Smart Monitoring of Health and Productivity at Work

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Abstract. The Health of the employees have adverse effects due to the work load and lack of health consciousness, which in-turn is affecting the productivity. The use of IoT technology to improve the productivity at work taking the employees health into account is significant.

Keywords: Smart Office · Health management · Automation · Productivity

1 System Introduction

The Intention of IoT devices in this project is to enable productivity of the employees by promoting good health in work environment.The Drowsiness, Posture, work time of the employee along with the humidity in the environment is monitored and the collected data is used to enable the machine to take decisions to make relevant actuation to these factors.

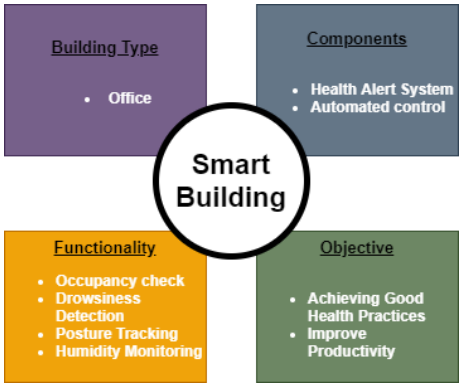

Fig. 1. Project Goal and Scope

2 System Analysis

A user can expect a health alert system that checks his drowsiness, posture and the surrounding humidity content in order to improve his health which in-turn improves his productivity.

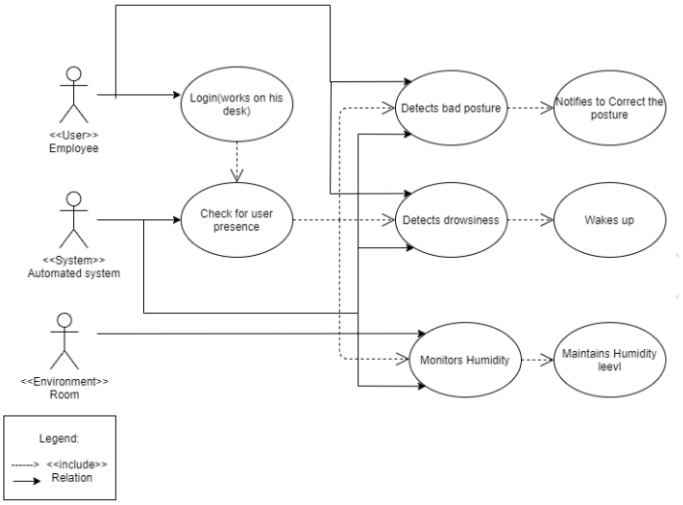

Fig. 2. Use case Diagram of the system

Functional Requirements

Occupancy Detection
Factors like drowsiness, posture and humidity is to be checked based on the occupancy on an employees seat. The presence of the user is detected, which in turn triggers these health checks.

Drowsiness Detection
Feeling heavy-eyed could reduce efficiency at work. There are various factors for this to happen, viz.., lack of sleep, excessive work-load, etc.To overcome this, we have designed a system to monitor the drowsiness factor of an individual, thus enhancing his/her productivity. In brief, the system implemented here continuously tracks the eye movement of the Employee seated in front of the system.

Posture Management

Another important aspect of human health is posture management. Maintaining a good posture not only does prevent neck and spinal damages but also helps in achieving comfort-ability at the workplace.The system designed here helps in monitoring the angle/bend thus determining the person's hunch.

Humidity Control
Humidity in the air could be an indirect factor that affects human health. Maintaining ambient humidity in the office atmosphere is very important. High humidity contributes to feelings of low energy, lethargy due to excessive sweating and heat evaporation from the skin,heat-strokes etc. thus resulting in distress. A trigger sent to actuate humidity help in stabilizing the environment.

Non-Functional Requirements

Health Monitoring
In-order to maintain good health of the employee in stressful work environment by monitoring their drowsiness level and posture. Also monitoring the humidity content in the environment to reduce effects like health distress overtime.

Productivity
In-order to improve the productivity, good health is promoted with various functional requirements as mentioned and triggering relevant actuation to restore his energy.

3 System Architecture Design

Sensing Components

User presence
The presence of the user is checked using a PIR sensor which has two slots with material sensitive to IR. When a warm object is placed in its vicinity then the one half of the PIR sensor causes positive differential change between the two halves. And when the warm body leaves the sensing area then a negative differential change is created. These change pulses are what detects the user in front of the sensor or a user passing by. Hence this is placed on the desk/mounted to the seat of an employee t identify his presence. His presence triggers the other three components of the health check.

Drowsiness
The system here captures the video streams from the webcam and labels the eyes using the available facial landmarks . The eye regions are captured and the corresponding eye aspect ratio is computed(EAR Values). The ear formula

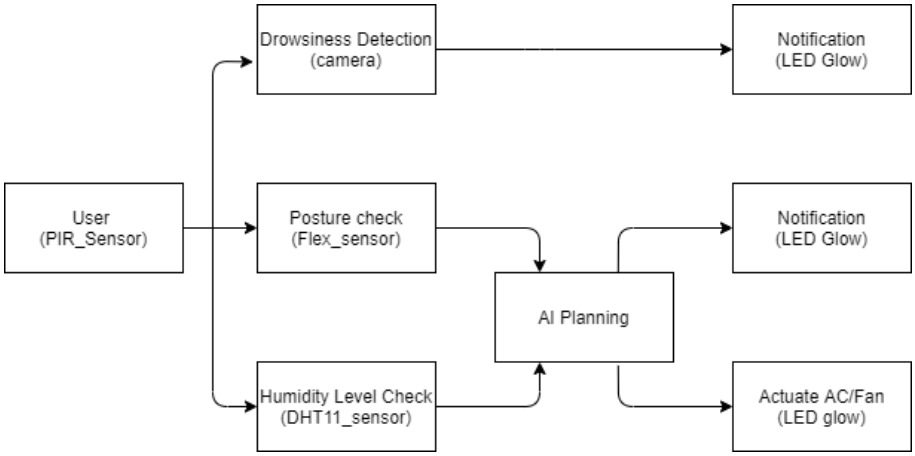

Fig. 3. System Architecture Block Diagram

calculates the Euclidean distance, i.e. the ratio between the height and length of the eye.

4 System Architecture Design

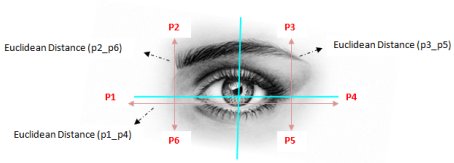

Fig. 4. Eye Aspects diagram

EAR = (||P2 -P6 ||+||P3 -P5 ||) /(2 *||P1 -P4 ||)
The facial landmark detector implemented inside dlib produces 68 (x, y)-coordinates that map to specific facial structures. These 68 point mappings were obtained by training a shape predictor on the labeled iBUG 300-W dataset. Eye can be accessed using simple Python indexing from 37 to 42 and 43 to 48 for the left and right eye correspondingly.The EAR values which are calculated can be used to detect whether the eyes are closed.If the eyes are closed a pop-up message is displayed with the beep sound .

The System detects the hunch of the user from the resistance values computed from the flex sensor using the voltage divider formula.

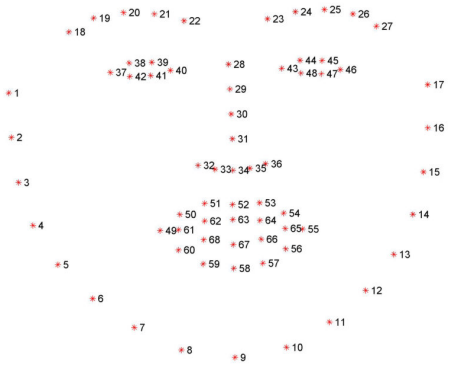

Fig. 5. Facial Landmarks diagram

$$R(flex) = R1*V(out)/(V(in)-V(out)) \tag{1}$$

These resistance values are converted into corresponding angles using,

$$\theta 1 = (R(flex)-10*103)/44.44 \tag{2}$$

$$\theta 2 = (R(flex)-6001)/88.88 \tag{3}$$

Posture

Posture is measured using a flex sensor which works on the mechanism of variable resistance. Depending on the angle of the bend the flex sensor is going produce varied resistance values proportional to the bend. An external circuit is used to connect it to the IoT device. It is used to identify the hunchback on a person by positioning it on the back of the person. The resistance values are used to detect the bend on the person thus notifying him/her to correct the posture.

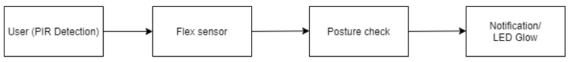

Fig. 6. Posture block diagram

Humidity

Humidity check is done using a DHT11 sensor which detects the Humidity as

well as the temperature of the surrounding. It has two electrodes with a moisture holding substrate as a dielectric between them. Change in the capacitance value occurs with the change in humidity levels. The IC available with the sensor measures and processes this changed values into digital form. The ideal range for humidity level indoors is 30-60 percentage.The role of humidity in our project is to monitor the humidity from going above the threshold by regulating the AC or a fan.

Fig. 7. Humidity block diagram

Indirect Communication
MQTT Protocol MQTT is a machine to machine connectivity protocol that can be used to establish a connection between two servers or two hosts in the same server. It performs a Publish and Subscribe handshake between two machines transferring data via ports.

Socket Connection

Socket is a two-way communication link between two programs on a network. It transfers the data by latching to a port and uses either Transmission Control Protocol or User datagram protocol to identify the application that awaits the transmission. This is done by subscribing or publishing by/to the IP address and port.

5 System Implementation

The system implementation here takes care of portability, accurate data flow without data loss, AI planning, and visualization.The main program file initially checks for the user count. This is self-sufficient to trigger the entire system, thus promising an automated system. If the count has reached a specific value and the sensor detects the user, the further processes are triggered.
The Raspberry pi 4B+ model IoT device is used to perform the overall implementation. Firstly, Since we are dealing with sensitive data collection we check for privacy. Once the user gives access to the system information, we continue further. Also, a socket connection which uses TCP protocol is established to send the user ID to the flex parser file. This is needed when we take in to account all the employees in the office. Another IoT device used here is ESP8266 which is connected wireless. This publishes value to the Raspberry Pi. Pi subscribes

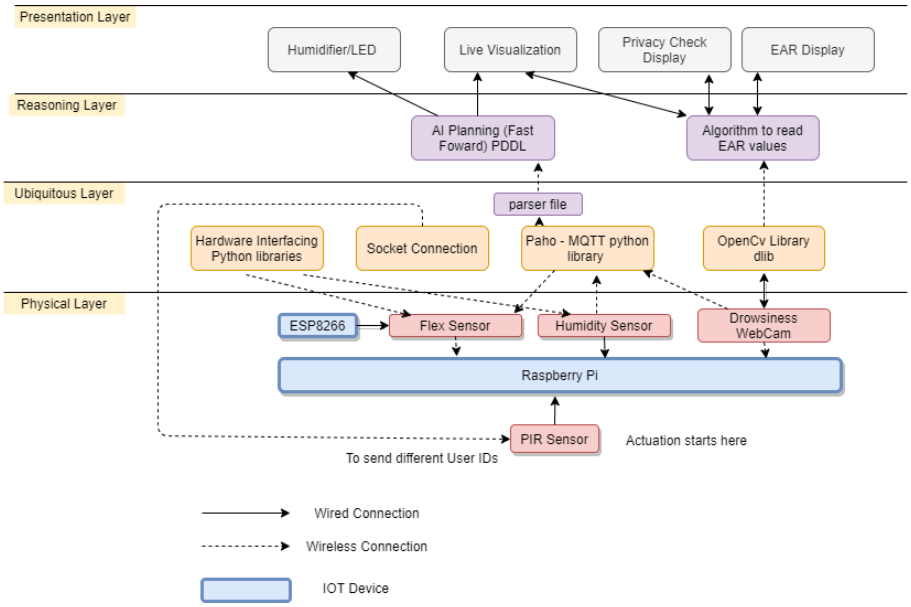

Fig. 8. System Architecture - Content and Layer

Fig. 9. System Implementation Overview

to these values using a specific topic name. This is done via the MQTT protocol. The flex parser file has the AI planning implementation which detects the threshold and the actuation is started. The actuation is an LED blink.
The drowsiness detection is also started simultaneously. The Raspberry Pi publishes using a topic name to the User's computer. The User's computer subscribes to the respective topic. The webcam detects the human eyes and computes EAR values. When a threshold is reached, a beep/alarm is triggered. Now the values are given back to the Pi for real-time plotting. The complete communication between the Pi and User's system happens when the MQTT publish Subscribe protocol.
The next part is the humidity sensing - Again when the user is detected, the surrounding humidity is monitored. This is planned in the AI planner. Once the threshold value is reached, the humidifier is switched on. When all these processes are running in parallel, the real-time values are collected in a CSV file. This is further used for plotting real-time data using matplotlib libraries. The entire sensor data collection, analysis, and workflow is as shown in the figure. The Implemented AI planning uses a fast forward algorithm that parses the Domain and the problem file that contains the initialisation and actions of the implemented system. The fast forward algorithm to provides the most suitable decision that has to taken and the relevant actuation can be done.

The values of a the sensing has been plotted using Matplotlib, Please see Fig9.

6 Discussion and Conclusions

With this application we are trying to improve the productivity of an employee.This project can be enhanced where each employees productivity can be measured and the data can be logged to human resource Department and they can take care of productivity of an employee.Here the data visualised using matplotlib can be send to employees mobile in real time so that the user can keep track of his posture and surroundings.The pulse of an employee can be detected and stress level can be tracked and can be notified to take proper breaks and can be added to the system in-order to improve the productivity.A series of flex sensor can be added to improve the accuracy for detecting the posture of an employee.The humidity detection can be implemented in various environments(eg:home).We can create a recovery system in case of loss of data.Such smart systems can provide guidelines for improving the productivity. Thus the proposed application can be extended for the betterment of the Health of Employees.

7 Github Link

`https://github.com/swetha104/SmartCitiesandIOT.git`

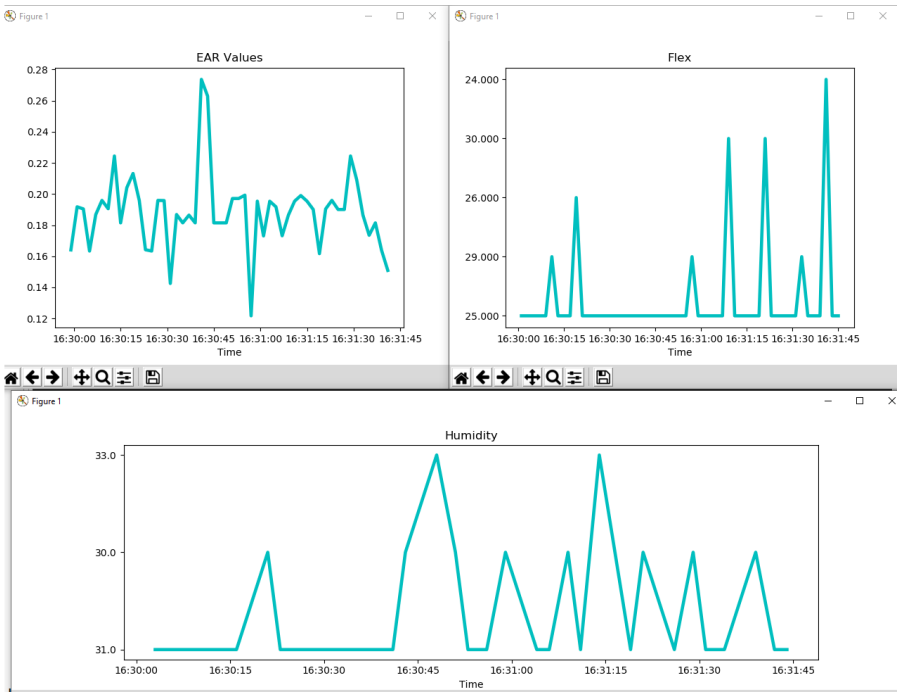

Fig. 10. Real Time Plotting of Sensor values

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