Fatigue Detection Post Physical Activity: A Review

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Abstract. Construction work is purely effortful and the prevention of injuries at construction job sites is essential for encouraging worker’s well being and health which is generally overlooked at the construction sites. A large number of labourers and construction workers have to undergo fatigue risk at their job place. So, it is necessary to detect fatigue in the workers prior to fateful effects. This paper describes the current state of the research carried out in case of fatigue detection after performing some physical activity providing an insight into fatigue, its detection and an overview of the causes of risk fatigue and its countermeasures. A number of subjective and objective fatigue assessment approaches have been used that have further stimulated the inclusion of latest and advanced approaches for fatigue detection. Although individual’s knowledge regarding the fatigue detection approaches has enhanced, there is yet a minimal research carried out in the field of fatigue detection post physical activity.

Keywords: Fatigue, construction, physical activity.

1 Introduction

The construction and labour sites record a considerable number of on-site injuries in India and abroad. Also, another major cause of nonlethal injuries that is caused mainly due to having a break from construction work, as well as a huge counterbalance costs and medical costs with frequent work dysfunctions [1]. Fatigue is one of the major causes for accidents happening in the construction sites. The construction industry often exposes workers to massive workloads, extended work timings, and iterative tasks making body fatigue unavoidable [2]. Physical fatigue can also give birth to continual health problems as well as task related body and joint disorders, inveterate fatigue problems, and immune system dysfunctions [3]. Thus fatigue detection and assessing technology that permit for mediation in advance of fateful effects to workers’ protection, fitness, and efficiency are worth studying.

Fatigue in general terms is defined as the reduction in the transient performance of the muscles to employ optimal force after undergoing a physical activity. Fatigue is a universal symptom, not a condition. Fatigue develops moderately in steps over a time period for works that do not demand continued employment of maximum possible force. As per a study on construction workers, a worker undergoes five to six hours of average walking in individual timeshift and around 40-44% of the individual carrying out these jobs are reported to be exhausted due to body fatigue [4]. Traditional approaches to assess the physical exposure experienced by the workers at construction sites are generally based on ocular observation carried out by a skilled observer or it may rely on any other subjective approaches such as questionnaires. However, as per the nature of fatigue detection, certain fatigue indicators may vary among different workers with distinct social and ethnic backgrounds [5]. This is the reason that subjective techniques of fatigue detection are generally implemented to the task specific environment and the target individuals.

Physical and body related measurements, encompassing pulse rate, oxygen intake and outer body temperature are employed to conquer the limitations of subjective detection methods [6]. As above said method may be clumsy and difficult to implement, sometimes secondary measures have been implemented to assess physical exhaustion, enhanced jerk, and joints related issues [7]. These detection methods are based on motion data collected using optoelectronic sensors, which is the pioneering approach for non-invasive physical locomotion capture in different studies. Practically, the above technique is limited to employ as it requires great skillfulness, a huge processing cost and it is also a difficult task to deploy these methods on most job sites [8].
2 Fatigue, Fatigue Characteristics and Corresponding Fatigue Detection Measures

2.1 Fatigue and Its Characteristics

Defining fatigue in terms of composite interplay of the biological phenomena, physiological processes, and behavioral demonstration is a tedious task. Authors in [9] define fatigue as functional organ failure. Excessive energy consumption may be the leading cause for such a functional organ failure. Fatigue in other words may be called a decay in efficiency and productivity due to partial healing from last physical activities. As per [10], fatigue is defined as a fall in any tissue’s ability to apply force as a result of carrying out a physical activity.

Author in [11] proposed to differentiate acute and chronic fatigue. Acute fatigue is sensed generally as normal, has a rapid start and short but severe course. But, chronic fatigue is specified as having an unspecified function, and it mainly affects persons with poor clinical health, having random causes. Chronic fatigue may worsen with any further physical or mental activity and there is little improvement even after taking a rest.

2.2 Fatigue Detection Methods

There are several methods of fatigue detection used for laboratory studies and field studies. Under this study, we will focus on the methods that can be utilized in field studies.

2.2.1 Subjective Methods

In the subjective approach of fatigue detection, the system relies on the surveys and questionnaires based on self perceived exertion scales, conducted on selected and suitable subjects. A consent for the same is taken from the subjects. Although these have the advantage of being cheap, they are unreliable [12].

2.2.2 Objective Methods

Objective approaches of fatigue detection are based on physiological processes (movement of different body parts) and are more reliable. The on-site implementation of these systems is a cumbersome and expensive task. In the current state, fatigue detection and physical exertion assessment has been implemented mostly by using Electromyography (EMG) and with the inception of cheap and reliable wearable motion sensors it has been performed using inertial measurement units (IMUs).

![Fig. 1. Electromyography (EMG) test contraction method [12]](image1)

![Fig. 5. Positioning of different IMU units in [13]](image5)
3 Conclusion

After having a review of research carried out in fatigue detection it can be concluded that in using subjective as well as objective approaches, there is always a requirement of large data sets. There is always a variation in the collected parameters in terms of demographic and other individual differences in the development. Although the objective approach is much more reliable and accurate, it also adds in the cost. This study also concludes that work exposes individuals to fatigue that they would rarely experience without work. A significant population across the world is exposed to fatigue risk due to their busy work schedules and other non-work related causes. So, there is always a need to assess fatigue effectively for fatigue risk management.

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