# Assistive Technology for Patients with Medical Face Blindness

A Device to Assist Social Interaction for Individuals with Prosopagnosia

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# 1. Introduction

## *1.1 Background*

Prosopagnosia [1] is a cognitive disorder which prevents afflicted individuals from recognizing familiar individuals upon viewing their face. For this reason, individuals with prosopagnosia may experience difficulty with social interaction, particularly in their relationships and careers. According to Bournemouth University, up to 1.5 million individuals in the UK alone may suffer from developmental prosopagnosia [1]; as such, we feel that designing a easy to use and intuitive network of devices to help facilitate social interactions is a worthwhile expenditure.

As a side note, this project builds considerably on the high level design of Project 30 from Spring 2015. Though the implementation of each module is drastically different, we would still like to give due credit to that project for giving us starting points to branch out our implementation. Their battery hardware in particular was analyzed for applicability, as we wanted to minimize development time spent on a feature that wouldn't benefit from our own innovation.

There are currently no similar solutions on the commercial market, though similar concepts have been recently deployed by the police agencies in China. Our application is unique in attempting a solution with minimal barrier of entry for patients, relying on low costs and existing widespread smart phone technology.

## *1.2 Background*

*Goals*

Allow for the networking of a smartphone, a digital wristband, and a wearable camera.

Using a facial recognition API, identifies a face in captured image.

*Functions*

Camera takes photographs that are relayed to Bluetooth-enabled smartphone.

App running in background of smartphone can successfully receive image obtained from camera, returning a vibration on a wristband ("recognized") or two vibrations ("not recognized") as well as displaying the name of recognized faces.

Unobtrusive design with input/output that can be used with minimal interference to the first 30 seconds of a regular conversation.

*Benefits*

Allows for individuals with prosopagnosia to identify familiar individuals successfully

Simple and non-intrusive design

*Features*

User-friendly interface and simple set-up/configuration. The user should be able to set-up the devices like any standard bluetooth device, and use a simple GUI to manage the database of known faces.

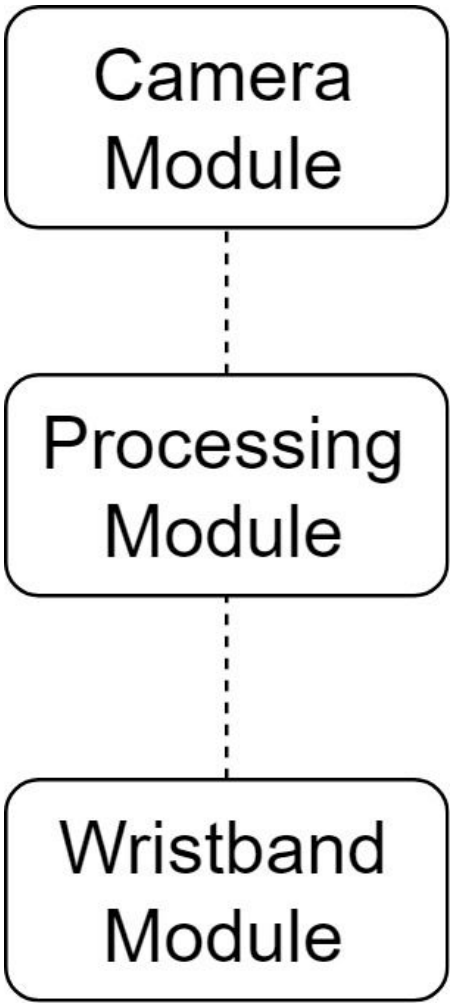
Bluetooth networking ability across all three devices allows for the transmission of pictures, as well as sending vibration commands to wristband.

### *1.3 High-Level Requirements*

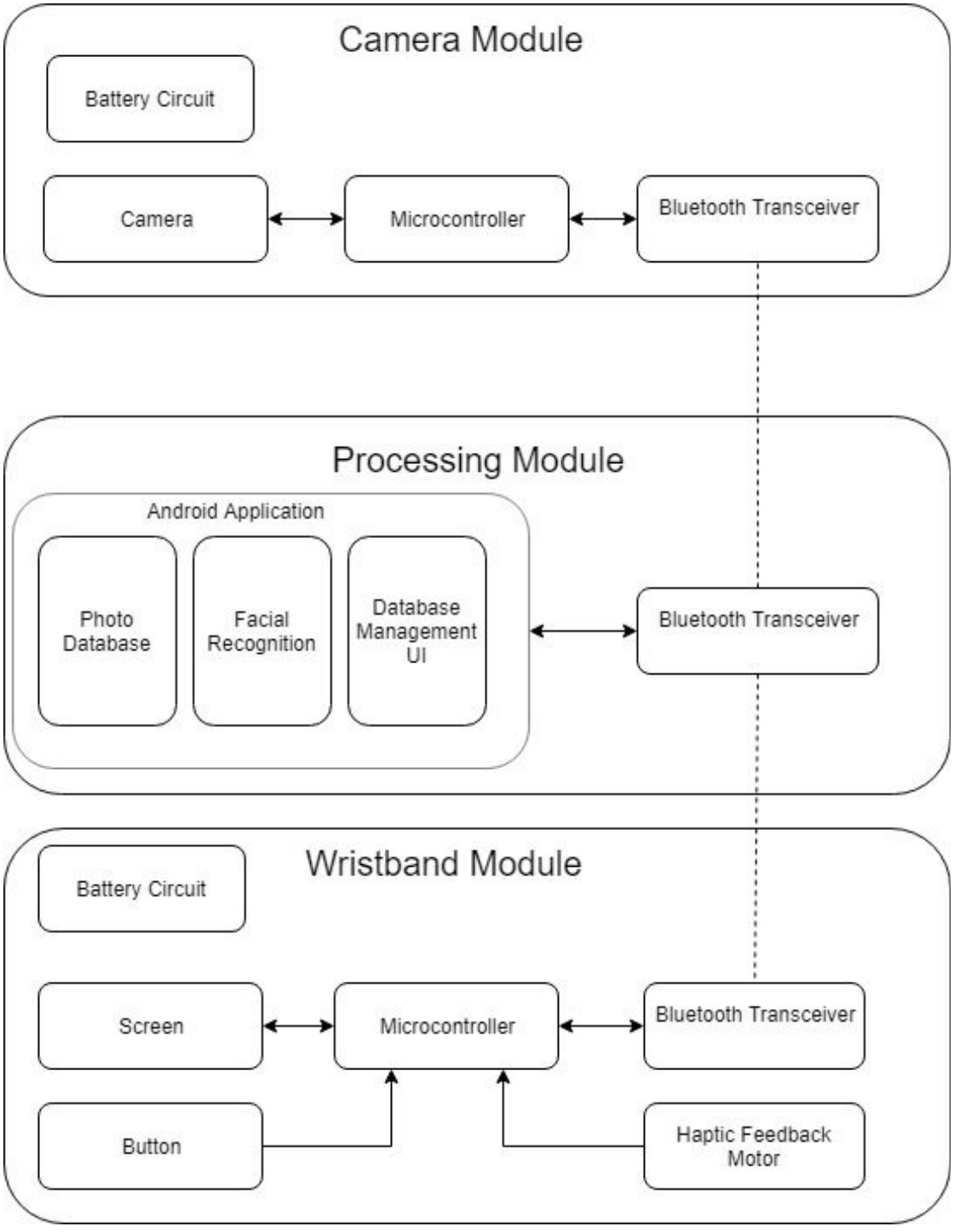
- Able to provide user with the needed information quickly enough to minimally interfere with social interaction.
- Able to consistently identify faces with reliability approximating typical human capabilities.
- Device batteries must provide enough power for regular use in a 24 hour period.

## 2. Design

### *2.1 High Level Block Diagram*



### *2.2 Detailed Block Diagram*



### *2.3 High Level Block Description*

There are three modules to be designed. The camera module is designed to be a battery powered wearable camera with bluetooth connectivity. The phone app module is entirely software based and designed for android phones in general. And the wristband module is a battery powered wearable screen with a button input, haptic feedback and bluetooth connectivity.

The connection between these modules is as such: the wristband button will prompt the phone to request an image from the camera. The camera will send an image to the phone, which will process it as needed, then send data to the wristband. The wristband will then vibrate and display text accordingly.

### *2.4 Detailed Block Description*

**Camera Module:** Due to the constraint of minimally disruptive wearable technology, we will implement our own PCB. The battery circuit will power a microcontroller, a bluetooth chip, and a camera.

**Processing Module**: An app for android phones. Serves as the bluetooth host for the camera and wristband. Using internet connectivity, also does API calls to process the images and generate output for the wristband.

**Wristband Module:** Again, we implement our own PCB with a battery subsystem. A microcontroller, a bluetooth chip, a button, an LCD screen, and a motor for haptic feedback.

### *2.5 Requirements and Verification*

| Module | Requirement | Verification |
|---|---|---|
| Power Circuit (Duplicated across wristband and camera) | • Rechargeable<br>• Usable Time: 20-24 hours<br>• Capacity: 12V<br>• Output: 3000mAH | Fully charge device(s), and perform various operations at a steady pace over a time period of 20-24 hours. |
| Bluetooth Transceiver | • Transmission Speed >= 460 kbps<br>• Effective Range > 2m<br>• Power Consumption: ~0.2 mW<br>• Sleep Mode | • Measure time between initial successful capture of 1 picture and response from smartphone.<br>• Attempt the above verification at varying distances, from 1ft to 8ft in 1ft intervals. |
| Android Application | Application must be able to match face in obtained picture from camera with image from a database of photos, if a matching face exists. | Upload 10 different pictures, 1 of which features a specific individual, and attempt to capture image of said individual through the camera and wait for a result. |
| Camera | • Resolution > 1920 x 1080<br>• Power Consumption: <0.5W | • Provide varying test cases involving:<br>  ○ Set of similar-looking individuals.<br>  ○ Photos with multiple faces. |

### *2.6 Risk Analysis*

We perceive the successful implementation of the camera and its interactions with the Android application to be the most difficult part. Because the camera, in conjunction with the Android app, must be able to perceive both faces and recognize facial features in a speed fast enough to facilitate real-world interaction between the user and other subjects, fast responsiveness of the camera is of great importance. Thus, any used Bluetooth chip in our ear-mounted camera module must transfer image data at a speed of 1 Mb/s or less, which ideally would allow a small image to be transmitted in around 5 seconds. We intend to first get this functionality working with an inexpensive Bluetooth module (ex: Nordic nRF51822), to ensure that our high-level blocks are functioning, then look to improve on performance using newer Bluetooth technology.

## 3. Ethics and Safety

### *3.1 Ethics*

We recognize the importance of the IEEE Code of Ethics [2]. In particular, because this is an device that is designed to improve the lives of those suffering a particular medical condition, tenet 5, "...the understanding by individuals and society of the capabilities and societal implications of conventional and emerging technologies…" [2] is most important to us. While our device can help alleviate the social hurdles that individuals with prosopagnosia undergo, we must recognize the possible ways that our technology can be used nefariously or compromised due to its power. Because a camera is used for a portion of our project, we understand that there may be security-related issues related to the use of the camera. In particular, we understand that any camera could be illegally accessed by hackers or other unscrupulous individuals. To prevent this, we will enable users to secure their cameras with a password and/or other measures.

### *3.2 Safety*

In addition to any ethics-related concerns, we also must recognize the possible occurrence of any potential safety-related issues, both in our design and testing of our project. Some of the potential Bluetooth devices we are looking into implementing would require the use of soldering for successful installation; if we choose to utilize these devices, we will follow all precautions, such as refraining from touching the tips of active soldering equipment and working in a well-ventilated area.

### *Sources*

[1] S. Bate, "Information About Prosopagnosia," *Prosopagnosia Research - About Prosopagnosia*. [Online]. Available: https://prosopagnosiaresearch.org/index/information.

[2] "IEEE Code of Ethics," *IEEE - IEEE Code of Ethics*. [Online]. Available: https://www.ieee.org/about/corporate/governance/p7-8.html.