CHAPTER IV

DATA COLLECTING AND PROCESSING

4.1. Data Collection

The data collection in this study include the respondent's profile, and EMG signal which has been recorded.

4.1.1. Respondent Profile

The respondent's profile was obtained through direct demographic questionnaire with the purpose to acquire the qualified respondents based on the criteria. Table 4.1 shows the summary of respondent profile.

Table 4.1. Respondent Profile

No	Characteristics		Percentage
1	Gender	Male	50%
		Female	50%
2	Age	20	14.3%
		21	42.9%
		22	35.7%
		23	7.1%
	Average (Std. Deviation)		21.35 ± 0.8
3	Computer Usage	3-6 Years	21.43%
		> 6 Years	78.57%

No	Characteristics		Percentage
4	Computer Usage Duration /Week	15-20 Hours	42.86%
		>20 Hours	57.14%
5	Dominant Hand	Left	0%
		Right	100%
6	Wrist Medical History	Yes	0%
		No	100%

Based on the summary on table above, it can be seen that the gender ratio is equal (7 male, 7 female). The minimum age is 20 and the maximum age is 23 with mean of 21.35. They have been using the computer for minimum 6 months with median duration per week for minimum 15 hours, thus, all of the respondents are categorized as proficient in using computer. Electromyograph will record the wrist muscle activity on the right hand, and all of the respondents are right-handed, which are homogenous, and none of them had wrist medical history based on questionnaire, interview, and physical examination.

4.1.2. EMG Processed Signal

This study uses Logger Pro software (Vernier) to record and process the data. The software will display the filtered, rectified, and smoothed data as the recording begins. The sample frequency was set to 500 Hz, which means there will be 500 data per second and 150000 data for one experiment (5 minutes). The filter will cut off frequencies which considered as noise and set into 10-500 Hz. The data then being rectified to avoid the mean value of zero, and the data will be smoothed with 100 ms and display the mean power of the signal called RMS.

a. *Flexor Digitorum Superficialis* at 0˚

Figure 4.1 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 0˚ wrist posture for five minutes experiment. The vertical line shows the muscle contraction in millivolt where the horizontal line shows the observation time. As for the mean of muscle contraction on each experiment were shown in appendices part E.

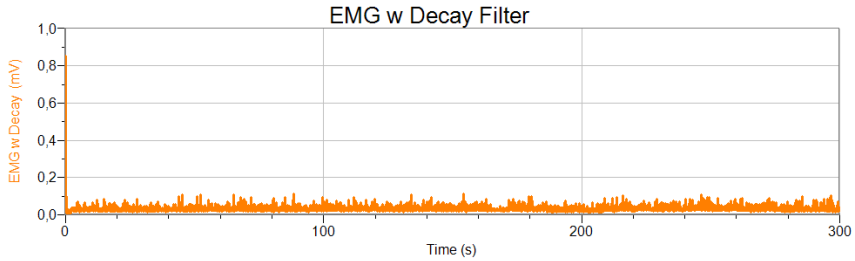

Figure 4.1. FDS EMG Signal at 0˚

b. *Flexor Digitorum Superficialis* at 10˚ Extension

Figure 4.2 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 10˚ extension wrist posture for five minutes experiment.

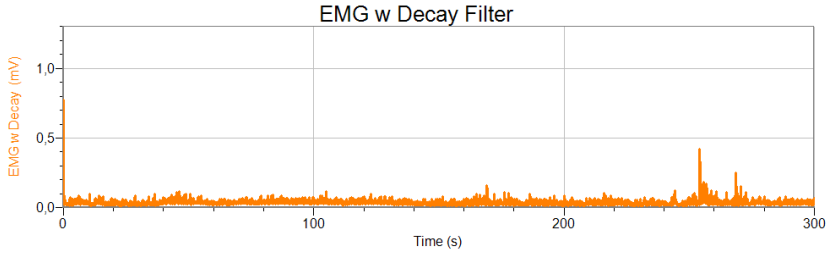

Figure 4.2. FDS EMG Signal at 10˚ Extension

c. *Flexor Digitorum Superficialis* at 20˚ Extension

The processed EMG signal of *Flexor Digitorum Superficialis* at 20˚ extension wrist posture for five minutes experiment is shown in Figure 4.3 below.

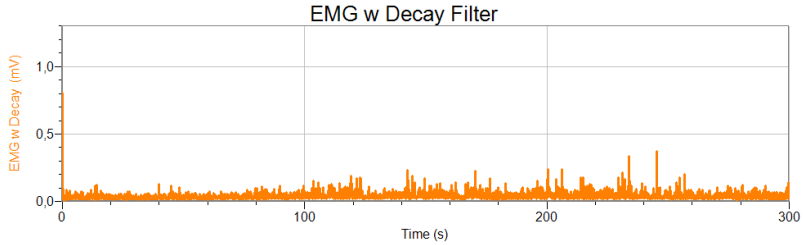

Figure 4.3. FDS EMG Signal at 20˚ Extension

d. *Flexor Digitorum Superficialis* at 30˚ Extension

Figure 4.4 below illustrates the EMG signal of *Flexor Digitorum Superficialis* at 30˚ extension wrist posture for five minutes experiment.

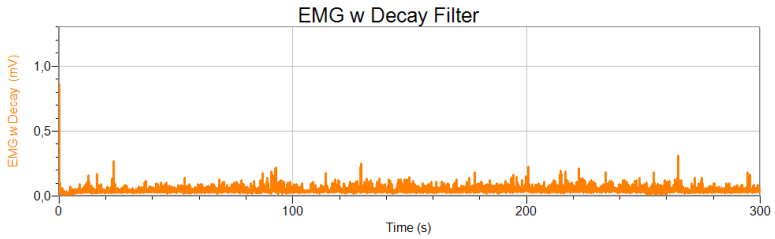

Figure 4.4. FDS EMG Signal at 30˚ Extension

e. *Flexor Digitorum Superficialis* at 40˚ Extension

Figure 4.5 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 40˚ extension wrist posture for five minutes experiment. The graph shows higher muscle contraction compares with other lower angle inclination in extension posture.

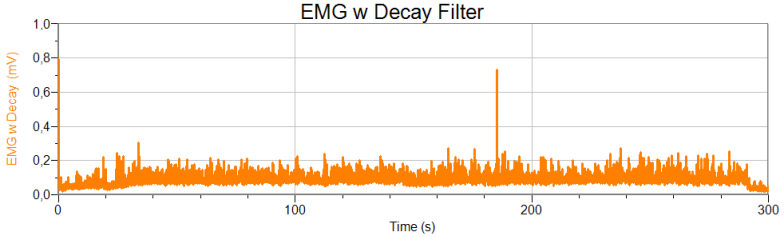

Figure 4.5. FDS EMG Signal at 40˚ Extension

f. *Flexor Digitorum Superficialis* at 10˚ Flexion

Figure 4.6 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 10˚ flexion wrist posture for five minutes experiment.

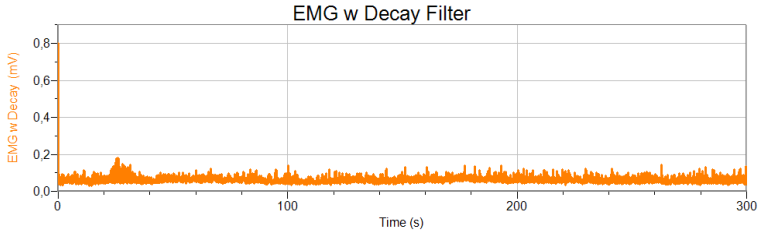

Figure 4.6. FDS EMG Signal at 10˚ Flexion

g. *Flexor Digitorum Superficialis* at 20˚ Flexion

The processed EMG signal of *Flexor Digitorum Superficialis* at 20˚ flexion wrist posture for five minutes experiment is shown in Figure 4.7 below.

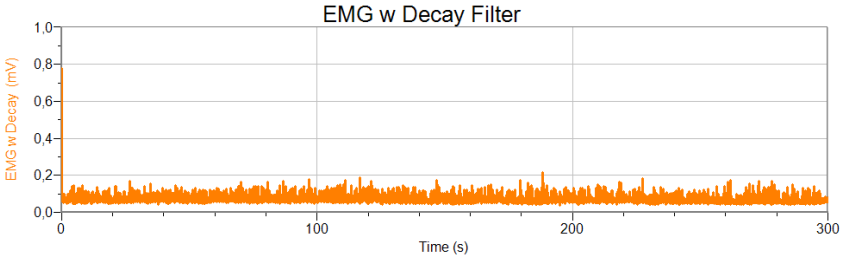

Figure 4.7. FDS EMG Signal at 20˚ Flexion

h. *Flexor Digitorum Superficialis* at 30˚ Flexion

Figure 4.8 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 30˚ flexion wrist posture for five minutes experiment. The increase muscle contraction already can be seen in the graph compared with the previous angle inclination.

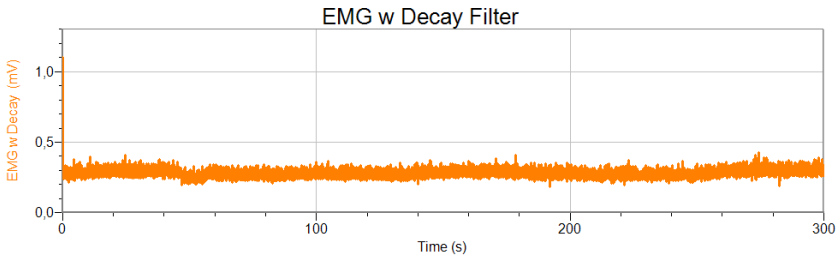

Figure 4.8. FDS EMG Signal at 30˚ Flexion

i. *Flexor Digitorum Superficialis* at 40˚ Flexion

Figure 4.9 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 40˚ flexion wrist posture for five minutes experiment.

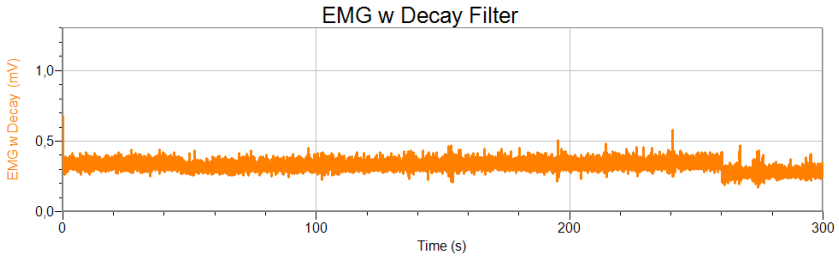

Figure 4.9. FDS EMG Signal at 40˚ Flexion

j. *Flexor Digitorum Superficialis* at 10˚ Ulnar

Figure 4.10 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 10˚ ulnar wrist posture for five minutes experiment.

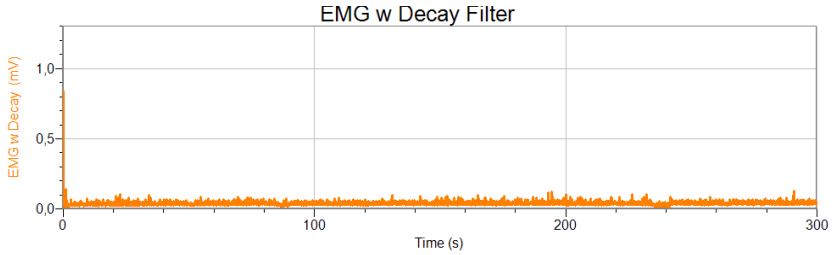

Figure 4.10. FDS EMG Signal at 10˚ Ulnar

k. *Flexor Digitorum Superficialis* at 20˚ Ulnar

Figure 4.11 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 20˚ ulnar wrist posture for five minutes experiment.

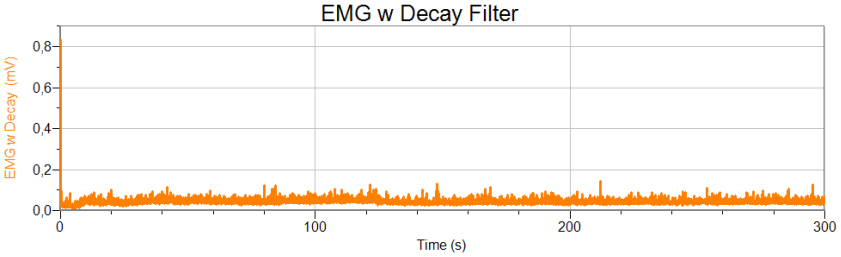

Figure 4.11. FDS EMG Signal at 20˚ Ulnar

l. *Flexor Digitorum Superficialis* at 30˚ Ulnar

Figure 4.12 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 30˚ ulnar wrist posture for five minutes experiment. The increase muscle contraction already can be seen in the graph compared with the previous angle inclination.

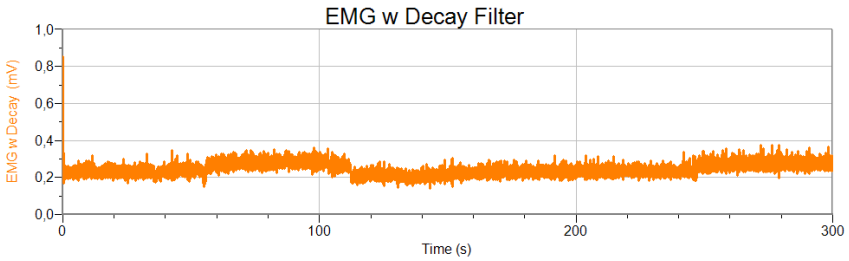

Figure 4.12. FDS EMG Signal at 30˚ Ulnar

m. *Flexor Digitorum Superficialis* at 10˚ Radial

The processed EMG signal of *Flexor Digitorum Superficialis* at 10˚ radial wrist posture for five minutes experiment is presented in Figure 4.13.

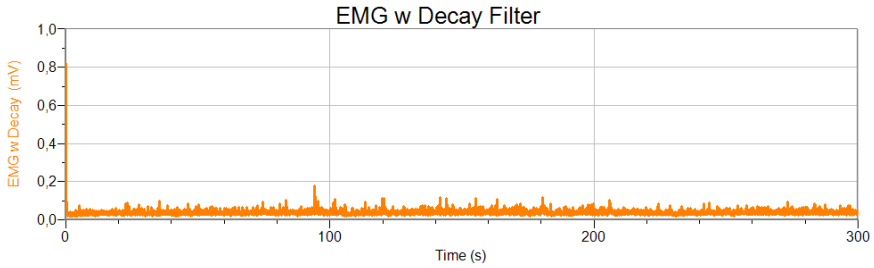

Figure 4.13. FDS EMG Signal at 10˚ Radial

n. *Flexor Digitorum Superficialis* at 20˚ Radial

Figure 4.14 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 20˚ radial wrist posture for five minutes experiment.

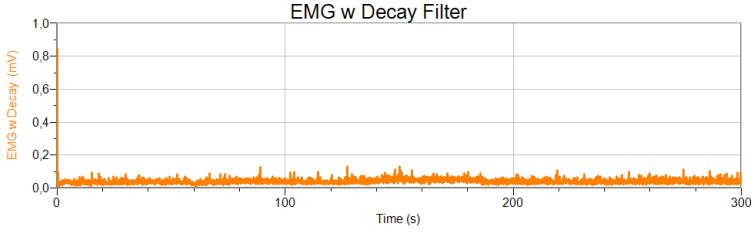

Figure 4.14. FDS EMG Signal at 20˚ Radial

o. *Flexor Digitorum Superficialis* at 30˚ Radial

Figure 4.15 below represents the processed EMG signal of *Flexor Digitorum Superficialis* at 30˚ radial wrist posture for five minutes experiment.

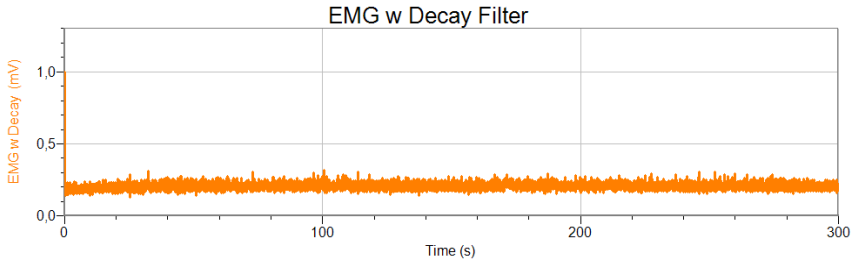

Figure 4.15. FDS EMG Signal at 30˚ Radial

p. *Flexor Digitorum Superficialis* Maximum Voluntary Contraction

Figure 4.16 below represents the processed EMG signal of *Flexor Digitorum Superficialis* on maximum voluntary contraction. The activity done in obtaining the MVC value is by having manual resistance in kneeling position.

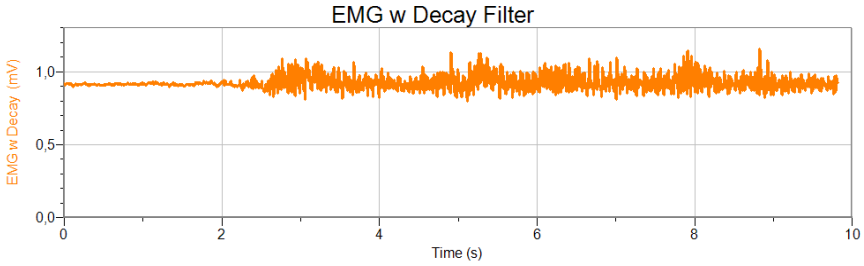

Figure 4.16. FDS EMG Maximum Voluntary Contraction Signal

q. *Abductor Pollicis Brevis* at 0˚

Figure 4.17 below shows the processed EMG signal of *Abductor Pollicis Brevis* at 0˚ wrist posture for five minutes experiment.

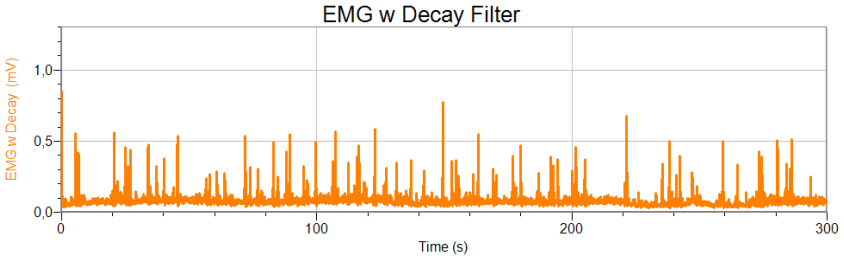

Figure 4.17. APB EMG Signal at 0˚

r. *Abductor Pollicis Brevis* at 10˚ Extension

The processed EMG signal of *Abductor Pollicis Brevis* at 10˚ extension wrist posture for five minutes experiment is shown in Figure 4.18 below.

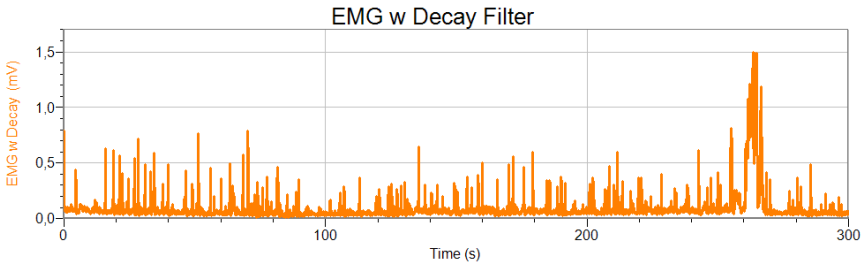

Figure 4.18. APB EMG Signal at 10˚ Extension

s. *Abductor Pollicis Brevis* at 20˚ Extension

Figure 4.19 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 20˚ extension wrist posture for five minutes experiment.

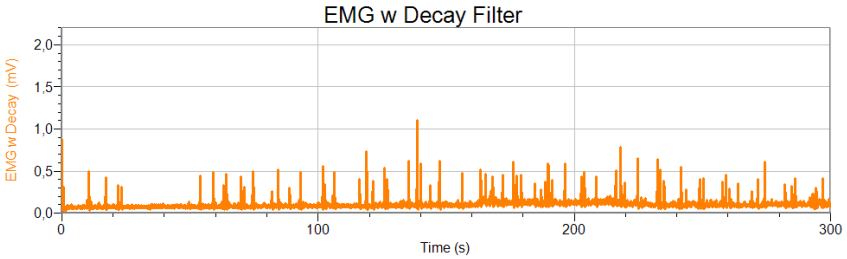

Figure 4.19. APB EMG Signal at 20˚ Extension

t. *Abductor Pollicis Brevis* at 30˚ Extension

Figure 4.20 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 30˚ extension wrist posture for five minutes experiment.

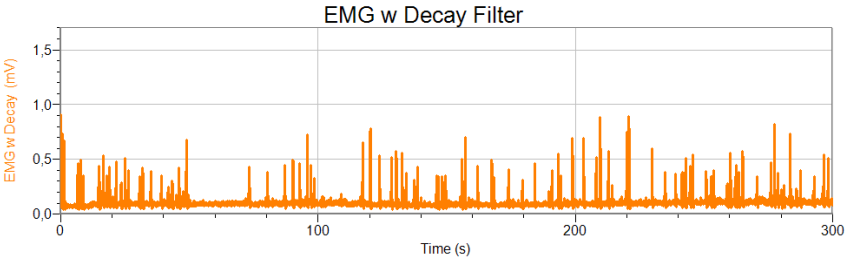

Figure 4.20. APB EMG Signal at 30˚ Extension

u. *Abductor Pollicis Brevis* at 40˚ Extension

Figure 4.21 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 40˚ extension wrist posture for five minutes experiment.

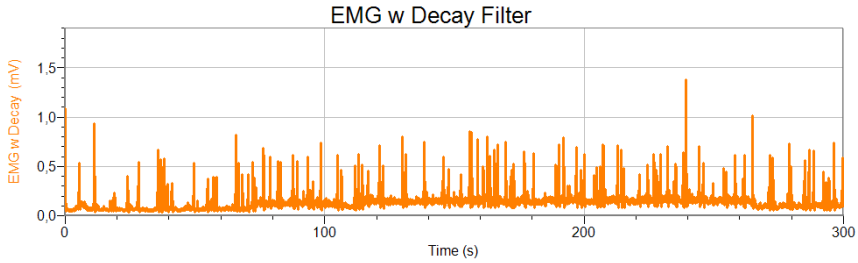

Figure 4.21. APB EMG Signal at 40˚ Extension

v. *Abductor Pollicis Brevis* at 10˚ Flexion

Figure 4.22 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 10˚ flexion wrist posture for five minutes experiment.

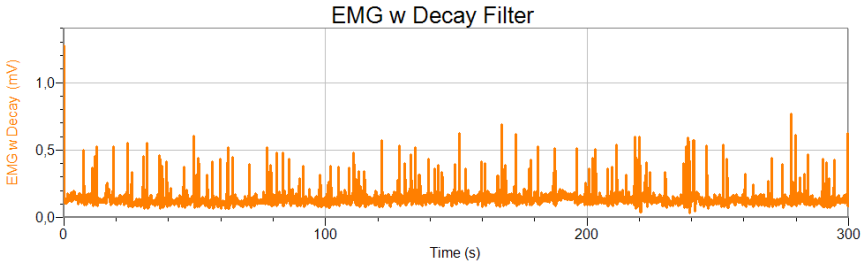

Figure 4.22. APB EMG Signal at 10˚ Flexion

w. *Abductor Pollicis Brevis* at 20˚ Flexion

Figure 4.23 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 20˚ flexion wrist posture for five minutes experiment.

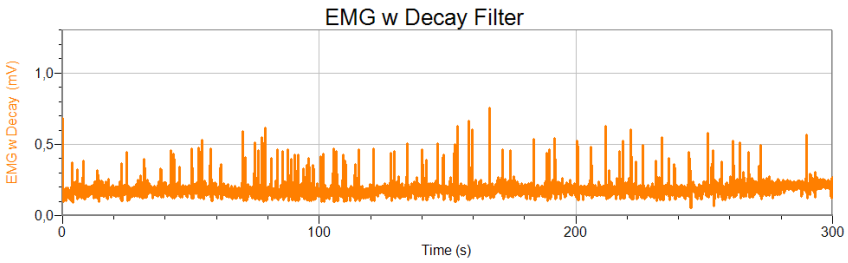

Figure 4.23. APB EMG Signal at 20˚ Flexion

x. *Abductor Pollicis Brevis* at 30˚ Flexion

Figure 4.24 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 30˚ flexion wrist posture for five minutes experiment.

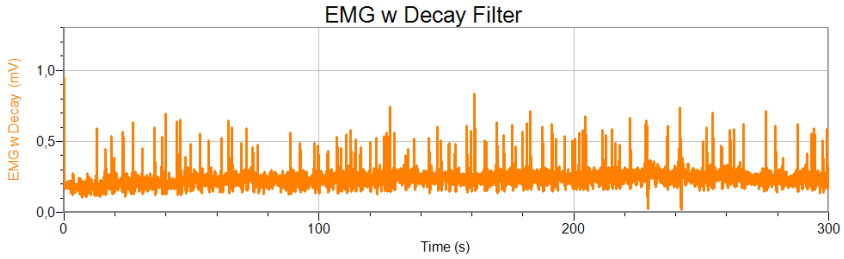

Figure 4.24. APB EMG Signal at 30˚ Flexion

y. *Abductor Pollicis Brevis* at 40˚ Flexion

Figure 4.25 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 40˚ flexion wrist posture for five minutes experiment.

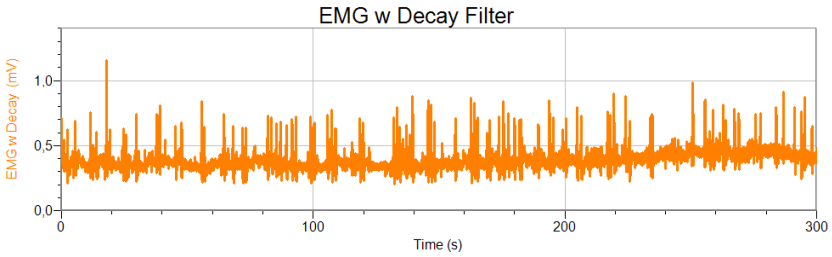

Figure 4.25. APB EMG Signal at 40˚ Flexion

z. *Abductor Pollicis Brevis* at 10˚ Ulnar

Figure 4.26 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 10˚ ulnar wrist posture for five minutes experiment.

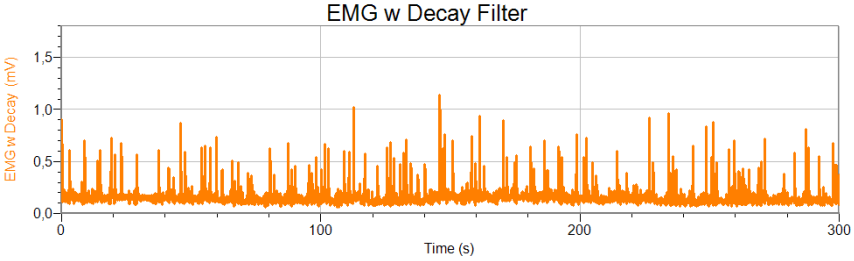

Figure 4.26. APB EMG Signal at 10˚ Ulnar

aa. *Abductor Pollicis Brevis* at 20˚ Ulnar

Figure 4.27 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 20˚ ulnar wrist posture for five minutes experiment.

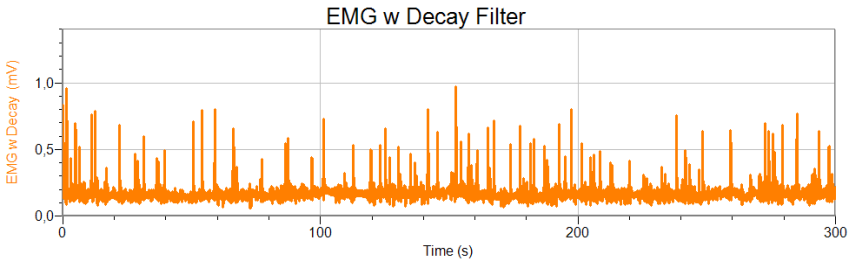

Figure 4.27. APB EMG Signal at 20˚ Ulnar

bb. *Abductor Pollicis Brevis* at 30˚ Ulnar

Figure 4.28 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 30˚ ulnar wrist posture for five minutes experiment.

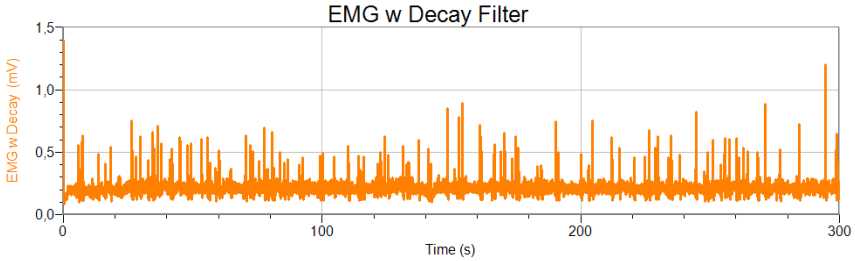

Figure 4.28. APB EMG Signal at 30˚ Ulnar

cc. *Abductor Pollicis Brevis* at 10˚ Radial

Figure 4.29 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 10˚ radial wrist posture for five minutes experiment.

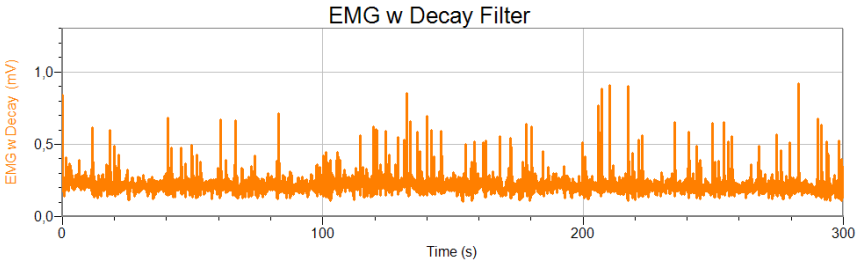

Figure 4.29. APB EMG Signal at 10˚ Radial

dd. *Abductor Pollicis Brevis* at 20˚ Radial

Figure 4.30 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 20˚ radial wrist posture for five minutes experiment.

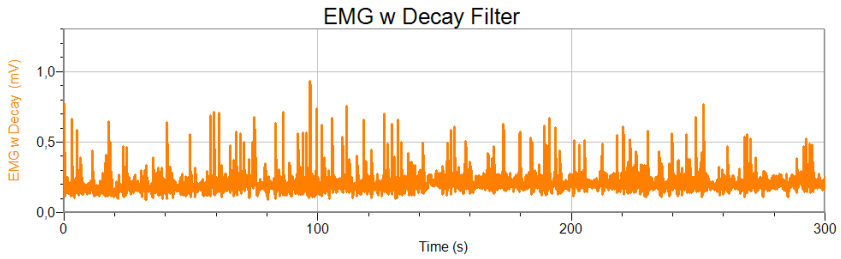

Figure 4.30. APB EMG Signal at 20˚ Radial

ee. *Abductor Pollicis Brevis* at 30˚ Radial

Figure 4.31 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 30˚ radial wrist posture for five minutes experiment.

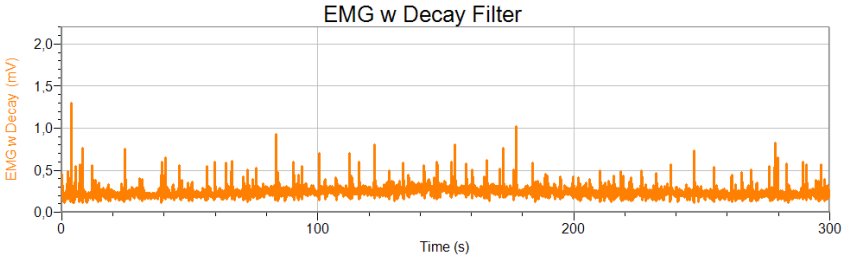

Figure 4.31. APB EMG Signal at 30˚ Radial

ff. *Abductor Pollicis Brevis* Maximum Voluntary Contraction

Figure 4.32 below represents the processed EMG signal of *Abductor Pollicis Brevis* at 30˚ radial wrist posture for five minutes experiment. The same activity done for obtaining MVC value as in FDS muscle, which is by having manual resistance activity by using barbell.

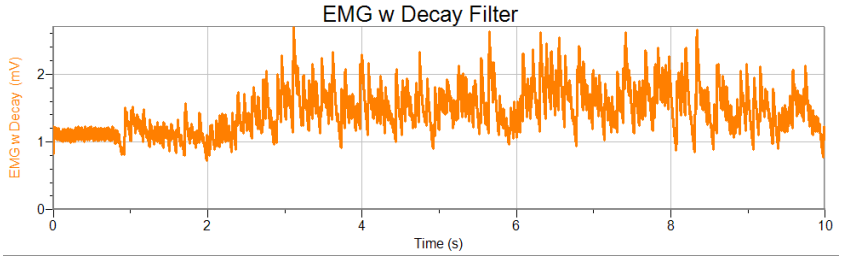

Figure 4.32. APB EMG Maximum Voluntary Contraction Signal

4.1.3. EMG %MVC Normalization

Table 4.2 below shows the recapitulation of percentage of Maximum Voluntary Contraction (%MVC) data on *Flexor Digitorum Superficialis* muscle in fifteen experiments. There are wrist posture of 0°, 10° extension, 20° extension, 30° extension, 40° extension, 10° flexion, 20° flexion, 30° flexion, 40° flexion, 10° ulnar, 20° ulnar, 30° ulnar, 10° radial, 20° radial, and 30° radial. The data will be the input for %MVC analysis and statistical analysis in order to determine the maximum ergonomic wrist posture for typing activity. The %MVC value obtained by dividing each muscle contraction in mV with the Maximum Voluntary Contraction data for each subject. As for the EMG muscle contraction data for both muscles in mV units can be seen in appendices part E.

Table 4.2. *Flexor Digitorum Superficialis* %MVC Data

%MVC Value (%)															
		Angle													
		0°	Ext 10°	Ext 20°	Ext 30°	Ext 40°	Flex 10°	Flex 20°	Flex 30°	Flex 40°	Uln 10°	Uln 20°	Uln 30°	Rad 10°	Rad 20°	Rad 30°
Male	1	7.755	9.817	10.383	13.914	14.316	9.434	13.321	13.668	15.356	10.401	14.772	15.693	14.124	15.283	17.345
	2	7.708	10.322	9.731	18.355	30.634	14.785	30.613	34.753	43.172	11.366	11.796	41.645	12.806	19.043	12.946
	3	4.992	7.615	9.110	18.094	18.764	20.063	20.291	21.394	21.945	6.783	12.629	24.126	11.157	20.850	27.094
	4	3.614	3.819	4.304	5.183	10.181	6.673	7.932	30.552	35.633	4.342	4.833	26.548	4.173	4.296	22.337
	5	10.445	13.043	14.040	36.108	42.248	19.088	19.279	40.636	41.453	12.068	29.639	37.243	22.736	25.217	50.901
	6	6.026	9.186	9.848	21.116	26.033	6.446	8.416	13.463	30.576	10.237	26.631	30.864	8.474	8.639	30.742
	7	5.134	8.433	9.557	11.236	20.713	6.085	13.018	18.105	45.686	6.837	15.100	15.797	8.399	18.802	28.483
	Average (Male)	**6.525**	**8.891**	**9.568**	**17.715**	**23.270**	**11.796**	**16.124**	**24.653**	**33.403**	**8.862**	**16.486**	**27.417**	**11.696**	**16.019**	**27.121**
Female	8	4.383	4.093	4.305	5.248	5.085	4.089	11.106	12.796	14.526	9.305	12.709	14.368	11.722	14.708	17.125

%MVC Value (%)															
		Angle													
		0°	Ext 10°	Ext 20°	Ext 30°	Ext 40°	Flex 10°	Flex 20°	Flex 30°	Flex 40°	Uln 10°	Uln 20°	Uln 30°	Rad 10°	Rad 20°	Rad 30°
	9	8.322	10.632	11.194	19.001	19.848	10.244	12.508	15.223	18.339	9.580	11.292	12.063	10.999	11.542	11.857
	10	7.296	8.538	8.773	24.908	34.166	10.514	30.794	28.810	33.828	10.940	14.651	28.112	13.145	14.181	24.100
	11	13.790	15.836	16.578	39.412	38.322	19.345	35.307	36.317	43.630	18.122	33.189	36.705	16.497	19.245	22.473
	12	2.514	3.100	4.706	4.957	21.471	4.011	5.061	6.790	10.074	5.025	5.734	6.212	4.182	5.196	17.337
	13	14.044	13.639	14.711	16.542	17.532	22.840	23.254	37.767	53.143	17.747	34.102	41.217	19.340	20.634	40.620
	14	3.661	5.866	7.878	14.156	20.087	7.400	5.009	10.122	10.735	7.601	6.859	10.612	5.997	9.326	11.190
	Average (Female)	**7.716**	**8.815**	**9.735**	**17.746**	**22.359**	**11.206**	**17.577**	**21.118**	**26.325**	**11.189**	**16.934**	**21.327**	**11.698**	**13.547**	**20.672**
	Average	**7.120**	**8.853**	**9.651**	**17.731**	**22.814**	**11.501**	**16.851**	**22.885**	**29.864**	**10.025**	**16.710**	**24.372**	**11.697**	**14.783**	**23.896**

Table 4.3 below shows the recapitulation of Maximum Voluntary Contraction percentage data on *Abductor Pollicis Brevis* muscle in fifteen experiments, from wrist posture of 0° neutral to 30° radial. The %MVC obtained as the result of dividing each experiment data with MVC data, as for the EMG muscle contraction data for APB in mV units can be seen in appendices part E.

Table 4.3. *Abductor Pollicis Brevis* %MVC Data

%MVC Value (%)															
		Angle													
		0°	Ext 10°	Ext 20°	Ext 30°	Ext 40°	Flex 10°	Flex 20°	Flex 30°	Flex 40°	Uln 10°	Uln 20°	Uln 30°	Rad 10°	Rad 20°	Rad 30°
Ma	1	5.173	6.411	9.659	14.395	23.873	6.701	8.291	15.480	38.648	6.581	28.938	34.458	14.429	36.173	39.313

%MVC Value (%)															
		Angle													
		0°	Ext 10°	Ext 20°	Ext 30°	Ext 40°	Flex 10°	Flex 20°	Flex 30°	Flex 40°	Uln 10°	Uln 20°	Uln 30°	Rad 10°	Rad 20°	Rad 30°
	2	7.504	7.677	8.222	39.927	41.067	12.893	24.357	25.416	26.750	14.827	25.804	25.602	13.800	21.746	21.180
	3	6.879	12.908	7.789	17.604	23.457	13.991	18.865	25.645	30.519	1.646	28.316	46.246	14.718	19.636	29.659
	4	18.789	20.094	21.164	29.509	39.872	18.257	32.860	32.921	33.116	18.835	24.502	25.552	25.303	30.666	31.844
	5	9.917	12.469	11.682	25.079	30.597	14.872	18.956	24.532	23.869	10.232	10.124	22.320	14.872	20.273	25.750
	6	2.836	2.776	7.990	20.396	22.788	2.093	2.506	9.038	14.376	8.825	6.537	13.573	11.942	15.350	18.892
	7	6.981	7.386	8.824	9.044	11.777	11.709	15.550	20.102	32.843	13.299	14.349	18.071	18.511	17.741	20.271
	Average (Male)	**8.297**	**9.960**	**10.761**	**22.279**	**27.633**	**11.502**	**17.341**	**21.876**	**28.589**	**10.607**	**19.796**	**26.546**	**16.225**	**23.084**	**26.701**
Female	8	14.268	14.426	16.414	17.338	20.225	15.458	17.820	21.797	45.175	18.136	25.374	31.364	14.052	34.584	34.101
	9	6.616	8.034	9.606	10.942	15.680	8.340	16.274	20.265	18.075	14.356	18.746	18.440	11.719	11.519	17.787
	10	5.283	7.826	9.900	14.450	27.242	7.306	9.267	11.942	17.958	5.614	8.425	10.975	5.352	6.953	7.501
	11	8.352	14.369	12.983	22.757	35.186	9.351	27.972	35.638	38.614	13.669	15.244	23.851	15.288	19.949	25.026
	12	4.753	5.861	6.215	10.000	19.240	6.447	8.927	8.390	25.739	5.586	9.818	11.726	6.461	7.971	17.473
	13	5.375	5.747	8.941	23.346	28.318	9.888	15.734	19.303	38.141	6.852	12.918	18.002	13.708	27.147	40.130
	14	3.856	9.565	10.445	27.268	28.134	9.793	13.577	23.349	38.455	3.945	14.526	32.317	10.285	13.722	19.559
	Average (Female)	**6.929**	**9.404**	**10.643**	**18.014**	**24.861**	**9.512**	**15.653**	**20.098**	**31.737**	**9.737**	**15.007**	**20.954**	**10.981**	**17.406**	**23.082**
	Average	**7.613**	**9.682**	**10.702**	**20.147**	**26.247**	**10.507**	**16.497**	**20.987**	**30.163**	**10.172**	**17.402**	**23.750**	**13.603**	**20.245**	**24.892**

4.1.4. EMG Statistical Test Results

In statistical test, the group data will be tested with non-parametric statistical test, which are Kruskal-Wallis and Mann Whitney U Test due to the data was not in normal distribution. Table 4.7 shows that the significance value in normality test was <0.05 (p=0.00). Kruskal-Wallis test performed to know whether there are statistically significant differences between each experiment group and an extension of Mann Whitney U test to identify the difference by comparing two experiment group data.

a. Statistical Test Between Groups (Kruskal-Wallis Test)

This test will compare each experiment group data for both 0˚, 10˚ extension, 20˚ extension, 30˚ extension, 40˚ extension, 10˚ flexion, 20˚ flexion, 30˚ flexion, 40˚ flexion, 10˚ ulnar, 20˚ ulnar, 30˚ ulnar, 10˚ radial, 20˚ radial, and 30˚ radial. The results of the test shown in table 4.4 and 4.5.

Table 4.4. Kruskal-Wallis Test Result of FDS Muscle

Assymp. Sig. (2-tailed)	0.003×10^{-9}

Table 4.4 shows that the asymptotic significance value for FDS muscle is below 0.05 ($0.003 \times 10^{-9} < 0.05$), thus H_0 is rejected means that the %MVC for each experiment angle were differ from one to another.

Table 4.5. Kruskal-Wallis Test Result of APB Muscle

Assymp. Sig. (2-tailed)	0.007×10^{-12}

Table 4.5 above shows that the asymptotic significance value for FDS muscle is below 0.05 ($0.007 \times 10^{-12} < 0.05$), thus H_0 is rejected means that the %MVC for each experiment angle were differ from one to another.

However, the exact group data which gives the significant difference still unknown. Therefore, Mann Whitney U test will be performed to know the difference between 2 groups of samples for each treatment.

b. Statistical Test Between Two Groups (Mann-Whitney U Test)

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 10˚ extension is 70 for the U value and 0.198 for the asymptotic significance value as shown in table 4.6. Both results accepted H_0 which means there is no significance difference between 0˚ and 10˚ extension.

Table 4.6. Mann Whitney Test Result of FDS Muscle between 0˚ and 10˚ Extension

Mann-Whitney U	70
Assymp. Sig. (2-tailed)	0.198

Based on table 4.17 below, the result of Mann-Whitney U Test in FDS muscle between 0˚ and 20˚ extension accepted H_0 which means there is no significance difference between 0˚ and 20˚ extension.

Table 4.7. Mann Whitney Test Result of FDS Muscle between 0˚ and 20˚ Extension

Mann-Whitney U	56
Assymp. Sig. (2-tailed)	0.054

Table 4.8 below shows the result of Mann-Whitney U Test in FDS muscle between 0˚ and 30˚ extension. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ extension.

Table 4.8. Mann Whitney Test Result of FDS Muscle between 0˚ and 30˚ Extension

Mann-Whitney U	29
Assymp. Sig. (2-tailed)	0.002

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 40˚ extension as shown in table 4.9 below. H_0 is rejected which means there is a significance difference between 0˚ and 40˚ extension.

Table 4.9. Mann Whitney Test Result of FDS Muscle between 0˚ and 40˚ Extension

Mann-Whitney U	12
Assymp. Sig. (2-tailed)	0.000078

Based on table 4.10, the result of Mann-Whitney U Test in FDS muscle between 0˚ and 10˚ flexion accepted H_0 which means there is no significance difference between 0˚ and 10˚ flexion.

Table 4.10. Mann Whitney Test Result of FDS Muscle between 0˚ and 10˚ Flexion

Mann-Whitney U	57
Assymp. Sig. (2-tailed)	0.006

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 20˚ flexion as shown in table 4.11 below. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ flexion.

Table 4.11. Mann Whitney Test Result of FDS Muscle between 0˚ and 20˚ Flexion

Mann-Whitney U	33
Assymp. Sig. (2-tailed)	0.003

Table 4.12 shows the result of Mann-Whitney U Test in FDS muscle between 0˚ and 30˚ flexion. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ flexion.

Table 4.12. Mann Whitney Test Result of FDS Muscle between 0˚ and 30˚ Flexion

Mann-Whitney U	16
Assymp. Sig. (2-tailed)	0.000165

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 40˚ flexion as shown in table 4.13 below. H_0 is rejected which means there is a significance difference between 0˚ and 40˚ flexion.

Table 4.13. Mann Whitney Test Result of FDS Muscle between 0˚ and 40˚ Flexion

Mann-Whitney U	5
Assymp. Sig. (2-tailed)	0.000019

Based on table 4.14 below, the result of Mann-Whitney U Test in FDS muscle between 0˚ and 10˚ ulnar accepted H_0 which means there is no significance difference between 0˚ and 10˚ ulnar.

Table 4.14. Mann Whitney Test Result of FDS Muscle between 0˚ and 10˚ Ulnar

Mann-Whitney U	58
Assymp. Sig. (2-tailed)	0.66

Table 4.15 shows the result of Mann-Whitney U Test in FDS muscle between 0˚ and 20˚ ulnar. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ ulnar.

Table 4.15. Mann Whitney Test Result of FDS Muscle between 0˚ and 20˚ Ulnar

Mann-Whitney U	33
Assymp. Sig. (2-tailed)	0.003

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 30˚ ulnar as shown in table 4.16 below. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ ulnar.

Table 4.16. Mann Whitney Test Result of FDS Muscle between 0˚ and 30˚ Ulnar

Mann-Whitney U	11
Assymp. Sig. (2-tailed)	0.000064

Table 4.17 shows the result of Mann-Whitney U Test in FDS muscle between 0˚ and 10˚ radial. H_0 is rejected which means there is a significance difference between 0˚ and 10˚ radial.

Table 4.17. Mann Whitney Test Result of FDS Muscle between 0˚ and 10˚ Radial

Mann-Whitney U	46
Assymp. Sig. (2-tailed)	0.017

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 20˚ radial as shown in table 4.18 below. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ radial.

Table 4.18. Mann Whitney Test Result of FDS Muscle between 0˚ and 20˚ Radial

Mann-Whitney U	27
Assymp. Sig. (2-tailed)	0.001

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 30˚ radial as shown in table 4.19 below. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ radial.

Table 4.19. Mann Whitney Test Result of FDS Muscle between 0˚ and 30˚ Radial

Mann-Whitney U	6
Assymp. Sig. (2-tailed)	0.000024

Based on table 4.20, the result of Mann-Whitney U Test in APB muscle between 0˚ and 10˚ extension accepted H_0 which means there is no significance difference between 0˚ and 10˚ extension.

Table 4.20. Mann Whitney Test Result of APB Muscle between 0˚ and 10˚ Extension

Mann-Whitney U	64
Assymp. Sig. (2-tailed)	0.118

Table 4.21 shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 20˚ extension. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ extension.

Table 4.21. Mann Whitney Test Result of APB Muscle between 0˚ and 20˚ Extension

Mann-Whitney U	42
Assymp. Sig. (2-tailed)	0.01

The result of Mann-Whitney U Test in APB muscle between 0˚ and 30˚ extension as shown in table 4.22 below. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ extension.

Table 4.22. Mann Whitney Test Result of APB Muscle between 0˚ and 30˚ Extension

Mann-Whitney U	11
Assymp. Sig. (2-tailed)	0.000064

Table 4.23 shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 40˚ extension. H_0 is rejected which means there is a significance difference between 0˚ and 40˚ extension.

Table 4.23. Mann Whitney Test Result of APB Muscle between 0˚ and 40˚ Extension

Mann-Whitney U	3
Assymp. Sig. (2-tailed)	0.000013

Based on table 4.24, the result of Mann-Whitney U Test in APB muscle between 0˚ and 10˚ flexion accepted H_0 which means there is no significance difference between 0˚ and 10˚ flexion.

Table 4.24. Mann Whitney Test Result of APB Muscle between 0˚ and 10˚ Flexion

Mann-Whitney U	56
Assymp. Sig. (2-tailed)	0.054

Table 4.25 shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 20˚ flexion. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ flexion.

Table 4.25. Mann Whitney Test Result of APB Muscle between 0˚ and 20˚ Flexion

Mann-Whitney U	30
Assymp. Sig. (2-tailed)	0.002

The result of Mann-Whitney U Test in APB muscle between 0˚ and 30˚ flexion as shown in table 4.26 below. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ flexion.

Table 4.26. Mann Whitney Test Result of APB Muscle between 0˚ and 30˚ Flexion

Mann-Whitney U	9
Assymp. Sig. (2-tailed)	0.000043

Table 4.27 shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 40˚ flexion. H_0 is rejected which means there is a significance difference between 0˚ and 40˚ flexion.

Table 4.27. Mann Whitney Test Result of APB Muscle between 0˚ and 40˚ Flexion

Mann-Whitney U	3
Assymp. Sig. (2-tailed)	0.000013

Based on table 4.28, the result of Mann-Whitney U Test in APB muscle between 0˚ and 10˚ ulnar accepted H_0 which means there is no significance difference between 0˚ and 10˚ ulnar.

Table 4.28. Mann Whitney Test Result of APB Muscle between 0˚ and 10˚ Ulnar

Mann-Whitney U	57
Assymp. Sig. (2-tailed)	0.06

Table 4.29 shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 20˚ ulnar. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ ulnar.

Table 4.29. Mann Whitney Test Result of APB Muscle between 0˚ and 20˚ Ulnar

Mann-Whitney U	22
Assymp. Sig. (2-tailed)	0.0000479

The result of Mann-Whitney U Test in APB muscle between 0˚ and 30˚ ulnar as shown in table 4.30 below. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ ulnar.

Table 4.30. Mann Whitney Test Result of APB Muscle between 0˚ and 30˚ Ulnar

Mann-Whitney U	9
Assymp. Sig. (2-tailed)	0.000043

Table 4.31 below shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 10˚ radial. H_0 is rejected which means there is a significance difference between 0˚ and 10˚ radial.

Table 4.31. Mann Whitney Test Result of APB Muscle between 0˚ and 10˚ Radial

Mann-Whitney U	34
Assymp. Sig. (2-tailed)	0.003

Table 4.32 shows the result of Mann-Whitney U Test in APB muscle between 0˚ and 20˚ radial. H_0 is rejected which means there is a significance difference between 0˚ and 20˚ radial.

Table 4.32. Mann Whitney Test Result of APB Muscle between 0˚ and 20˚ Radial

Mann-Whitney U	16
Assymp. Sig. (2-tailed)	0.000165

The result of Mann-Whitney U Test in FDS muscle between 0˚ and 30˚ radial as shown in table 4.33 below. H_0 is rejected which means there is a significance difference between 0˚ and 30˚ radial.

Table 4.33. Mann Whitney Test Result of APB Muscle between 0˚ and 30˚ Radial

Mann-Whitney U	7
Assymp. Sig. (2-tailed)	0.000029

c. Statistical Test Between Male and Female Groups

The result of Mann-Whitney U Test in FDS muscle between male and female as shown in table 4.34 below. H_0 is accepted which means there is no significance difference between gender.

Table 4.34. Mann Whitney Test Result of FDS Muscle between Male and Female

Mann-Whitney U	105
Assymp. Sig. (2-tailed)	0.756

Based on table 4.35 below, the result of Mann-Whitney U Test in APB muscle between male and female accepted H_0 which means there is no significance difference between gender.

Table 4.35. Mann Whitney Test Result of APB Muscle between Male and Female

Mann-Whitney U	86
Assymp. Sig. (2-tailed)	0.272

d. Statistical Test of Typing Performance

Table 4.36. Kruskal-Wallis Test Result of Typing Performance

Assymp. Sig. (2-tailed)	0.313

Table 4.36 above shows that the asymptotic significance value for typing performance in every experiment is above 0.05 (0.313 > 0.05), thus H_0 is accepted means that there is no significant difference between typing performance on each experiment.