Office Ergonomics and Ambiental Environment Monitoring System

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Abstract

More and more people suffer from back health issues and other afflictions due to their position at the desk, their working ambiental environment and growing sedentarism. The proposed IoT system aims to help people and companies with such concerns and create a healthier environment to work in. The proposed system is placed on a person's desk. The system uses a camera and a computer vision model to analyse a person's position at the desk. It also uses a set of sensors to assess the ambiental environment's quality in accordance with ESH (Environmental, Safety, and Health) recommendations. The information analysed can be accessed by the end-user through a visual report that emphasizes the deviations from the recommended standards. The possibility to faster detect non-conformities in working environments and bad habits in ergonomics can improve the quality of the working space and delay or prevent health issues in the long term.

Keywords: office ergonomics, office ambiental environment, office microclimate, IoT system

1 Introduction

In recent decades, with the rapid development of the technological world and the continuous digitization of daily activities, humans have become increasingly dependent on technology, both in professional environments and personal life. Most of the time, this technology involves viewing a screen, whether it's a phone, tablet, or computer. An article from January 2023 reveals that, globally, a person spends an average of approximately 6 hours and 58 minutes per day in front of a screen [1]. This average can be even higher for people working a desk job. These prolonged periods of time spent in front of a screen combined with unhealthy posture habits, sedentarism and a non-standard indoor microclimate can lead to different health issues. They can be observed in the near future or in the long-term and are generally related to eyesight, back muscles and back bones problems, headaches, excessive tiredness and even depression [2] [3] [4] [5] [6].

The purpose of this paper is to propose a potential solution to these everyday challenges, enabling employees and employers to continuously monitor the work environment, promote a healthier workspace, and reduce the risk of health issues.

This paper is structured as follows: the second section presents the system prototype and the technologies used, being split in individual subsections for hardware and

software components, and the last section presents the conclusions and future developments of this project.

2   Methodology

This section presents the monitoring system's development in terms of hardware and software used in the project such as TensorFlow library, Node-RED, MySQL database and Microsoft PowerBI. The scope of this section is to present the purpose of the technologies used and how they interact with each other to deliver the end result to the user in a friendly and easy to interpret manner.

The proposed IoT system is placed on the person's desk. An overview of the system is presented in Figure 1.
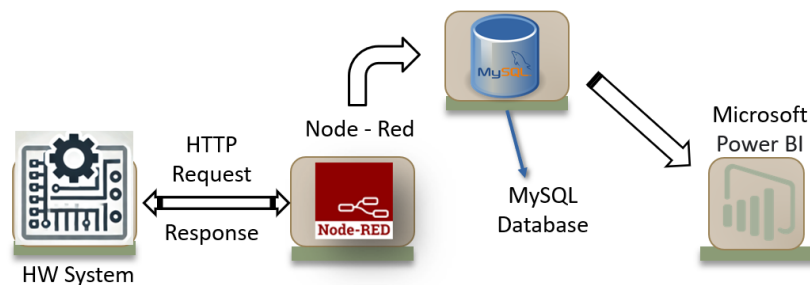

Figure 1. Implementation of main components of the system

2.1 Hardware components

In this subsection the hardware part of the system will be presented. It emphasizes the two purposes of the hardware: the collection of office microclimate data and the picture taken of the person working at the desk.

The data is collected and sent periodically, at the request of the main application, during the usual working hours of a person.

2.1.1   Office microclimate data

As presented in the introduction, the microclimate in which a person is working can have a direct impact on his or her health. Therefore, certain standards regarding the microclimate exist that, if respected, create the healthiest office environment to work in.

For this reason, an important part of the proposed system consists of a set of sensors that collects ambiental environment data (temperature, humidity and light intensity) and sends it to the server (the Node-RED application) to be analysed against the standards established by specialists and stored in the database.

2.1.2   Ergonomics

Another important factor to be monitored is the posture of a person at the desk. As previously presented, a bad posture for prolonged periods of time and unhealthy habits regarding sedentarism can lead to issues at back muscles and back bones level.

The purpose of this proposed solution is to verify the upper-body posture of a person, considering that this is the one visible above a desk
A camera is used to take a picture upon request. The picture taken is then sent to the main application to be analysed.

2.2 Software components

The three main software components of this system are the Node-RED application, the MySQL database and the PowerBI report.

2.2.1   Main application

The application behind this IoT monitoring system is implemented in the Node-RED platform. The main objectives of the application are:
- periodically request data from the hardware;
- analyze the upper-body posture using a model from the Tensorflow library to get important body key points and make relevant observations;
- analyze the microclimate data and calculate the deviation from the standards, if applicable;
- store the collected data in the MySQL database;
- if deviations were observed (regarding either the microclimate or the posture of the person), a request is sent back to the hardware system to display a relevant message for the user on a small display.

For GDPR reasons, the picture taken of the user at the desk is discarded immediately after it is processed. The only information saved is the observation regarding the user's posture, information derived from the taken picture and above-mentioned analysis.
If the person is not at the desk when the data is collected, this scenario is verified and treated accordingly.
The application also takes into account the current season (warm season or cold season), as the microclimate standards have small but important differences depending on the period of the year.

2.2.2   Database

A MySQL database was chosen for this application for its easy-to-use properties and the already implemented connection algorithms in the Node-RED platform.
The database stores the timestamp of data collection, microclimate information, deviations from standards and relevant observations regarding ergonomics.

2.2.3   Microsoft PowerBI

PowerBI is a tool provided by Microsoft that offers a simplified and more visual and interactive method of creating reports. It can connect directly to a database and extract the desired data for the reports, which is helpful for scenarios like this one when new data is constantly added to the database.

The report created for this project is simple in order to provide a friendly and easy to interpret analysis for the end-user. It consists of a filter for the date, a table which showcases the microclimate data collected through that date and relevant observations about the ergonomics, and a visual report which presents the deviation from the standard for each metric.
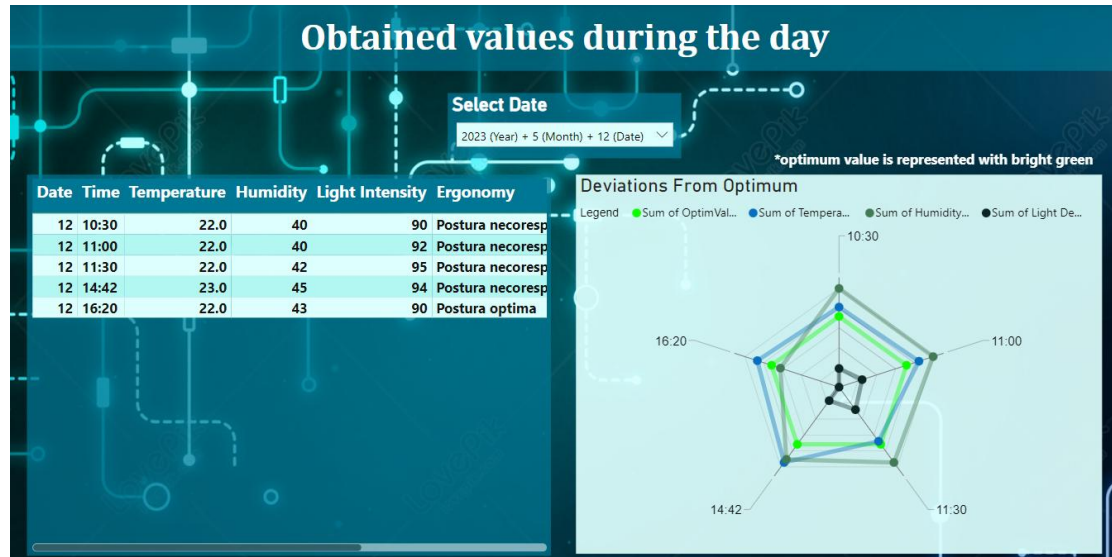

Figure 2. PowerBI visual report

3   Conclusions

In today's society, working at a desk and using a computer have become the new norm, whether it is the case of a student or an employee in a company. This new reality has come with its own challenges when it comes to health issues. More and more people encounter health problems that are often related to their working environment and unhealthy unconscious habits.

The purpose of this IoT prototype is to spread awareness about these important factors that are usually neglected in the working day-to-day life. The purpose is also to address and provide a potential solution to this contemporary problem in a manner that is as simple, cost-efficient, and space-saving as possible.

This system was tested in an environment with one person working at a desk. The results obtained from using this prototype have drawn attention to irregularities in the working space microclimate and generally bad posture, aspects that were rarely observed before.

The future developments considered for this project are: finding solutions to make the system even simpler and more compact while still being cost-efficient, monitoring more microclimate-relevant metrics, scaling the system to have multiple users simultaneously, creating a mobile application for the user interface.

Acknowledgment

expertise and insights have been a crucial part of getting this project from just an idea to a working first prototype.

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