EMG-Based Mobile Assessment System for Neck and Shoulder Fatigue

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ABSTRACT

The neck and shoulders are the key channels for blood supply to the head. Bad blood circulation cannot only cause dizziness and headache but can also affect the vitality of brain cells and cognitive function. The neck muscles also provide all support for the head, and incorrect posture can put stress on the lower cervical vertebrae, accelerating joint wear and poor blood circulation, leading to hypoxia of neck muscle and tissue, and resulting in muscle fatigue and stiffness. Keeping the neck and shoulders rigid over an extended period, can produce neck and shoulder pain, dizziness and headache, and possibly even memory loss and short-term cognitive impairment, which can thus negatively impact learning ability and work efficiency. In this article, electromyography (EMG) characteristics were extracted through EMG analysis. Test subjects wore sensors while engaged in work or studying. The sensors retrieved EMG data which was then uploaded to a cloud-based platform for computation. A smartphone-based app then allowed users to monitor their own neck and shoulder fatigue in real time. Moreover, based on users’ personal basic information, the system recommends personalized exercises to promote neck and shoulder relief, thus promoting comfort and reducing stress.

KEYWORDS

Neck and Shoulder, Neck Pain, Muscle Fatigue, Electromyography (EMG), Machine Learning
INTRODUCTION

Working populations in economically advanced countries are increasingly sedentary, spending their entire working week sitting and facing computer screens, resulting in an epidemic of chronic neck and shoulder fatigue, conditions which busy people tend to ignore until it leads to serious issues including neck and shoulder stiffness and pain, poor blood circulation, dizziness, headache, and decreased cognitive and work productivity. Although the proximate causes of neck and shoulder fatigue can usually be easily corrected, most people are too busy or are accustomed to some degree of neck and shoulder fatigue, and thus ignore the warning signs. Over time, chronic neck and shoulder fatigue can lead to physiological deformation, adhesive capsulitis, and even scoliosis. Therefore, mechanisms for monitoring and correcting poor posture in real-time would potentially be beneficial.

Electromyography (EMG) has been used to study muscle activity along with neck and shoulder pain and fatigue. EMG characteristics can reflect degree of muscular damage and identify the impact of different posture issues. EMG has been found to be a fairly objective assessment tool for muscle activity and fatigue (Castelein et al., 2015; Murray et al., 2016). In this study, EMG characteristics were extracted through EMG analysis, were used to assess neck and shoulder fatigue. Real-time alerts encourage users to intentionally relax or change activity patterns to relieve neck and shoulder fatigue. Wearable sensors were integrated with a mobile device and cloud computing services to develop an EMG-based mobile evaluation system for neck and shoulder fatigue. The system collects the user’s basic information and EMG characteristics and uploads this data to the cloud for inspection and analysis. Analysis results are then transmitted to a native application in the mobile device to inform the user of potential posture issues in real time, and provide personalized exercises and other relief methods specific to the user’s posture issues to help the user continuously reduce fatigue level.

BACKGROUND

Neck and Shoulder Fatigue

Neck and shoulder muscle fatigue can seriously impact work efficiency and quality of life. The definition of muscle fatigue in many studies focuses on fatigue-induced action potential changes or changes in power. Bigland-Ritchie et al. (1986) suggested that reduced maximal capacity of the central nervous system or muscle fatigue from exercise may cause muscles to fail to generate normal force, leaving them unable to maintain the required or desired power output (Gandevia, 2001; Huang et al., 2009). Other scholars have interpreted fatigue from a dynamic perspective as the reduction of maximal power output or maximal capacity to generate force, or failure to maintain a required force or output of power during sustained or repeated muscle contraction (Vøllestad, 1997; Vøllestad et al., 1988).

Fatigue is any reduction in the maximal capacity to generate force or power output; it may be caused by obstructed transmission of motor signals and may result
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