Patient Status Monitor

18-500 ECE Capstone Project, Team B4
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Intro (Use Case)

- Traditional Hospital Care in Wards
  - Regular in-person checking by doctors and nurses (once a day or a couple hours)
  - Health monitoring infrastructures (heart rate, blood pressure, oxygen level etc.)
  - Patient initiated help request (help buttons etc.)
- Potential Improvement
  - The monitoring with human involvement is discontinuous and can not cover 24/7
    - Can not afford the human resource and time commitment
- GOAL
  - Use artificial intelligence to fill the gap and provide extra danger monitoring beyond data points
- ECE Areas: Software System, Hardware System, Signal Processing (Audio)

Use Case Cont.

- We aim on providing intelligent behavioral and audio analysis using deep learning technology
  - Behavior (Video) – Analyze whether the action indicates danger or pain (falling down, grabbing heart...)
  - Audio – Analyze painful sounds and asking for help wording (*If time allows)
- Impact
  - We hope to use technology to act as human monitoring to provide an extra layer of protection to the patients as if there is a real medical care staff checking
  - We hope to go beyond data points and make the process passive to patient since they might not be able to actively notify the medical care staff when danger suddenly happens

Use Case Requirement

- Users need to be comfortable with installing the device, which consists the minimum of the main computation device and an edge device camera within the patient's ward/room. Our system could work as an add-on to the current monitoring system and work as an alert system on its own for patients with lower risks.
- The main computation device needs sufficient computing power. This is not yet quantitatively known, but more computing power will increase efficiency and accuracy.
- The video and audio quality of the camera (and other edge devices). This is not yet quantitatively known, but picture and voice of higher quality will yield more accurate identifications.

Use Case Requirement

- Our data collection plan is to start with one camera, but more add-ons might prove necessary during implementation. Functions could include a camera with motion to trace the patient, or a microphone to detect irregular voice cues or help prompts.
- Accuracy of output patient status. We aim to provide an accuracy of 90 percent.
- Efficiency of analysis and report. We aim to produce real-time reports of patient status on the backend.

Technical Challenges

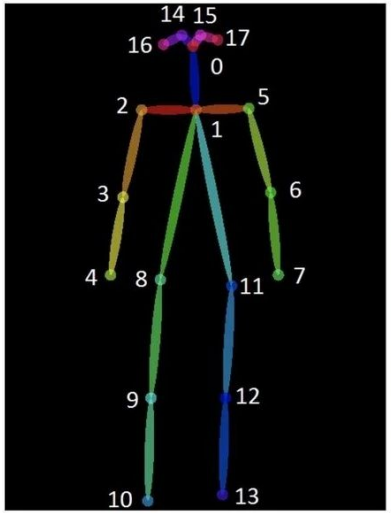
- Connection between video, audio, and the main computation device
  - Solution: customized embedded programming on arduino or raspberry pi

- Signal preprocessing to get visual and audio data optimized for analysis
  - Solution: using OpenPose to get coordinates of critical body points instead of directly using whole image

- Deep learning algorithm implementation and application on edge devices
  - Solutions: Choose correct deep learning model like RNN or LSTM with memory ability for more intuitive solution, e.g. taking multiple time frames into account

Technical Challenges

- Accuracy optimization for deep learning recognition algorithm:
  - Optimization through fine tuning and cost function selection.
- Backend system design (notification, warning, other integration) for better usability:
  - Solution: A valid backend service with good user experience if time allows.
- Privacy concerns for users:
  - Solution: Application of signal preprocessing (OpenPose algorithm) on edge devices utilize data solely for identification purposes.
  - A standalone patient monitor system, i.e. all computations only on the device, and backend for solely the purpose of monitoring and receiving warnings to medical professionals.



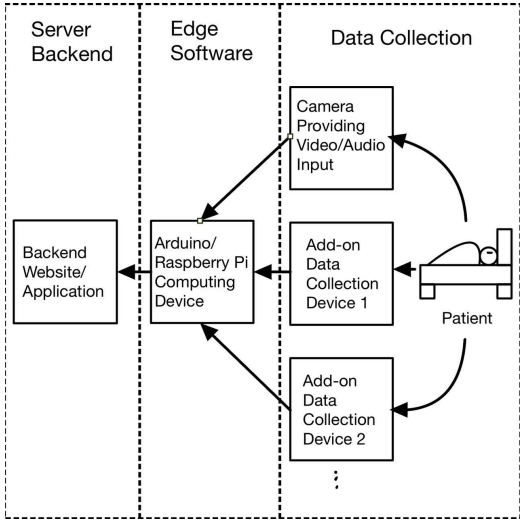
Solution Approach

Our project mainly consists of the following three parts:

- **Data collection** – Collecte video data from camera. Collect audio data from the supported camera or add-on audio device (microphone).

- **Edge software** – Use arduino or raspberry pi as the main computation device to process received signal and evaluate them through deep learning algorithm.

- **Server Backend** – Provide backend services like website/application to users for visualizing detection results and receive warnings.



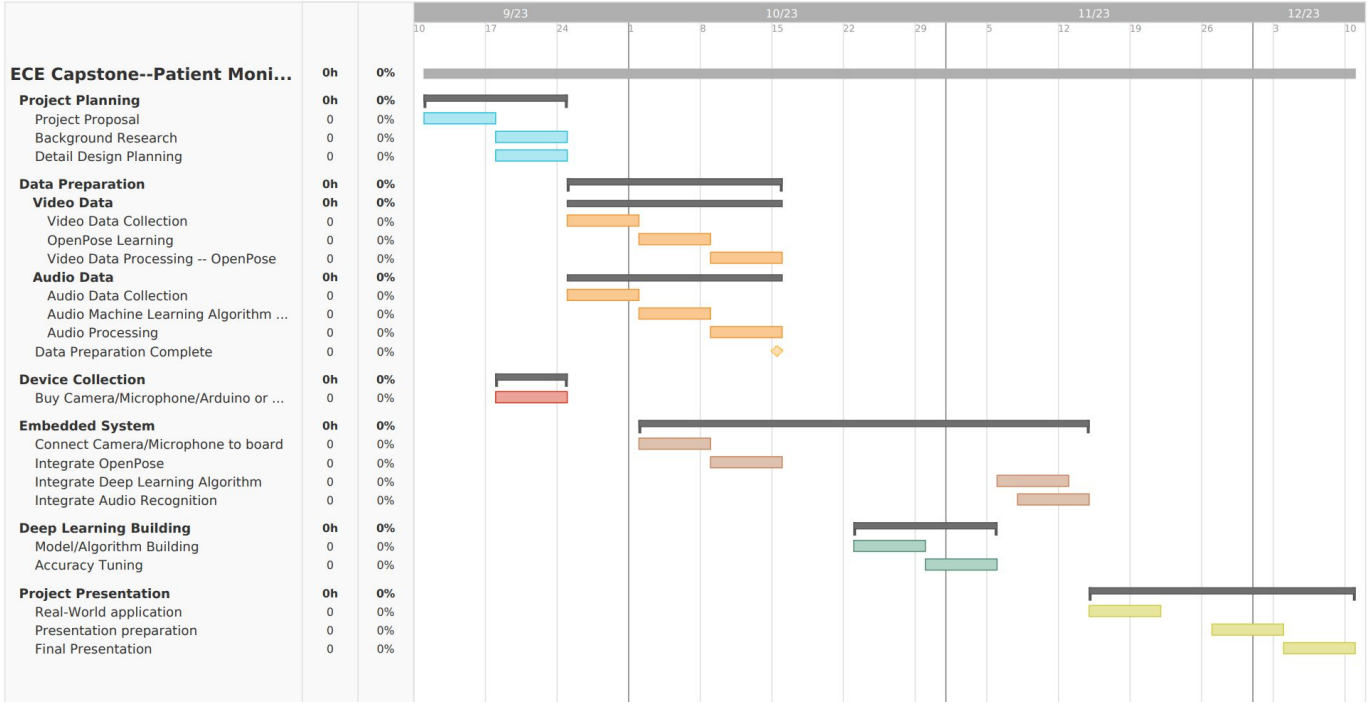
Testing, Verification and Metrics

- Component Testing
  - Valid connection between data input (camera) to computation device, and device to backend
  - Neural Network accuracy testing and tuning
- Product Full-Scale Verification
  - Smooth process from data input to a warning produced on the backend
  - Latency measurement for the delay of generating the warning
- Final Metrics
  - Accuracy of danger recognition – training accuracy, verification accuracy, real-world testing
  - Latency of danger notification

Tasks and Division of Labor

- **Hongzhe Cheng:** Background Research (interviewing medical staff etc.), OpenPose Usage, Deep Learning Neural Network building and tuning
- **Sirui Huang:** Audio signal processing, Audio recognition ML algorithm, Software interfacing on raspberry pi
- **Shiheng Wu:** Embedded System connections, Hardware interfacing on raspberry pi, Patient (test case) data collection

Schedule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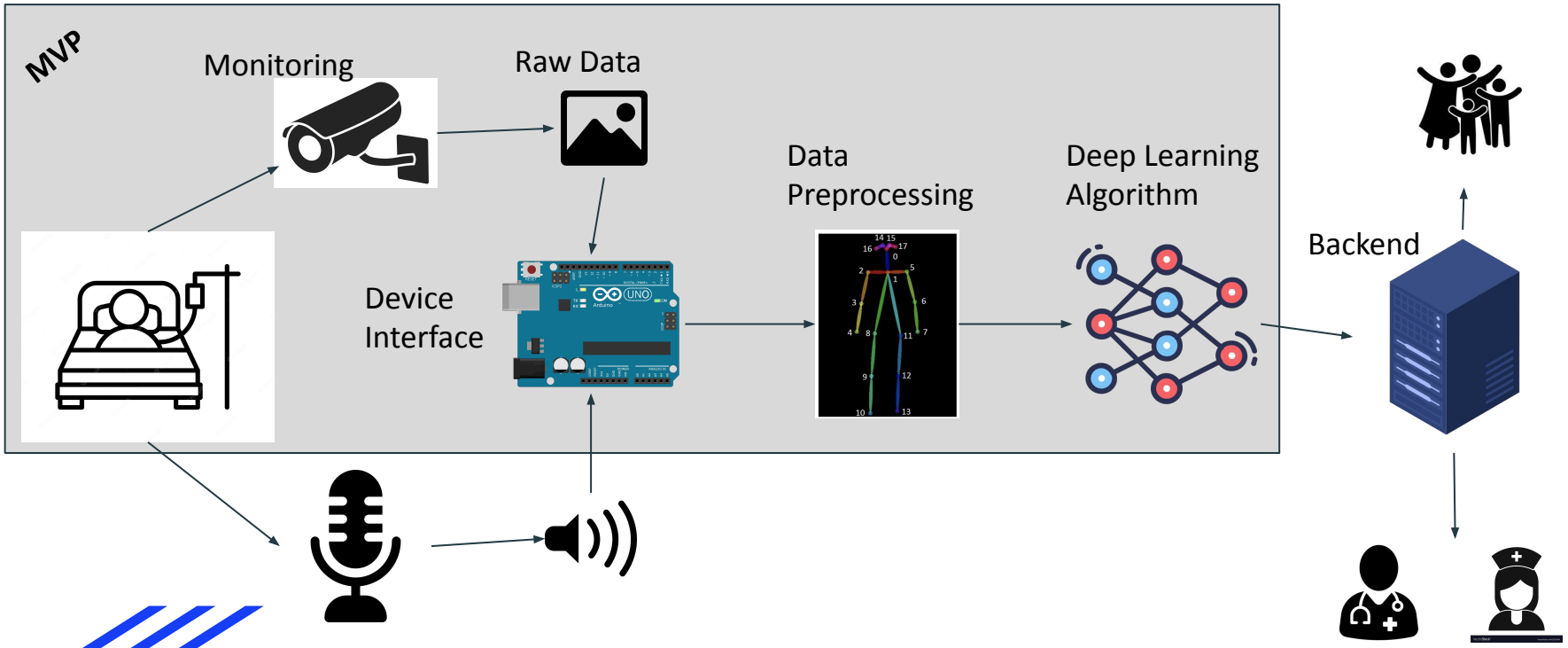
ECE Capstone--Patient Moni... 0h 0%
Project Planning 0h 0%
Project Proposal 0 0%
Background Research 0 0%
Detail Design Planning 0 0%
Data Preparation 0h 0%
Video Data 0h 0%
Video Data Collection 0 0%
OpenPose Learning 0 0%
Video Data Processing -- OpenPose 0 0%
Audio Data 0h 0%
Audio Data Collection 0 0%
Audio Machine Learning Algorithm ... 0 0%
Audio Processing 0 0%
Data Preparation Complete 0 0%
Device Collection 0h 0%
Buy Camera/Microphone/Arduino or ... 0 0%
Embedded System 0h 0%
Connect Camera/Microphone to board 0 0%
Integrate OpenPose 0 0%
Integrate Deep Learning Algorithm 0 0%
Integrate Audio Recognition 0 0%
Deep Learning Building 0h 0%
Model/Algorithm Building 0 0%
Accuracy Tuning 0 0%
Project Presentation 0h 0%
Real-World application 0 0%
Presentation preparation 0 0%
Final Presentation 0 0%

Conclusion


MVP
Monitoring
Raw Data
Data
Preprocessing
Deep Learning
Algorithm
Backend
Device
Interface