software system (see Figure 1) called ATHEMOS (Automatic THERmal MONitoring System). Processing of the thermal signals captured by ATHEMOS is based on bio-heat modeling and advanced statistics. So far, we have developed algorithms for measuring vital signs such as superficial blood flow [1], [2], pulse [3], breathing [4], and emotional perspiration. We have used these measurements to quantify stress during mental exercises [5] and detect deceit in high-stakes interviews [7]. We have also developed algorithms for biometrics applications such as physiology-based face recognition [6]. All these algorithms are supported by an advanced game-based tracking algorithm [8] that accurately registers and tracks tissue of a freely moving face. The video presents results of this novel line of research, which we came to call physio-vision.



(a)



(b)

Fig. 1

AUTOMATIC THERMAL MONITORING SYSTEM (ATHEMOS): (A) HARDWARE; (B) SOFTWARE.

II. ACKNOWLEDGEMENTS

This research is part of the Interacting with Human Physiology project funded by the National Science Foundation (grant #IIS-0414754). The views expressed by the authors

in this paper do not necessarily reflect the views of the funding agency. Special thanks to Jonathan Dowdall from the Computational Physiology Lab at the University of Houston for his invaluable tracking algorithms.

REFERENCES

- [1] I. Pavlidis and J. Levine, "Monitoring of periorbital blood flow rate through thermal image analysis and its application to polygraph testing," in *Proceedings of the 23rd Annual International Conference of the IEEE Engineering in Medicine and Biology*, vol. 3, Istanbul, Turkey, October 25-28 2001, pp. 2826-9.
- [2] M. Garbey and A. Merla and I. Pavlidis, "Estimation of blood flow speed and vessel location from thermal video," in *Proceedings of the 2004 IEEE Society Conference on Computer Vision and Pattern Recognition*, vol. 1, Washington D.C., June 27 - July 2 2004, pp. 356-363.
- [3] N. Sun, M. Garbey, A. Merla, and I. Pavlidis, "Imaging the cardiovascular pulse," in *Proceedings of the 2005 IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, vol. 2, San Diego, California, June 20-25 2005, pp. 416-21.
- [4] J. Fei, Z. Zhu, and I. Pavlidis, "Imaging breathing rate in the CO₂ absorption band," in *Proceedings of the 27th Annual International Conference of the IEEE Engineering in Medicine and Biology*, Shanghai, China, September 1-4 2005, pp. 700-705.
- [5] C. Puri, L. Olson, I. Pavlidis, J. Levine, and J. Starren, "StressCam: Non-contact Measurement of Users Emotional States through Thermal Imaging," in *Proceedings of the 2005 ACM Conference on Human Factors in Computing Systems (CHI)*, Portland, OR, April 2-7, 2005, pp. 1725-1728.
- [6] P. Buddharaju, I. Pavlidis, and P. Tsiamyrtzis, "Physiology-based face recognition," in *Proceedings of the IEEE International Conference on Advanced Video and Signal based Surveillance*, Como, Italy, September 15-16, 2005, pp. 354-359.
- [7] I. Pavlidis, N. Eberhardt, and J. Levine, "Human behavior: Seeing through the face of deception," *Nature*, vol. 415, no. 6867, p. 35, January 3 2002.
- [8] P. Tsiamyrtzis, J. Dowdall, I. Pavlidis, and M.G. Frank, "Imaging Facial Physiology for the Detection of Deceit," to appear in *International Journal of Computer Vision*, 2006.