

CHAPTER I

INTRODUCTION

1.1 Background

The increasing dependence of modern lifestyles on computers, laptops, and other digital technologies has led many individuals to spend a significant portion of their time in prolonged sitting positions. Maintaining a non-ergonomic sitting posture for extended periods has been shown to contribute to various health problems, particularly those affecting the spine, neck, and shoulders [1].

One of the most common health issues associated with poor sitting posture is musculoskeletal disorders (MSDs). These disorders affect the muscles, joints, and spinal structures, resulting in pain, fatigue, and, in severe cases, interference with daily activities. According to data reported by the World Health Organization (WHO), more than 60% of office workers worldwide experience MSD-related symptoms [2][3]. Studies conducted in Indonesia indicate that the prevalence of ergonomic risk factors associated with MSDs in office environments reaches approximately 73%. The most frequently reported complaints involve the back, lower back, and neck, with severity levels ranging from mild discomfort to severe pain [4]. This issue is particularly concerning because it negatively affects both individual health and work productivity.

Following the COVID-19 pandemic, the trends of working from home and online learning have not completely disappeared; instead, they have evolved into hybrid working and learning models [5]. As a result, many individuals continue to spend long hours sitting in front of computers and laptops for work, education, and various digital activities, including gaming and content creation [6]. Unfortunately, many users pay little attention to their sitting posture. This situation has created a growing demand for technologies capable not only of detecting users' sitting posture but also of providing real-time corrective feedback while simultaneously monitoring long-term sitting habits.

One of the emerging solutions is the application of Internet of Things (IoT) technology in health monitoring systems. By utilizing sensors such as gyroscopes, body posture can be continuously monitored and transmitted to an application for further analysis [7]. However, most existing systems are limited to monitoring functions or application-based notifications, which are often overlooked by users.

In addition, sensor data are frequently affected by instability due to individual differences in body shape and signal disturbances. To address this challenge, fuzzy logic has been widely adopted because it mimics human decision-making processes when handling

uncertain and imprecise data [8]. Compared with Type-1 Fuzzy Logic, Type-2 Fuzzy Logic offers superior capabilities in managing uncertainty and producing more accurate results [9]. Nevertheless, fuzzy systems primarily rely on predefined rules, making them less adaptive when confronted with variations among different users.

To overcome these limitations, Type-2 Fuzzy Logic can be integrated with machine learning algorithms to create a more intelligent and adaptive system. In this approach, Type-2 Fuzzy Logic functions as an intelligent filtering mechanism that stabilizes sensor data and reduces uncertainty, while machine learning serves as an adaptive classifier capable of learning from real-world data. One suitable algorithm for this purpose is Support Vector Machine (SVM), which has demonstrated strong performance on relatively small datasets with well-defined class boundaries [10]. By incorporating Type-2 Fuzzy Logic, the input data provided to the SVM become more structured and less affected by noise, thereby improving classification accuracy [11]. This combination is expected to produce a system that is not only accurate in detecting current posture conditions for corrective purposes but also reliable and consistent in monitoring long-term sitting behavior.

Based on these considerations, this study aims to design and develop a system capable of detecting non-ergonomic sitting postures, providing vibration-based alerts as immediate corrective feedback, and transmitting user posture data to an IoT platform (Blynk) for monitoring long-term sitting habits. The proposed system integrates IoT sensors, Type-2 Fuzzy Logic, and a machine learning algorithm (Support Vector Machine) as the core data-processing framework. Through the implementation of this system, users are expected to improve their sitting posture in real time while simultaneously evaluating their long-term sitting behavior, thereby reducing the risk of health problems associated with prolonged non-ergonomic sitting postures.

1.2 Problem Statement

Based on the background presented above, several key issues are identified as the focus of this study:

1. How can a system be designed and developed to detect sitting posture using a gyroscope sensor with Type-2 Fuzzy Logic-based data processing?
2. How can the Support Vector Machine (SVM) machine learning algorithm be implemented to classify sitting posture into three categories: upright, slightly slouched, and slouched?

3. How can the proposed system provide real-time feedback through a vibration motor when a user maintains a non-ergonomic sitting posture?
4. How can the system be integrated with an Internet of Things (IoT) platform (Blynk) to enable the monitoring and analysis of users' posture data over a specified period?

1.3 Research Objectives

This study aims to achieve the following objectives:

1. To design and develop a system capable of detecting sitting posture using a gyroscope sensor with Type-2 Fuzzy Logic-based data processing.
2. To implement the Support Vector Machine (SVM) machine learning algorithm for classifying sitting posture into three categories: upright, slightly slouched, and slouched.
3. To develop a posture correction system that provides real-time feedback through a vibration motor whenever the user adopts a non-ergonomic sitting posture.
4. To integrate the proposed system with an Internet of Things (IoT) platform (Blynk), enabling posture data and correction outcomes to be continuously monitored and analyzed over time.

1.4 Research Benefits

Based on the research objectives outlined above, the benefits of this study can be summarized as follows:

1.4.1 Theoretical Benefits

From a theoretical perspective, this study is expected to contribute to the advancement of knowledge in the fields of informatics and intelligent systems. The integration of Type-2 Fuzzy Logic and the Support Vector Machine (SVM) machine learning algorithm for sitting posture classification may serve as a valuable reference for the application of artificial intelligence methods in handling uncertain sensor data. Furthermore, the implementation of Internet of Things (IoT) technology in a sitting habit monitoring system is expected to enrich the existing body of literature concerning the use of IoT in healthcare and ergonomics. Therefore, this study may provide a foundation for future research focused on developing more adaptive, accurate, and effective posture correction systems.

1.4.2 Practical Benefits

From a practical perspective, this study is expected to benefit users by increasing awareness of non-ergonomic sitting habits and facilitating posture correction through real-time

vibration-based feedback. In addition, the proposed system enables users to monitor their posture development over a certain period through a monitoring application. For educational and research institutions, the findings of this study may serve as an example of how artificial intelligence and IoT technologies can be applied to address real-world problems in the healthcare domain, particularly in ergonomics. For the general public, this study offers an alternative technological solution that is simple, portable, and practical for reducing the risk of health problems caused by poor sitting habits.

1.5 Research Scope and Limitations

The scope and limitations of this study are defined as follows:

1. The sitting posture classification is limited to three categories: upright, slightly slouched, and slouched.
2. The sensor used for posture detection is the MPU-6500 gyroscope/accelerometer sensor.
3. The data processing method employs Type-2 Fuzzy Logic to reduce data uncertainty, and the resulting outputs are subsequently classified using the Support Vector Machine (SVM) machine learning algorithm.
4. Posture correction is provided through a vibration motor actuator as a form of real-time feedback to the user.
5. Posture monitoring is conducted using the Blynk IoT platform.
6. The system is evaluated using a limited number of participants (two respondents) over a testing period of several hours to assess the effectiveness of the wearable system.
7. This study does not address the ergonomic design aspects of chairs or workplace environments; instead, it focuses exclusively on the development of a wearable system for posture monitoring and correction.