Temporal Amplification of Photoplethysmographic and Biometric Signals Hidden in Video Streams for Contactless Monitoring of Cardiovascular Health and Identity Authentication

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With the rising cost of healthcare and the ubiquity of the internet, telemedicine is becoming a necessary and viable option. Physicians need to be able to remotely monitor a patient's well-being and have foolproof identity verification systems to avoid healthcare fraud. Unfortunately, remote monitoring of vital signs requires the patient to wear specialized equipment, which is expensive and obtrusive, limiting its use. This research focused on developing computational techniques for contactless assessment of vital signs and biometrics from ordinary webcam/smartphone video. Research indicated that videos capture minute temporal variations in color, intensity, and motion at a pixel level that are imperceptible to humans but easily distinguishable by computers. For instance, the human face becomes redder as blood is pumped by the heart, the skin on the wrist rises slightly with each pulse beat, and the ridges in our fingerprints reflect light at different intensities. Computational techniques were successfully developed to detect and magnify these subtle variations in color, intensity, and motion. These techniques were verified with the development of three applications: 1. Continuous, contactless, remote video monitoring of patient's cardiovascular health 2. Contactless measurement of infant's respiration rate with baby-cam 3. Extraction of fingerprints plus vital signs from video stream for foolproof identity verification The innovative algorithms developed rely on computation, rather than optics, to selectively magnify hidden signals in ordinary videos to unlock and visualize a new world of previously invisible information. In addition to health care, the techniques have wide-ranging applications in biology, structural analysis, and mechanical engineering.

Awards Won:

Third Award of $1,000

Oracle Academy: Award of $5,000 for outstanding project in the systems software category.

International Council on Systems Engineering - INCOSE: Certificate of Honorable Mention