Faculty of Mechanical and Manufacturing Engineering Technology

DESIGN AND DEVELOPMENT AN ERGONOMIC HAND WRIST SUPPORT FOR COMPUTER MOUSE USER

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A thesis submitted
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ABSTRAK

Dalam kehidupan seharian, komputer memainkan peranan penting di dunia. Komputer digunakan untuk melakukan semua jenis kerja sama ada di pejabat, industri atau di rumah.. Salah satu kecederaan kerja muskuloskeletal yang paling biasa adalah sindrom carpal tunnel (Schneider and Irastorza, 2010). Sindrom Terowong Carpal adalah kesakitan biasa di kalangan pengguna tetikus dan ini berlaku kerana kerja yang menggunakan komputer dilakukan berulang kali dan berterusan sepanjang masa. Objektif kajian ini adalah untuk menentukan sindrom carpal tunnel di kalangan pengguna komputer menggunakan tinjauan, untuk merancang sokongan pada pergelangan tangan yang ergonomik dan untuk membangunkan sokongan pada pergelangan tangan yang ergonomic. Satu kaji selidik akan dijalankan terhadap 100 pengguna tikus untuk mengenal pasti masalah yang akan membawa kepada kejadian CTS. Dalam penyelidikan yang dijalankan, produk direka sebagai sokongan pada pergelangan tangan untuk mencegah terjadinya CTS apabila tetikus komputer beroperasi dalam jangka waktu yang lama. Produk ini direka berdasarkan sudut sesuai untuk pergelangan tangan bagi mengelakkan CTS. Proses reka bentuk dan pembangunan ini bermula dengan soal selidik yang bertujuan untuk mendapatkan data mengenai sindrom carpal tunnel dan juga untuk mendapatkan reka bentuk produk berdasarkan keperluan pelanggan. Selanjutnya, proses menganalisis data juga dilakukan menggunakan rumah kualiti (HOQ) dan seterusnya carta morfologi telah dibangunkan untuk mendapatkan reka bentuk konsep sesuai dengan keperluan pengguna. Dari carta morfologi, kaedah Pugh juga digunakan untuk mengenal pasti reka bentuk terbaik di antara reka bentuk konsep yang telah dicipta. Selepas itu, prototaip produk itu dibuat dari bahan nilon menggunakan Selective Laser Sintering (SLS), dan akhirnya perbandingan dibuat antara produk pergelangan tangan baru dan produk sedia ada yang dipasarkan untuk menganalisis sudut terbaik antara kedua-dua produk.

ABSTRACT

In everyday life, computers play an essential role in the world. Computers are used to do all types of work whether in office, industry or at home. Though computer work has relatively little physiological demand, reports of adverse health effects have increased due to extended computer use. This study focuses only on Carpal Tunnel Syndrome(CTS) that occurs among mouse users. One of the most common musculoskeletal occupational injuries is carpal tunnel syndrome (Schneider and Irastorza, 2010). Carpal Tunnel Syndrome is a common pain among mouse users and this happens because the work that uses the computer is done repeatedly and continuously all the time. The objective of this study was to determine carpal tunnel syndrome among computer users using survey, to design an ergonomic hand wrist support and to develop an ergonomic hand wrist support. A survey will be conducted against 100 mouse users to identify problems that will lead to the occurrence of CTS. In research carried out, a product is designed as a hand wrist support for preventing the occurrence of CTS when a computer mouse is operating over a long period of time. The product is designed based on the suitable angle for hand wrist to avoid CTS. This design and development process begins with a questionnaire aimed at obtaining data on carpal tunnel syndrome and also to obtain a design of the product based on customer need. Subsequently, the process of analyzing the data was performed using house of quality (HOQ) and subsequently morphological was developed to obtain the concept design to suit the needs of the user. From the morphological chart, the Pugh method is also used to identify the best design among the concept design that have been created. After that, the prototype of the product was made from nylon material using Selective Laser Sintering (SLS), and finally a comparison was made between the new product of hand wrist support and the existing product marketed to analyze the best angle between the two products.

DEDICATION

Alhamdulillah

Praise to Allah SWT

Thanks to

My only

Appreciated Father and Beloved Mother,

For giving me moral support, money, cooperation and encouragement.

Remember my supervisor who taught me a lot

Thank You So Much

&

I Love You

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CTS	Carpal Tunnel Syndrome
SLS	Selective Laser Sintering
MSD	Musculoskeletal Disorders
RSI	Recurrent Stress Injury
CTD	Cumulative Trauma Disorder
GMA	General Morphological Analysis
HOQ	House Of Quality
PM	Pugh Matrix
CAD	Computer-Aided Design
FDM	Fused Deposition Modeling
FEA	Finite Element Analysis
KG	Kilograms
STL	Standard Triangle Language
CO2	Carbon Dioxide

CHAPTER 1

INTRODUCTION

This chapter explains about the background of the study and the current background of the carpal tunnel syndrome. The problem statement explains briefly about the CTS problem toward computer mouse user. Objective and scope of this report also stated in this chapter. This case study was conducted at Universiti Teknikal Malaysia Melaka (UTeM). Analysis will be done by using Solidwork Simulation on the new product to find the stress and strain of the product. This study is focusing on design and develop an ergonomic hand wrist support for computer mouse user.

1.1 Background Research

In everyday life, computers play an essential role in the world. Computers are used to do all types of work whether in office, industry or at home. Though computer work has relatively little physiological demand, reports of adverse health effects have increased due to extended computer use. Several research studies have shown that computer users have high prevalence of work-related musculoskeletal disorders (Tittiranonda et al., 1999; Buckle and Devereux, 2002; Gerr et al., 2004; Andersen et al., 2011). A number of feeds affecting soft tissue structures including tendons, ligaments, cartilage, muscles and nerves of musculoskeletal disorders (MSDs). Musculoskeletal disorder focuses on several parts, including the upper limbs of the hand, wrist, elbow, arm, shoulder and neck. Occupational MSDs include several different names, including recurrent stress injury (RSI), cumulative trauma disorder (CTD), recurrent motion disorders, and excessive shaking. (NCR/IOM,

2001) found that Work - related MSDs are a significant burden on public health. According to (Schlossberg et al., 2004; Levanon et al., 2012) Many studies have investigated methods to reduce computer related musculoskeletal pain. Preventative strategies are effective, including customizing individual reuse equipment, using ergonomic keyboards and regular rest.

This study focuses only on Carpal Tunnel Syndrome(CTS) that occurs among mouse users. One of the most common musculoskeletal occupational injuries is carpal tunnel syndrome (Schneider and Irastorza, 2010). Carpal Tunnel Syndrome is a common pain among mouse users and this happens because the work that uses the computer is done repeatedly and continuously all the time. As identified by (Rempel et al., 1997, 1998; Fung et al., 2007; Keir et al., 2007) Computer usage features that are believed to be associated with an increased CTS risk are non - neutral wrist and forearm posture, repetitive and lasting hand loading while use of the keyboard and mouse. (Rempel et al., 1997, 1998; Keir et al., 1999; Rempel et al., 2008; Keir et al., 1998) also mentioned an intrinsic increase in carpal tunnel pressure is the common mechanism underlying these functions. (Lundborg et al., 1982) showed that external pressure over the palmar wrist region can also increase the carpal tunnel pressure. Based on the ideas of (Wigley, 2004) this will cause carpal tunnel syndrome to occur when the hand controls the mouse and indirectly touches the hands touching the table.

In addition, an incorrect hand posture on mouse is also a factor that will contribute to carpal tunnel syndrome. Factors that incorrectly contribute to the posture problem are lack of education or proper posture extension, inactive lifestyle, muscle weakness and non-ergonomic workstation. According to today's human lifestyle, CTS problems are increasing daily and this is due to the incorrect posture of hand on the computer. (Mital and Kilbom, 1992; Punnett and Wegman, 2004) specified that the use of arms and hands in an awkward position and frequent hand wrist motions are linked to pain and discomfort. Similarly, (Armstrong and Chaffin, 1979; Tanaka et al., 1995) stated that in many professions, flexion, extension, and radial and ulnar wrist deviation are associated with carpal tunnel syndrome (CTS).

A product of hand wrist support has been designed to help people to reduce problem with the carpal tunnel syndrome while using the computer mouse. (Hoe et al., 2012) claims that It is expected that improving ergonomic factors such as tool and equipment design, work environments or both, and training workers in ergonomic principles will reduce the risk of developing MSDs. (Kadefors et al., 1993a; Sperling et al., 1993) highlights hand tool redesign plays an important role in loosening manual work requirements and controlling task problems involving the use of hands and forearms and improving user satisfaction.

1.2 Problem Statement

Lately, the problem of Carpal Tunnel Syndrome (CTS) among computer users has recently increased, especially among university students or office workers who often face computers. The most common cause of Carpal Tunnel Syndrome (CTS) was pain in the soft tissues (muscles, tendons, and ligaments), which usually occurs as a result of an acute (sudden) or a chronic (long-term) muscle strain. body, and more easily injured. First problem was, the space of the mouse located also plays a key role in ensuring comfort and no pain in the hand wrist. Besides that, the non - ergonomic design of the mouse will also contribute to the Carpal Tunnel Syndrome (CTS) factor. Then, the wrong position of hand posture on the mouse also affects the movement of the finger because the finger movement causes the nerves movement of the hands

1.3 Objective

I. To determine carpal tunnel syndrome among computer user using survey.

II. To design an ergonomic hand wrist support.

III. To develop an ergonomic hand wrist support.

1.4 Scope

This study is focusing on Carpal Tunnel Syndrome (CTS) among computer mouse user and will be done only in Universiti Teknikal Malaysia Melaka(UTeM) A survey has been conducted against 100 mouse users to identify problems that will lead to the occurrence of CTS. In research carried out, a product is designed as a hand wrist support for preventing the occurrence of CTS when a computer mouse is operating over a long period of time. The product is designed based on the suitable angle for hand wrist to avoid CTS and Solidwork simulation is used to analyze the new product by identifying the stress and strain in the product structure. A comparison between new product of hand wrist support and product already in the market will be done to see the best angle between the two products.

1.5 Expected Outcome

The expected outcome of the research program to provide understanding to computer mouse users about the dangers of carpal tunnel syndrome that occurs if the hand posture when holding the mouse is not in the correct condition. Designing a hand wrist support that would help the user to maintain a computer mouse over a long period of time without any pain in the wrist section. Lastly, this product will be able to provide users with correct posture when using computer mouse.

CHAPTER 2

LITERATURE REVIEW

2.1 Ergonomic Knowledge

Ergonomics is commonly known as the task for the person. This definition, albeit simple, provides the basic directive on ergonomics in which task or work requirements are adapted to the employee's capabilities. As explained by (Pheasant, 2003) ergonomics is the knowledge to fit a worker and a product for a user. Other definitions describe the equilibrium or the corresponding human and labor capabilities. While ergonomics in modern definition are The scientific discipline concerned with the low standing of interactions between men and other elements of a system and the profession which is designed to optimize human welfare and system performance in theory, principles, data and techniques. Therefore, ergonomic posture is also important to ensure comfort during work. (Burgess-Limerick, 1999; Jensen, 1998; Karlqvist et al., 1998; Sjøgaard and Søgaard, 1998) found that in particular, prolonged use of the mouse is linked to ergonomic risk factors including long muscle load and non - neutral postures associated with extremely extreme ulnar deviation, wrist extension and forearm pronation.

2.1.1 Ergonomic Design

Ergonomic design is becoming omnipresent common in our society and this trend is evident in design activities. According to (Fan et al., 2019) ergonomic design is used to solve health problems in discomfort and disease on the basis of anthropometric human data. (Ball, 2011; Lacko et al., 2017, Peres et al., 2017) also mentioned the categorization of measurements and products is considered as an effective method for determining human body shapes and ergonomic design risks and facilitating data matching for different product types. Main component analysis is frequently used in the analysis of the features of human design, which have been shown to resolve engineering design problems effectively. Similarly, (Fan et al., 2019) stated that The principal part analysis is frequently used to deal with human related design feature analysis which has been shown to resolve engineering problems, the recognition of human body, anthropometrical analysis and ergonomic design issues effectively.

2.1.2 Anthropometry Data

The field of anthropometry concerns measurements of body. As explained by (Pheasant, 2003; Nowak, 1996) It is closely related to human physical characteristics in different circumstances, in particular with the measurement of body size, shape, strength and ability to work. Similarly, (Mandahawi et al., 2008; Kar et al., 2003; Okunribido 2000). Jung et al. (2000) stated that a very significant department of ergonomics is described as anthropometry as misalliances between anthropometric dimensions and dimensions of equipment may result in discomfort, productivity plunge, accidents, biomechanical stress, fatigue, injury and cumulative trauma. The anthropometry data will be useful for product designers in order to design and develop ergonomic products that will cater to the special needs of Malaysian people. There are two types of anthropometric information, including information about structures and functions. Structural or static anthropometric information is linked in a fixed structural position to a body size and is normally measured in some position by marked anatomical points. The second type of anthropometric information, comprised of measures of limit access and measured in practical conditions, is anthropometric function or dynamic information (Tavana, Kazemi, Vafadarnikjoo, & Mobin, 2016).

Table 2.1: Anthropometry Data of Malaysian People (Jee et al., 2016)

No	Dimension	Male ($n = 56$)				Female ($n = 56$)			
		Mean	SD	5th pct	95th pct	Mean	SD	5th pct	95th pct
1.	Weight (in kg)	63.0	17.0	49.5	79.1	60.8	12.2	49.4	84.6
2.	Stature	1611	5.0	1529	1685	1499	5.3	1405	1593
3.	Eye height, standing	1499	4.9	1425	1566	1387	5.1	1321	1449
4.	Shoulder height	1336	4.7	1258	1401	1236	4.7	1175	1295
5.	Elbow height	984	6.3	891	1060	918	4.6	835	979
6.	Knee height, mid-patella	462	2.9	421	504	451	3.4	391	505
7.	Calf height	408	3.2	355	453	366	5.8	284	446
8.	Span	1644	7.0	1514	1738	1509	7.2	1364	1630
9.	Elbow span	820	5.5	701	899	744	7.1	560	822
10	Shoulder breadth, standing	393	3.6	342	453	366	2.4	322	400
11.	Wrist-wall length, extended	707	9.7	565	867	695	14.7	513	875
12.	Sleeve inseam	420	3.1	366	478	377	3.2	322	420
13.	Elbow−elbow breadth	439	5.5	346	529	422	6.5	306	516
14.	Sitting height	821	3.9	746	865	756	3.5	706	818
15	Eye height, sitting	708	4.0	648	761	650	4.2	594	734
16.	Acromion height, sitting (shoulder height sitting)	550	3.3	494	599	496	3.7	450	559
17.	Arm reach upward	1216	6.7	1100	1321	1099	6.4	977	1195
18	Forearm-hand length	449	2.0	416	480	419	3.4	357	466
19	Shoulder-elbow length	331	2.2	300	357	313	2.6	275	346
20	Hip breadth, sitting	345	3.7	288	405	330	3.9	272	386
21.	Hand length	183	1.0	166	197	170	0.8	157	186
22.	Wrist-index finger length	169	1.0	156	185	158	1.0	145	177
23.	Index finger breadth, proximal	18	0.1	16	20	16	0.3	14	18
24.	Foot length	240	1.2	219	263	223	1.3	208	246
25.	Foot breadth, horizontal	98	0.7	87	109	87	0.8	74	101
26.	Heel breadth	62	0.6	54	73	55	0.7	43	65
27.	Head breadth	143	1.4	120	161	128	1.5	107	148
28.	Interpupillary breadth	65	0.6	55	75	64	0.7	50	72
29.	Elbow circumference, straight	258	1.9	229	289	248	3.0	203	304
30.	Forearm circumference, flexed 90°	260	3.1	200	303	235	3.8	168	287
31	Wrist circumference	169	1.3	142	186	156	1.3	138	179
32.	Hand circumference	201	1.4	181	221	178	1.2	155	198
33.	Thumb circumference	74	0.5	68	82	65	0.5	58	72
34.	Index finger circumference	66	0.5	58	73	58	0.4	52	66
35.	Middle finger circumference	67	0.6	56	76	59	0.5	52	68

2.1.3 Hand dimension

(Jee et al., 2016) found that the body measurements used in this study were taken from the National Technology and Standards Measurement Agency's Size Korea Project, that is an anthropometric survey institution in the Republic of Korea. A total of 321 participants were measured with an average age of 42.5 and 46.5, consisting of 167 males and 154 females. In Korea, all the subjects were born and raised.

There were four variables in the measurements: hand length, hand width, hand thickness and hand circumference. (Aboul-Hagag, Mohamed, Hilal, & Mohamed, 2011) demonstrated the length of the hand (HL) is the distance from the middle of the inter - stylion to the middle finger tip, and the width of the hand (HB) is the distance from the lateral point