CHAPTER 4

SMART CONTROL FOR CONTINUOUS PASSIVE MOTION FOR KNEE REHABILITATION

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4.1 INTRODUCTION

The use of continuous passive motion (CPM) therapy is commonly used in the medical sector to automate the therapeutic for rehabilitation in physiotherapy sessions for a patient's affected body part. A specific physical therapy tool for knee rehabilitation, known as a knee CPM machine, is used to move a patient's leg through a set range of motion for knee rehabilitation. The machine follows the healthcare provider's instructions to improve the therapy, which includes total knee rehabilitation, stroke knee rehabilitation, etc. CPM has been a long-standing approach utilized in the recovery of total knee arthroplasty (TKA) patients (Mistry et al., 2016). The example of an existing commercial CPM machine as shown in Figure 4.1.

The motivation for this project arises from workforce limitations in healthcare, where nurses and physiotherapists cannot manage every patient's therapy session. Malaysia's nursing industry, facing a critical shortage due to longstanding issues (Gan, 2022), would benefit from reducing reliance on manual labour. Healthcare providers need to reduce their dependency on manpower for task that require repetition and can be done automatically such as rehabilitation work on patients, which can be narrowed down to consultation and monitoring only.

Figure 4.1 Existing commercial CPM machine (Source: Scimedstore, n.d.)

Secondly, the conventional CPM machine is equipped with a mechanical control pendant, which is mechanically controlled and may have less accuracy, no flexibility for its setting, and the need for high maintenance costs when some parts wear out or break. The mechanical control pendant is illustrated in Figure 4.2.

Figure 4.2 The mechanical control pendant of CPM machine (Source: Chattanooga OptiFlex K1 Knee CPM Classic Hand Control with Spiral Cable, n.d.)

The only issue is that the CPM machine's safety is jeopardised because certain devices does not include safety precautions for the patient's knee while it is running. This can lead to injury to the joint or surrounding tissues. Although there is healthcare provider to consult with and monitor the therapy sessions, there are some precautions that need to be considered to prevent unwanted things from happening.

Lastly, the spread of the virus posed a problem as it highlighted the need for devices to be set up, controlled, and monitored remotely by healthcare providers during therapy sessions, to eliminate the need for in-person therapy sessions and reduce the risk of virus transmission.

4.2 CONTINUOUS PASSIVE MOTION REVIEW

This section covers literature reviews from papers, articles and journals related to the continuous passive motion for knee rehabilitation project. These reviews focused on the methodology, system, and the studies of each paper. This section will also be including the summary of the review.

The patient's knee needs to be trained to move like a normal knee through exercise, so the therapist needs a gadget that can automatically flex and extend patients who have recently undergone knee surgery. To be able to do that, some researchers with a biomedical engineering background have developed a CPM machine that can help with rehabilitation and extend patients who have recently undergone knee surgery. To be able to do that, some researchers with a biomedical engineering background have developed a CPM machine that can help with rehabilitation. This development can be done by an integrating software, mechanical, and electronic systems to build a machine that can help rehabilitation. The automatic CPM therapeutic system can be made using a microcontroller, H-bridge, ADC, and a DC motor (Saputra & Iskandar, 2011). There are many projects that had been done to develop and built a CPM machine.

Besides that, most of the development use almost the same mechanical fabrication and motion system with different method of control and software system. An ET ARM7-LPC2138 from Philips was employed as a microcontroller (Saputra & Iskandar, 2011). This paper shows the system used an ARM7 type microcontroller that was distributed by Philips to build a control system. Another project used a master-slave control system that used an ARM9 microcontroller as a master and an Arduino Nano as a slave for their system. A friendly ARM Micro 2440 Stamp Module with 400 MHz Samsung S3C2440 ARM9