Demo Abstract: ThirdEye: Your Guardian Against Myopia

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***Abstract*—In this paper we presented the design of the ThirdEye, a pair of smart glasses which could help people fight against myopia. It incorporates gyroscope, accelerometer, proximity and ambient light sensor in a small sensor board mounted on commercial glasses. It could recognize various scenarios in our daily life, and give alarm when the user violates given rules that may cause myopia, such as reading too close or in dimly conditions.The glasses could also log data, providing valuable information to the research of myopia.**

I. Introduction

Myopia [1] is a significant, prevalent disease in children with an increasing rate of progression. It is estimated that up to 80% of the people in Singapore have myopia while 30% $\sim$ 40% people in China and India also suffer from it.

A substantial amount of research has been done to discover the etiology of myopia. Among all the risk factors, many studies have reported a strong correlation between near work and increased myopia. A survey in 2008 by Ip et. al. [2] suggested a correlation between reading too near for a long time and increased rates of myopia. They found that near work such as close reading distance (<30 cm) and continuous reading (>30 minutes) independently increased the odds of having myopia in this sample of children. In addition to that, another study [3] revealed that light levels may be a relevant factor in the development of myopia.

There are some problems in the studies of myopia. The leading one is that near work was self-reported by the participants, so the estimation of near work could be subject to recall bias. How to get the detailed and accurate environment information eliminating human factors can contribute to the study of myopia. Although the cause for myopia is still unclear, people universally believe that prolonged near work could lead to the development of myopia [4] . Some actions to help prevent myopia:

- Avoid reading too close
- Avoid reading while the ambient light is too bright or too dim
- Avoiding reading in a strong vibration environment, such as a bus
- Rest for a while after using eyes for a long time

These tips are not hard to understand but unfortunately, people tend to forget about these tips when they are immersed in reading, watching videos, etc. To solve these problems, we present the ThirdEye - by attaching a tiny sensor board to normal glasses, we could recognize the environment and warn the users of improper behaviors. The sensor board is shown in figure 1. It consists of an IMU (including a 3-axis gyroscope and 3-axis accelerometer), IR proximity meter, light sensor, FRAM storage, Bluetooth module and MCU. We use IMU, IR proximity meter and light sensor to determine the user's behavior and give warnings if the user violates given rules. The detailed information will be recorded in the storage. With the help of the Bluetooth module, we can get the log data use any device with a Bluetooth connection.

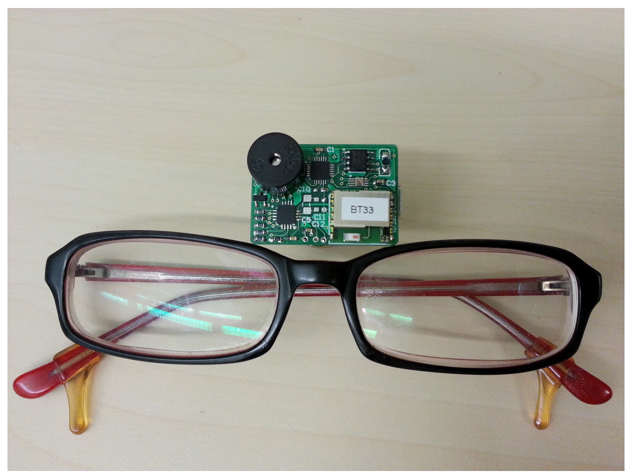

Fig. 1. The ThirdEye mounted on a commercial glasses

II. Hardware Architecture

The hardware system diagram is shown in 2.

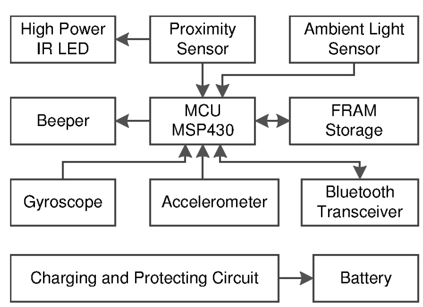

Fig. 2. Hareware diagram of the ThirdEye.

There are several issues we need to take into consideration when designing the glasses: form factor, weight and energy consumption. The bridge of nose could not support heavy things, especially for the young. Also, it is troublesome if we need to charge the batter too often.

A. Accelerometer and Gyroscope

For the accelerometer and gyroscope, we choose MPU6050. It integrates these sensors in a very small package. Its accelerometer supports various low power modes and consumes only 10uA at 1.25Hz update rate. The gyroscope consumes 3.6mA in operating mode while the standby current is as low as 5uA.

B. Proximity and Ambient Light Sensor

There are many different methods to measure the distance: ultrasonic, laser and IR. The first two are not applicable in our project because the ultrasound transducer is too big and laser requires complex optical system. However, by measuring the IR reflected by the paper we could get the distance between the IR sensor and the paper. However, there is a challenge that the sense range of traditional proximity sensor is about ten centimeters, which is not enough for our application. To solve this problem, we used a high power IR LED - it consumes 360mA current while the traditional ones consumes only several only several mA. This technique successfully extended the range to more than 50 cm to meet the requirement of our application. At the same time, we employed a pulse-working scheme. The IR LED needs to work for only 25.6us for each measurement. If we measure the distance once per second, the average current is only 9.2uA.

C. MCU, Storage and Bluetooth

Generally people tend to use MSP430F1611 in their design where low-power is needed, such TelosB and Hijack. But this 64-pin MCU is too big to fit into our frame. Instead, we chose the MSP430G2452. It has only 16 pins in a 4×4 cm^2, much small that MSP430F1611 (11×11 cm^2).

For the storage, we have several choices: the EEPROM, FLASH, DRAM and FRAM. Among them, FRAM consume the less current (150uA), making it ideal for our application.

To enable communication between the glasses and other devices, we incorporated a Bluetooth module in our design, making it very convenient for us to get the logged data out. However, this module is optional. If we do not need to get the logged data via Bluetooth, we could remove it to make the board smaller and lighter.

III. Software Algorithm

The software system diagram is shown in figure 3.

The basic idea is that, by using the raw sensor data we get from the IMU sensor, IR proximity sensor and the ambient light sensor, we can detect the user's behavior and give warnings if it's bad for the eyes. At the same time, the information will be recorded in the database for future study.

After gathering the sensor data, we will use Support Vector Machine (SVM) for our classification. If there exists multiple classes, we will use the one-againstone strategy instead. To accommodate sequential data, we will uses Hidden Markov Model (HMM). By aggregating each feature across time, we can use SVM to handle the sequential sensor data. We can detect the user's behavior and record it in the JSON (JavaScript Objective Notification) format. For example, {"Activity": "reading", "Distance": "25", "AmbientLight": "500", "TimeLength": "1" } means that the user has reading with the distance of 25cm for one minute under normal laboratory lighting(500 lux). In addition, by comparing the user's latest behavior and environment with the history log, we can update the sensing schedule algorithm.

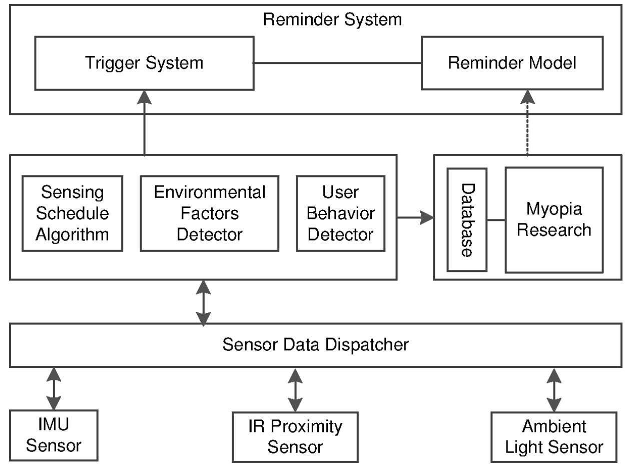

Fig. 3. Overview of the software platform

The reminder system has a basic reminder model. It has rules such as "if reading distance is less than 30 cm, then give warnings". The trigger system gets the triggering information now and then and it will give warnings if it's a rule in the reminder model. For example, when it gets the above JSON data, because the distance is less than 30 cm, then it will give warnings.

IV. Demonstration Setup

The user will put on our glasses (without lens). A cellphone connected to the glasses via Bluetooth will show the raw data from sensors and could recognize different behaviors. The alarm will sound if the user tried to misbehavior, such as reading in the dark, or reading too near. Also, we will show the user statistics logged in the database, giving the users an intuitive knowledge about his/her daily activities.

References

[1] http://eyewiki.aao.org/Myopia.

[2] Ip JM, Saw SM, Rose KA, et al. Role of near work in myopia: Findings in a sample of Australian school children. Invest Ophthalmol Vis Sci 2008;49:2903–2910

[3] Ashby R, Ohlendorf A, Schaeffel F. The effect of ambient illuminance on the development of deprivation myopia in chicks. Invest Ophthalmol Vis Sci 2009; 50: 5348–5354

[4] Douglas R Fredrick, Myopia. BMJ. 2002 May 18; 324(7347): 1195–1199