Embedded AI (Mid) Project Report

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1 Problem Statement

A smart mirror to help with everyday fashion choices: to suggest matching outfits, outfits based on weather prediction, styling everyday attires, and more! We plan to attach a camera and a raspberry pi to mirrors, along with a microphone and a speaker, to enable interactivity. We plan to use Large Language Models (LLMs) to suggest fashion choices. If provided by the user, the closet inventory will be added to improve the feasibility of suggestions. We aim to keep the interaction as local as possible to protect the user's privacy. On a more fun note, we would like our users to follow the foot steps of evil queen [1].

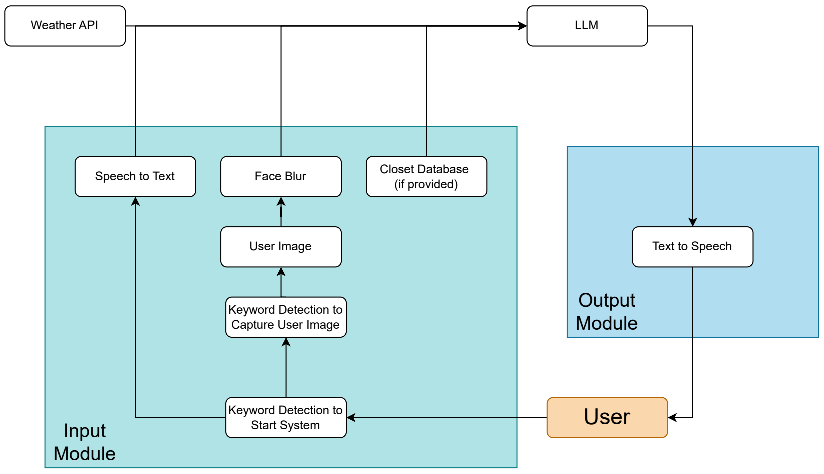
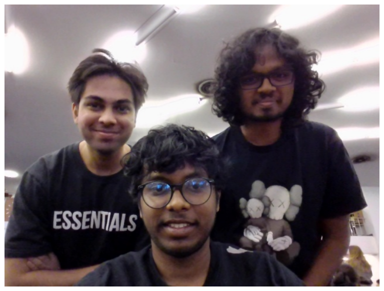
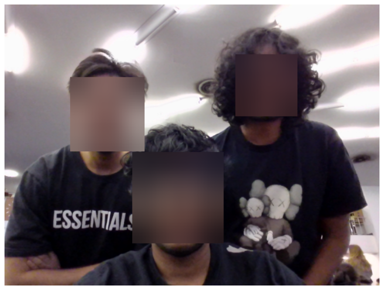

Weather API
LLM
Speech to Text
Face Blur
Closet Database (if provided)
User Image
Keyword Detection to Capture User Image
Keyword Detection to Start System
Input Module
Text to Speech
Output Module
User

Figure 1: Proposed architecture for our system



(a) Original Image



(b) Blurred Image

2 Minimum Viable Prototype (Code [2])

2.1 Initialization and Data Collection

During setup, the user is prompted with an initialization stage. Here, the user is asked to repeat the word "yes" a few times to fine tune the keyword detection model [2]. The user is also requested for the location (city) and an inventory of the wardrobe.

2.2 Voice Activation and Speech-to-Text

The system is activated using a lightweight, offline keyword spotting mechanism powered by the faster whisper model [3, 4]. We record 2 second audio segments using the system microphone and transcribe them using Whisper's quantized variant (int8) optimized for edge devices [5]. If the transcription contains predefined keywords, the system switches to active listening mode. A longer, 10 second recording is then captured to extract user intent in detail.

2.3 Image Capture and Face Blur

Once activated, the system requests the user's permission to capture an image. Upon consent, the Raspberry Pi camera captures the user's image. During our tests, we use our desktop webcam for initial testing. To preserve privacy, the OpenCV Haar cascade classifier [6] is used to detect facial regions, which are then blurred using Gaussian blur (See Figures 1a, 1b). The resulting anonymized image is saved locally for further processing.

2.4 LLM Based Outfit Recommendation (Gemini Flash 2.0)

To increase the relevance of output suggestions, the system uses the user's mentioned location (if specified 2.1). Subsequently, it queries the OpenWeatherMap API [7] using this location to fetch real time weather conditions. We then have a predefined prompt framework that contains four primary characteristics: user speech, real time weather data, blurred user image, and wardrobe inventory (2.1). This prompt is sent to the Gemini Flash 2.0 model [8] using the 'google.generativeai' client [9]. The model, capable of multimodal reasoning, interprets the image and context to generate a tailored outfit recommendation. This interaction is handled securely using API keys.

2.5 Text-to-Speech Feedback

The generated response is converted into speech using 'pyttsx3' [10], an offline text-to-speech engine ensuring responsiveness. This feedback is delivered to the user in a natural voice, completing the conversational loop.

2.6 Edge Aware Design

All of audio recording, keyword spotting, image capture, face detection, and text-to-speech are planned to be executed locally on the Raspberry Pi to minimize latency and protect privacy. Only the blurred image and text prompt are sent to Gemini Flash for outfit generation, making the system suitable for smart home deployment in resource constrained environments.

3 Preliminary Results (Test Example)

To validate the functionality of our smart mirror system, we tested the initial pipeline locally. The webcam was used to simulate the image capture stage, instead of the Raspberry Pi camera. The pipeline successfully demonstrated the following:

- **Offline speech-to-text conversion:** The Whisper model transcribed the user's spoken input accurately, and the system correctly detected activation keywords.
- **Input information:** The webcam image was captured, and OpenCV successfully applied Gaussian blur to all detected facial regions. The system parsed the location taking during initialization (2.1) accurately and retrieved real time weather information from the OpenWeatherMap API.
- **Multimodal LLM inference:** The blurred image, combined with the user's voice command and weather context, was sent to the Gemini Flash 2.0 API. The model returned a relevant and descriptive outfit recommendation.

The next phase involves deployment and testing on a Raspberry Pi to evaluate latency, energy efficiency, and user interaction in real time edge settings.

References

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