Machine Learning for Human Biometrics

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Target Users: Surgeons

How does it work:

- The device monitors the surgeon's eye movement
- Real-time analysis on the condition of the surgeon (stress, fatigue, cognitive overload, etc)
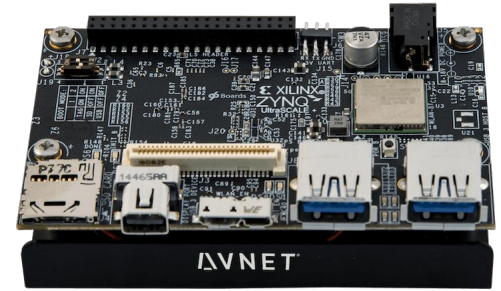- Provide appropriate advice to the surgeon

Problem

- Surgeons can be stressed or tired during surgery
- Humans are not perfect, and they tend to make mistakes
- Surgeons can also be impatient, or get frustrated when they are not in good condition
- Sometimes, they can be too focus on their task, and not aware of their physical condition
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Solution

- Using a video camera to record the movement of the eye/pupil
- Detect the fixation/saccade of the pupil
- Use machine learning to determine if the surgeon is stressed or tired
- The device will determine the surgeon's condition
- After data processing or analysis, inform the surgeon that he/she needs to take a break, or let someone else take over
- Give new surgeons feedback, teach them what is good/bad

Action

- The surgeon can decide on a course of action recommended by the device
    - Take a short break
    - Let another surgeon take over
    - Take deep breaths/calm down for a bit
    - etc.

Other Use Cases

- Provide data for post-surgery analysis
    - Analyse the surgeon's behavior during surgery
    - Identify some patterns in the surgeon's biometric data
- Training new surgeon
    - Show new surgeons the characteristics of a good and experienced surgeon

Storyline: Teaching new surgeon

Use biometric data to teach new surgeons to show how are they responding and what they should do differently

Ritz - biometric data need to be protected because it is associated to a human being

- Identify threats and mitigations to security of the biometric data
- Laws involved
- Scenario (e.g., where these data security threats come from, how to mitigate them)

Yee - how data flow through hardware

- From camera, to the FPGA, through FPGA pipeline into processor, through DDR, how it gets processed using multiple processors, multithreaded OS, data placed on SD card, and removed for analysis on a PC

Storyline: Teaching new surgeon

- Ron: database and why it matters, various scenarios and how the database is used in various scenarios, why is influxdb a particular value in this type of design, the attributes of influx that made it our choice

- Jan: The neural network, how the NN takes in the video frames and processes each frames one by one through the NN, using a regression algorithm
    - Outputting a value of the location (x, y) of the pupil
    - How NN is trained by the use of RMSE error as the matric that it tries to minimize during back propagation

- Nathan: output of NN is taken by ReModNaV to collect a number of different metrics
    - Talk about what are the metrics and what each of them mean, where are they important (stress, fatigue, cognitive workload)
    - A number of metrics that ReModNav provides - should know what they are and what they mean

- What data to be sent to the database
- 3 for intro, prob statement, target users, etc, 3-4 slides each for each area, some slides to talk about goals and future (planning for next semester)

Thank you