Autonomous Vital Signs Monitoring Using Microsoft Kinect
Sponsors: Microsoft & WSU’s Systems-on-Chip Lab
Mentor: Subhanshu Gupta
Jon Clements, David Hoekman, Luke Darrow, Mackenzie Meade, Huong Doan

Motivation
- The current way to take an Electrocardiogram requires the patient to remove their shirt before the sensor placement is determined by a medical professional.
- The objective of this project is to provide an easier/non-invasive system that allows the patient to place ECG sensors over their clothing without the help of a medical professional.

Project Goals
- Require no ‘prepping’ or dedicated medical resources
- Generate medical quality measurements
- Cause as little discomfort or irritation to the patient as possible
- Affordable and small form-factor

Implementation
- The system stores skeletal point data of various people, along with sensor point data provided by a doctor, and chooses the closest physical match to a new user of the system when they stand in front of the Kinect.
- The algorithm that chooses the best match to a new subject uses the property of similar triangles, comparing the user’s biometrics to the stored data set. Each side of the triangle was given its own score relative to how closely it matches the user, then weighted based on how important that side of the triangle is. The reference data with the lowest score is the best fit for the current user.
- The algorithm for sensor placement is to stretch a reference image using the distance between the shoulders, and the distance between the shoulder points and the intersection point of two lines drawn from each shoulder to the opposite hip.
- The algorithm for sensor tracking:
  1. LEDs are attached to the sensors to create an intense light.
  2. EMGU turns the RGB image from the Kinect into a grayscale image, and filters everything by its white value. The brightest objects are the only ones remaining.
  3. For each circle of light in the EMGU feed, the center of the circle is found. This is the center of the placed sensor.
  4. If the center of the placed sensor is within the boxes for where the sensors should be placed, the boxes change to green, indicating that the sensor is in the correct location.

Data
- To check the sensor prediction accuracy, we removed members of the project from the data pool, then had the program tell us where to place the sensors. We then compared the predicted placement with the images we used as a reference. The results were very pleasing and we measured an average error of less than 1 cm, which is within the original specifications.

Result
- The algorithm’s sensor placement calculations were, on average, below 3 cm of error when compared to the sample data. A final prototype would include a custom built system with LEDs on the ECG sensors along with ECG input support built into the program.

Glossary
- ECG: Electrocardiogram, assesses the electrical and muscular functions of the heart.
- Kinect V2 SDK: Kinect software development kit.
- EMGU: .NET wrapper to the OpenCV image processing library

References
[1] Human Figure Proportions – Cranial Units – Robert Beverly Hale, by Stan Prokopenko, Nov. 21, 2013.

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