



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DEVELOPMENT OF IOT BASED EXOSKELETON FOR
MONITORING ELBOW REHABILITATION THERAPY**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Electrical Engineering Technology (Industrial Automation and Robotics) With Honours.

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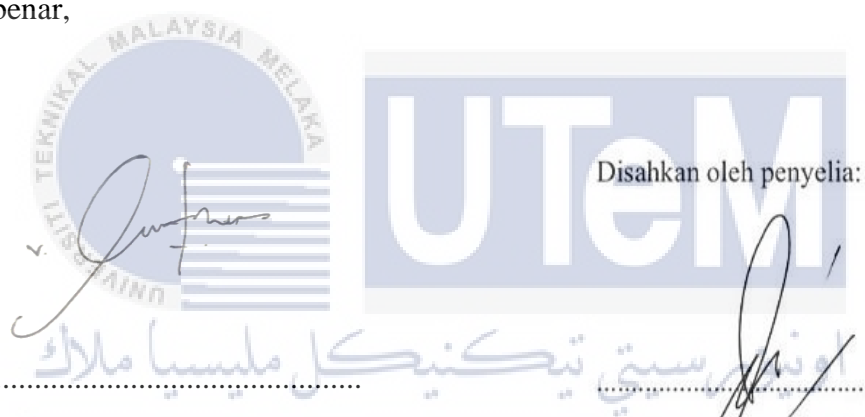
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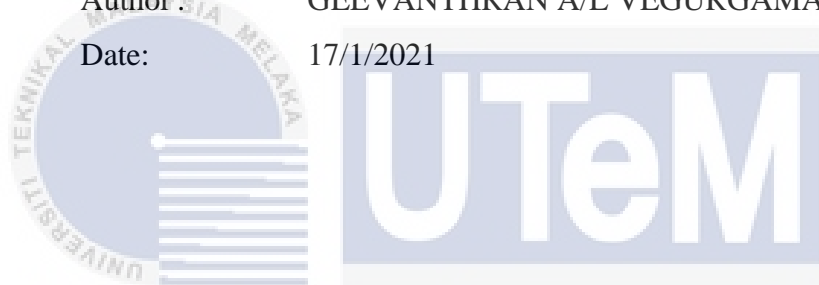
I hereby, declared this report entitled DEVELOPMENT OF IOT BASED EXOSKELETON FOR MONITORING ELBOW REHABILITATION THERAPY is the results of my own research except as cited in references.



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APPROVAL

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Automotive) with Honours. The member of the supervisory is as follow:



ABSTRAK

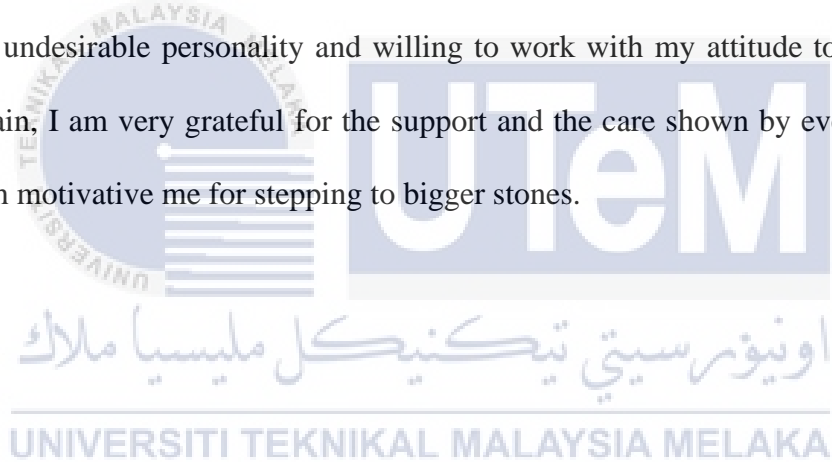
Sendi siku merupakan artikulasi kompleks yang terdiri daripada sendi 'humeroulnar' dan 'humeroradial' untuk pergerakan lenturan-pemanjangan. Pergerakan siku memainkan peranan yang utama untuk melakukan aktiviti harian yang penting. Tambahan, disebabkan sistem semasa dan paradigma yang terhubung seperti 'Internet of Things' (IoT) adalah mungkin untuk mengembangkan 'elbow exoskeleton' yang lebih maju, berkesan dan perubatan berkos rendah yang boleh dimiliki oleh pesakit di rumah mereka. 1DOF memberikan julat pergerakan siku (lenturan / pemanjangan) secara naturalistik. Projek ini membentangkan 'elbow exoskeleton' yang dapat memantau pemulihan pesakit melalui alat seperti aplikasi mudah alih dan 'web server' melalui pengumpulan data kualitatif. Pergerakan ini adalah banyak digunakan dalam terapi pemulihan dan dapat dilakukan dengan efisien dengan 'exoskeleton' berdasarkan IoT yang semakin berkembang untuk memantau siku. Pesakit dapat menyimpan status pemulihan mereka melalui data dan sekiranya diperlukan di masa depan, doktor dapat merujuk pada data tersebut di mana-mana lokasi atau masa. Bagi pesakit yang tidak dapat mengangkat tangan, 'servo motor' akan membantu mereka untuk mencapai sudut yang diinginkan untuk proses pemulihan. Grafik masa nyata dari platform IoT akan menentukan proses pemulihan siku melalui analisis data. Projek ini adalah penting dalam rawatan klinikal dan kesihatan kerana ia dilakukan tanpa sokongan manusia atau ahli fisioterapi.

ABSTRACT

The elbow joint is a complex articulation composed of the humeroulnar and humeroradial joint for flexion-extension movement. To perform essential daily activities the movement of elbow plays a crucial role. In addition, due to current connected systems and paradigms such as the Internet of Things (IoT) it is possible to develop advanced, effective and low-cost medical elbow exoskeleton that patients may have in their home. This proposed 1DOF will provide naturalistic range of movements of elbow (flexion / extension). This project presents an elbow exoskeleton which can monitor patient's rehabilitation via gadgets such as mobile application and web server through qualitative data collection. These movements are widely used in rehabilitation therapy and could be performed efficiently with development of IoT based exoskeleton for monitoring elbow. Patient can save their rehabilitation status through data and the doctor can refer to the data at any location or time in case for future needed. For those who unable to lift their hand, servo motor will help them to assist to reach desired angle for rehabilitation process. The real time graph from IoT platform will determine the process of recovery of the elbow through data analysis. This project is important in clinical and health care because it is done without human support or physiotherapist.

DEDICATION

I dedicate my project to my family and friends. A special feeling of gratitude to my beloved parents who boost me throughout my struggle moment. I also dedicate this project to my lecture especially my supervisor, Mohd Razali Bin Mohamad Sapiee for being there entirely during my project and troubleshoot my doubts without any hesitation. I also take this chance to thank for giving me an opportunity to accept my attitude while writing this paper. My deepest appreciation for the people around me who I have been showing undesirable personality and willing to work with my attitude to achieve task. Once again, I am very grateful for the support and the care shown by everyone around me which motivate me for stepping to bigger stones.



ACKNOWLEDGEMENTS

In the present world of competition there is a race of existence in which those are having will to come forward succeed. Project is like a bridge between theoretical and practical working. With this willing I joined this project. First and foremost, research and studies about this project for this past six months was interesting. During this period, I have learnt a lot about elbow exoskeleton especially method of doing of it. I perceive this opportunity of making project as big milestone in my degree life. I will strive to use gained skills and knowledge in the best possible way and I will continue work on project improvement, to attain desired career objectives.

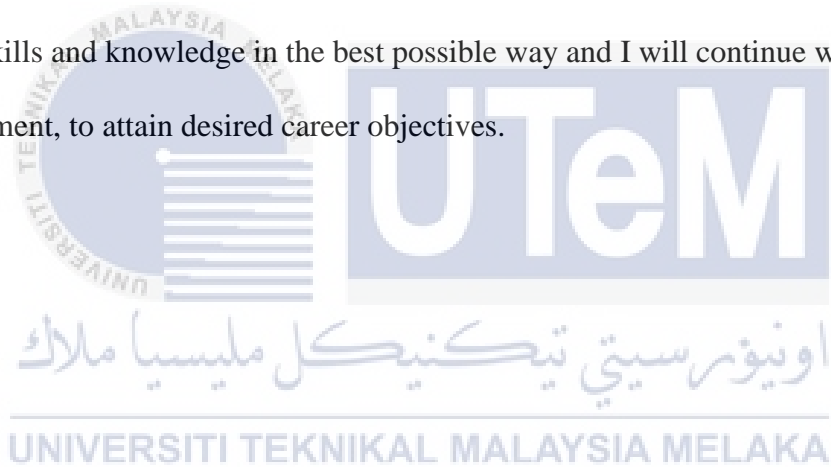


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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

This section will explain the purpose and goals of the project that has been implemented. Also, this chapter will explain certain elements that are important to the user, which is the background of study, problem statement, objectives, scope of work as well as the expected result of this study.

1.1 Background of Study

According to the Michigan Medicine University, everyone has had a minor elbow injury in their lifetime, which varies according to the type of accidents that cause for the injury. Elbow joint is made up of bone, cartilage, ligaments, and fluid in which works with the help of muscles and tendons which aids the joints to move swiftly. When any of these structures is hurt or diseased, it is known as elbow injury. These injuries might include symptoms such as numbness, swelling, tingling, pain weakness, or decreased range of movement. Based on the research been conducted by the university, there are few highly risked reasons been identified as the cause of elbow injuries which are been enlisted as firstly, sports or recreational activities. Secondly, tasks related to work, thirdly, work or projects around the home and lastly, falls.

The statistics of elbow recoveries also varies based on the depth of the injury been caused and experts had reviewed that factors such as age, sex, medication, health quality and etc could be the driving factors on the recovery duration.

There are few mechanisms of injury in elbow fractures and dislocation been listed by the researchers, as for example, first and foremost is tendonitis which is caused by continuity of vigorous activities that will cause inflammation, pain and difficulty using the elbow joint. Secondly is an injury known as tendinosis, which occurs because of aging that causes the tear of tendons. Besides that, another type of elbow injury is tennis elbow in which the outer elbow tendon is prone to injury meanwhile golfers' elbow injury condition occurs when there is an injury to the inner elbow tendon. Apart from the mentioned injuries types, there are abundance of other injuries as well been linked to elbow fractures. Hence, an effective and proactive treatment should be developed and used to treat these injuries. The range of motion consists of two which is extension and flexion that take place within the sagittal plane. Elbow extension is simply conducting the forearm backwards to anatomical position. This action is carrying out by triceps brachii with an unimportant assistance from anconeus. Triceps arise with two heads dorsal on the humerus and with its long head on the scapula just under the shoulder point. Elbow flexion is when your forearm moves in the direction of your body by flex at your elbow. The three bones complicated in the flexion of elbow are the humerus, ulna, radius. There are three muscles complicated in your flexing your elbow. They attach your upper arm to your forearm. When they compact, they become tiny and pull your forearm in the direction of the upper arm.

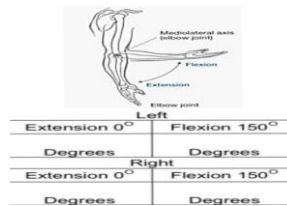


Figure 1. 1 Elbow Movement

One of the well-defined treatments for elbow treatments is known as Exoskeleton, which uses the rapidly growing military and rehabilitation exoskeleton technology in industrial settings. In this globalization era, robotic exoskeletons have emerged as rehabilitation tool that may ameliorate quite several health-related consequences after the joint been damaged. The usage of exoskeletons may provide individuals with these elbow injuries or fracture with the opportunity to improve their level of physical activity in an independent manner which indirectly will be helpful in elevating their psychological well-being by improving quality of life and decreasing anxiety and depressive symptoms.

Exoskeleton technology is known as elbow exoskeleton, a design of an intelligent mechanism that can give higher torque to weight ratio compared to existing models. This widespread technology is used to help individuals for external support of their movement, precisely on elbow injuries or fracture treatment the usage of the elbow exoskeleton model can assist the patients to self-support themselves with greater stability as well. This framework works under Internet of Things (IoT) system to record movement

This technique vastly differs from the traditional method of rehabilitation process where the attention and care of physiotherapy to heal the injury by monitoring and provide help by assist them physically. The experts work to monitor the corresponding therapy performance which is a hassle with the high numbers of patients. Hence the developed system allows a quantitative measure of the evolution and capabilities of the patient over the usage of IoT that has historical data on progress individually and in detail of the entire recovery. This is because the data recorded by the sensors are used for characterization of movement thus always allowing for monitoring and estimation of patients' state which also analytically measure the patient's healing, as well as the generation of new exercises adapted to that evolution. This system works with three main parts known as data acquisition unit, data processing unit and cloud- based service for remote access to data which will then demonstrate the result of monitoring the elbow rehabilitation process.