Development and Validation of a Novel Posture Monitoring System

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*Abstract*—In contemporary society, posture-related musculoskeletal disorders are on the rise due to extended periods of sedentary behavior and repetitive tasks with people spending most of their time slouching and hunching over desktop screens, tablets and mobile phones. This continuous behavior over extended periods of time causes severe upper and lower backpain that subsequently leads to cervical spondylosis and bulging of lumbar discs. In response to the prevalence of this issue, we have developed a posture monitoring system realized through a shoulder strap to capture the siting posture of individuals. This is achieved by utilizing 3 IMU sensors to monitor and Machine Learning Algorithms to classify. The classification algorithms were trained with data acquired from 12 healthy individuals and the bests chosen one is the KNN algorithm with an accuracy of 99%. The system was further validated with a real time validation routine and was identified with 80% accuracy.

Keywords—IMU, Spinal Posture, Data Classification

# Introduction (*Heading 1*)

Sitting is one of the most common postures in daily life [1.2-7], with studies indicating that people spend around six hours sitting each day. Consequently, back pain has become a widespread and troubling issue, now ranking as the third most common reason for individuals to seek medical attention [3.?]. Approximately 70-80% of those experiencing back pain attribute it to poor posture [d1?]. Chronic back pain develops gradually due to sedentary behavior, often exacerbated by prolonged use of digital devices. This has resulted in 15-19% of people suffering from upper back pain and 60-70% from lower back pain [d1?].

The most frequent activity while sitting is using mobile phones, with an estimated 4.77 billion users worldwide as of 2017. This number was projected to increase to 5.07 billion by 2019 [2.1]. As more essential services are integrated into smartphones, and with the growing number of mobile applications, this has further promoted a sedentary lifestyle. Alarmingly, a recent study reveals that looking down at a phone is comparable to placing 60 pounds of pressure on the neck [4.1]. Correspondingly, another study highlighted that a condition known as "Text Neck," caused by 60 pounds of neck pressure, can lead to Kyphosis [2...?]This disease is an excessive spine curve because of abnormal rounding of upper back. which can lead to breathing problems that may eventually require a surgical treatment.[4.?].

Chronic Low Back Pain (CLBP) is another significant cause of disability, affecting similar populations across various countries and cultures, with one in five adults experiencing CLBP each year [1.2]. In industrialized nations, chronic pain is rapidly becoming the foremost health issue, contributing to annual low back pain costs of $100-$200 billion [1.4].

Acute back pain, which often results from injuries like muscle strains or ligament tears due to activities such as heavy lifting or sudden movements, can also lead to considerable discomfort and mobility limitations [d.?]. Back pain significantly affects an individual’s quality of life, reducing productivity, limiting movement, and causing emotional distress. Studies have found that slouched or hunched posture not only reduces energy levels but also negatively impacts mental well-being, such as happiness and depression [2.4]. Poor posture also affects workplace productivity, with approximately 75% to 85% of worker absenteeism being attributed to recurrent or chronic back pain [1.6].

Despite its prevalence, simple preventive measures can effectively mitigate these disorders. According to medical research, most cases of severe Kyphosis can be treated and prevented through exercises aimed at improving posture and maintaining a straight spine [4.2]. A study by Robertson et al. [5.1] found that musculoskeletal risk decreased after 16 months of ergonomic posture training for seated individuals. Further studies by Choobineh et al. [5.2] and Menendez et al. [5.3] demonstrated that ergonomic interventions could reduce musculoskeletal discomfort and related symptoms. Additionally, research by Taieb-Maimon et al. [5.5] showed that posture risk diminished after three weeks of an experiment using a camera to display the seated individual’s sagittal posture. Therefore, maintaining proper spinal posture is possible and essential, which is the goal of our system’s design.

Several systems have been developed to address this issue, comprising three main components: data collection, data analysis, and feedback [4.?]. Our system incorporates all these elements, with a particular focus on analyzing the collected data while in a seated position.

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