MindFlow Focus Tracker

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18-500 Capstone Design, Spring 2024
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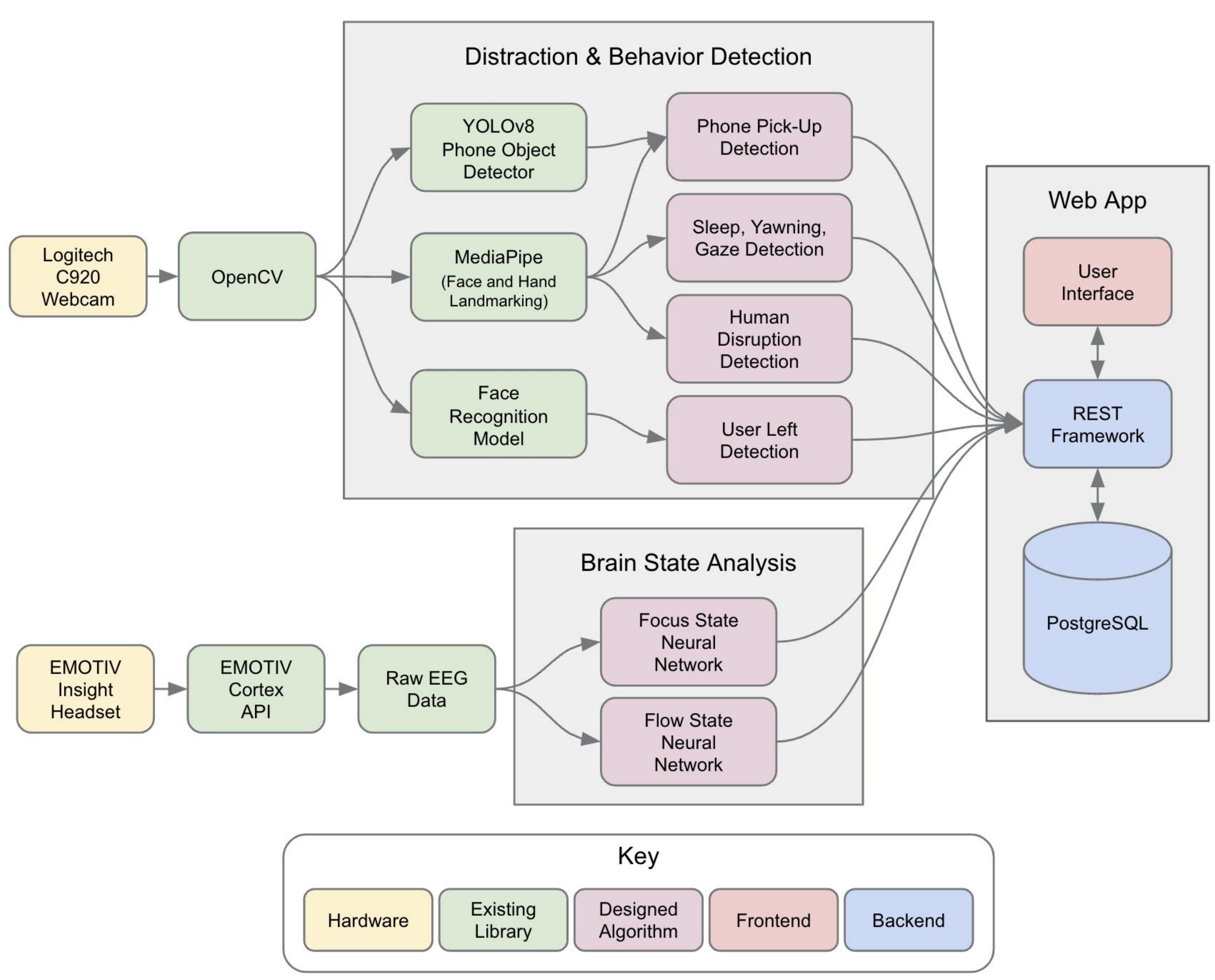
Product Pitch

In today's digital era, where social media and instant connectivity are pervasive, maintaining sustained focus has become a formidable challenge for many. Current productivity technologies depend heavily on the user's ability to self-regulate and follow through with the app's recommendations or features. Additionally, a significant number of focus-enhancing technologies offer generic solutions that do not account for the individual differences in work habits, environments, and the nature of distractions faced by users. MindFlow enables users to measure their focus and flow states and associated distractions during work sessions to help them identify actionable steps to improve productivity. This app utilizes an EEG headset and a web camera, coupled with machine learning algorithms, to accurately detect focus and flow states and identify distractions in real-time.

System Architecture

Images are captured via the Logitech C920 Webcam and passed into the distraction and behavior detection algorithms, which informs the user when they pick up their phone, fall asleep, gaze off-screen, are disrupted by other people, or leave the workspace via our user interface. The EMOTIV Insight Headset captures raw EEG data, which passes through the brain state neural network models to determine the user's focus and flow states. The distractions, behaviors, focus, and flow states are sent to a database and then displayed in real-time in the web application.



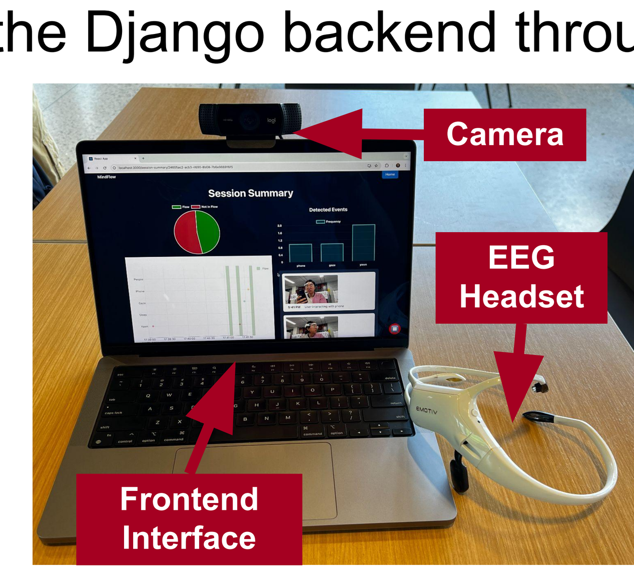
Conclusions & Additional Information

The field of EEG and distraction-based focus and flow state analysis is continually evolving, driven by advancements in neuroscience. Our experience developing MindFlow has provided our team with invaluable insights into this area of research. We were able to work with Professor Jocelyn Dueck, an expert in collaborative piano, to determine flow states of musicians. This collaboration helped us understand the intersection between engineering, arts, and music. We are excited to see how our technology can be applied to various other fields such as sports and meditation, where focus and flow are critical to performance.

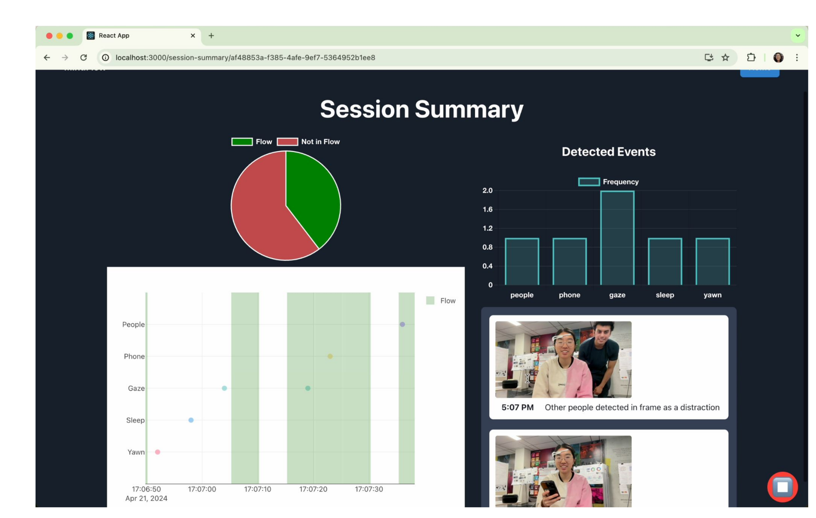
http://course.ece.cmu.edu/~ece500/projects/s24-teame0/

System Description

MindFlow incorporates three subsystems: distraction and behavior detection, brain state analysis, and a web application. The distraction and behavior detection subsystem uses facial landmarking to determine if a user is sleeping, yawning, or gazing away from the screen. Hand landmarking and a phone object detector are used to determine when a user picks up their phone. Lastly, a face recognition model detects disruptions from other people and when the user leaves. For brain state analysis, we extract 5 frequency band power values from the 3 sensors closest to the frontal and parietal lobes and pass these 15 input features into 4-layer neural network classifiers for focus and flow. The focus model is trained on self-reported focused and distracted work sessions with Arnav, Karen, and Rohan. The flow model is trained on data collected from collaborative pianists and singers in the CMU music department with Professor Jocelyn Dueck's flow labels as ground truth. The web application subsystem involves Django, SQLite, and React. Django operates as the backend framework orchestrating data flow and application logic. It interacts with the SQLite database to manage and store real-time data. React operates as the frontend and it fetches data from the Django backend through API calls.



Overall System



Web Application

System Evaluation

Users interacted with our system for 10-minute sessions, engaging in each distraction and behavior type. The number of true positives, false positives, and false negatives were recorded to calculate recall and F-score. The system achieves the defined metric of recall ≥ 0.9 and F-score ≥ 0.7 for all behaviors.

	Yawning	Sleeping	Gaze	Phone	Other People	User Away
Recall	0.96	0.98	0.92	0.90	0.92	1.00
F-score	0.94	0.97	0.96	0.95	0.96	0.84

We evaluated our focus and flow state models against two distinct test sets to understand to what extent our models are able to generalize/to what degree they are overfitting. For both models, Test Set 1 included data that was not included in the training/validation sets but came from the same recordings used in training. Test Set 2 for the focus model was from a work setting with a subject who was included in the training.Test Set 2 for the flow model was from the music setting but the subject was not included in training at all.

Requirement	Testing Strategy	Quantitative Metric	Result
Data Capture and Analysis Latency	Measure image processing and model evaluation time	≤ 3s delay between data capture and analysis	Image processing: **100ms** Focus model: **0.004ms** Flow model: **0.007ms**
Usability and Usefulness	Survey users after a using the app	≥90% of users find app usable and useful	**90%** of users find app usable and useful
Focus State Model Performance	Test Set 1 Test Set 2	F-score (F) ≥ 0.7 Recall (R) ≥ 0.9	F: **0.92** R: **0.91** F: **0.60** R: **0.56**
Flow State Model Performance	Test Set 1 Test Set 2	F-score (F) ≥ 0.7 Recall (R) ≥ 0.9	F: **0.92** R: **0.92** F: **0.69** R: **0.64**

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