CHAPTER 1

INTRODUCTION

1.1 Background

The anatomy of the hand is complicated and interesting. Its uniqueness is absolutely essential for our daily routine. The function of upper limb especially the hand in normal human daily activity includes light activity such as opening a door by squeezing the doorknob, and heavy activity such as lifting heavy box and transporting it to another place. Hand functions are classified into prehensile (grasping or gripping) and non-prehensile (non-grasp) like pushing and lifting (Napier, 1956). Of all human physical activities none is more important than gripping that generally employs a combination of hand-wrist-forearm movements (Adams, 2006; Imrhan, 2006).

Gripping is one of the hand activities that involves the movement of approximately 35 muscles in the forearm and hand. During gripping activities, the muscles of the flexor mechanism in the hand and forearm create grip strength while the extensors of the forearm stabilize the wrist (Waldo, 1996). There are two types of gripping namely, power grip and precision grip. For the power grip, the object is pressed against the palm of the hand for the generation of force by the fingers and thumb (Napier, 1956) as depicted in Figure 1.1(a). For the precision grip, the object is manipulated between the thumb and the fingertips in a fine movement without the involvement of the palm (Napier, 1956) as depicted in Figure 1.1(b). Power grip is commonly used as an index to assess impairment and treatment outcome of hand function (Talsania and Kozin, 1998).

Figure 1.1. Example of gripping. (a) Power grip. (b) Precision grip.
(Source: Napier, 1956)
The capability of muscular force during power grip can be evaluated in terms of Hand grip Strength (HGS) and Hand grip Endurance (HGE). The HGS is typically examining maximum force during a single repetition. Meanwhile the HGE is examining activities that refers to the ability of maintaining a constant desired force over time (Nicolay and Walker, 2005). There are two types of movements that are associated with HGE which are dynamic or repetitive (HGEd) and static (HGEs) movements. An example of HGEd is typing using the typewriter, while carrying a furniture is an example for HGEs.

It is important to study both HGS and HGE due to the increasing prevalence of Cumulative Trauma Disorders (CTDs) such as carpal tunnel syndrome, strained muscle, tendonitis, rheumatoid arthritis and many others. Evaluation of HGS and HGE may help to identify individuals at risk of CTDs and improvement of treatment and rehabilitation processes (Robertson et al., 1996). In addition, due to the importance of gripping in many daily activities, HGS is often used in several fields for example, in medical, as an indicator of overall physical strength and health (Boissy et al., 1999; Chilima and Ismail, 2001; Pieterse et al., 2002; Massy-Westropp et al., 2004; Kaburagi et al., 2011) and medical therapy for rehabilitation and recovery (Bohannon, 2001) as well as sports that involves hand performance such as tennis and weightlifting (Fry et al., 2006; Lucki and Nicolay, 2007). The information of HGS can also be used in designing ergonomic hand tools (Nicolay and Walker, 2005; Imrhan, 2006). Other study that focuses on women health, states that normal grip strength is highly related to normal bone mineral density in postmenopausal women (Kärkkäinen et al., 2009) and they suggest that grip strength is a potential screening tool for women at risk of osteoporosis (Di Monaco et al., 2000).

1.2 Problem Statements

There are many studies which have been done to investigate the correlation of socio-demographic variables, for example, age, gender, BMI, occupation and ethnics with hand grip strength (Nicolay and Walker, 2005; Bandyopadhyay, 2008; Koley and Singh, 2009; Wu et al., 2009). Similar studies on factors that influenced hand grip strength, which are, hand dominance, gender, occupation, height and weight have also been done on Malaysian population, (Kamarul et al., 2006b; Moy et al., 2011; Hossain et al., 2012). Comparing the studies between Asian and Western populations indicate the studies using Western based data do not necessarily applies to Malaysian population as reported (Kamarul et al., 2006a).

Those studies concluded that Western norm of hand grip strength measurement were different to the Asian people, since the hand dimension of Asian were slightly smaller that Westerners. Furthermore there are many studies which have been done to check the relationship such as demographic factors with HGS. This has been used as a predictive factor for rehabilitation and recovery. However there is lack of evidence showing the relationship of
demographics and hand anthropometric dimensions to HGE which is considered to be factors for hand rehabilitation and recovery. And to narrow down, there is lack of study for Malaysian population that has been done to investigate the influences of demographic hand anthropometric dimensions to HGS and HGE.

Hence, the need of study arises due to the lack of study in Malaysian population. This study is conducted to investigate two main points. Firstly is the relationship between HGS and demographic data as well as anthropometric of hand dimensions. The second study is the relationship between HGE and demographic data as well as anthropometric of hand dimensions. And this study is constrained to Malaysian women population only. In the process of this investigation the hand grip strength, hand gripping system is designed for Asian hand size. In addition, the HGS and HGE data analysis for Malaysian population are compared with the Western population based study.

This study is useful for post hand surgery rehabilitation tracking. For example, a carpal tunnel syndrome patient will undergo rehabilitation process to regain their grip strength and endurance back to his or her original level. However, the actual level cannot be determined since the patient whom admitted for surgery has a compromised hand function. Due to that motivation, there need such model of HGS and HGE to predict his or her normal level of grip strength based on Asian population.

1.3 Objectives
By referring to the problems explained in Section 1.2, this research focuses on developing models that can be used to predict HGS and HGE using demographic and hand anthropometric dimensions information of young Malaysian female.

The objectives of the research are listed as follows:

1) To develop a electronic hand grip strength measuring system that records and analyze the HGS and HGE time series signals.
2) To determine the correlation between demographic and hand anthropometric dimensions, and the HGS as well as HGE of young Malaysian female.
3) To develop an intelligent predictive model of HGS and HGE.