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Utilization of Depth Camera to Ease Posture-Risk Assessment of Related Sitting Work

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Abstract

Sitting work posture is often used in office work. Work position failures when sitting can cause Musculoskeletal Disorders. Therefore, ergonomists are necessary for the workplace to assist workers' posture. However, these needs cannot be met due to the limited number of ergonomists and costs. So a practical and inexpensive semi-automatic application is needed. One method for assessing upper body work posture is RULA. This study aims to develop a posture assessment application for sitting work and suggest improvement. In addition, the effect of changes in room brightness, the variability of chair height, and types of office-work tasks were explored in this study to determine the accuracy level of the depth camera to measure the worker's posture. Research design uses empirical research with independent variables: room illuminance, chair height, and four types of office-work tasks. The two levels of room illuminance are 32 lux and 60 lux; the seat height consists of three levels, i.e., 40, 45, and 50cm, while four types of tasks include writing, typing, writing with a cheat sheet, and typing with a cheat sheet beside the Subject. The experiment tests the difference between the application's RULA estimation results and the ergonomist's RULA value. The experiment results showed that the proposed application successfully assessed RULA with the same results as the calculations by the ergonomist. This study makes posture assessment easier for sitting work and provides suggestions for posture improvement. In addition, automation of posture assessment using a depth camera helps provide evaluations and recommendations for improving posture while working sitting.

Keywords: RULA, posture assessment, Kinect V2

1. Introduction

Sitting work posture is often used in office work. The health risks of office workers with prolonged sitting work can raise concerns for society and industry [1]. Many office workers do their jobs in poor sitting positions, unlike those advocated by ergonomics literature, even though workers use ergonomic workstations [2]. Although office work leads to static and prolonged work positions, office work also has a very minimal variety of work movements. The job of sitting in the office includes work that requires little muscle movement. However, this muscle contraction can cause pain if lived for a long time because the muscles will feel tense [3].

Incorrect work positions often cause musculoskeletal disorders (MSD). According to Generosi et al. [4], improper posture can give rise to an accumulated critical disorder called Musculoskeletal disorder, commonly experienced by workers when doing manual labour. Then it is necessary to evaluate and calculate the value of the existing risk to minimize musculoskeletal disorders. Some practical ways to eliminate the hazards of MSD in the workplace are to develop wellness programs to raise workers' awareness of workstation ergonomics and advocate for healthy lifestyle behaviours and work organization [5]. The working posture could also support using a human supervisor and semi-automatic apparatus. One of the consequences of MSD is low back pain (LBP). The pain from LBP is quite severe and can limit everyday activities for more than a day. LBP is a pain in the back of the body, from the lower edge of the 12th rib to the gluteal fold [6]. Data analysis by [5] also revealed that the factors determining the risk of MSD in workers aged 40-45 years are mainly related to working conditions and computer ergonomics.

RULA (Rapid Upper Limb Assessment) is a method used to assess the upper limb's posture, force, and movement. The use of RULA for ergonomic risk assessment is commonly found in working procedures for dentists and dental assistants [7], [8] and office working [3]. Moreover, package or material handling [9], Petrol Pump Workers [10], and many others. The RULA procedure is described neatly and clearly in the famous paper "RULA: a survey method for investigating work-related upper limb disorders" [11]. However, RULA evaluation is generally still done manually, namely through an expert analysis of an image of a worker [12]. Nevertheless, this method takes a lot of money and time, especially in finding an ergonomist. So it is necessary to have a new idea to facilitate the analysis of posture risks that are accurate, effective, efficient, and the minimum possible operational costs.

Using RGB cameras to detect posture requires image processing techniques and more considerable computer resources because postures recognition utilizes deep learning [13], [14]. As one alternative, depth cameras on Kinect are often used to detect postures based on human skeletons. According to Ul Ain et al.[15], using Kinect also provides therapeutic benefits for upper limb rehabilitation compared to conventional therapy in stroke patients. Furthermore, Kinect

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is also used as a sensor to detect Alzheimer's disease [16]. On the other side, such researchers also evaluate the use of Kinect for observing upper limb functional tasks [17]–[19].

Workers often neglect good and correct sitting posture. The presence of an ergonomist is not always on the site. Manual RULA assessment is less efficient, so a semi-automatic system is needed to monitor and evaluate a person's work posture as done [13], [20], [21]. In the description above, many studies use Kinect, but we found no evaluation of the office work posture in the sitting position using Kinect specifically. We found the following research gaps: 1) In the study [18] about twelve static posture recognition using the *dynamic time warping* method from a distance between joints, but in the study, there was no RULA assessment for certain types of work (body work posture); 2) In the study [19] about looking for an upper-limb joint trajectory with two Kinects, but in the study aimed to eliminate occlusion, there was no assessment for bodywork posture at all; 3) In research [21] on using Kinect v2 to explore risk factors in the workplace and reduce musculoskeletal disorders, there are two types of evaluation, namely with motion capture systems and RULA experts; in that study, 15 postures were tried but did not focus on office work, primarily work such as typing and writing. So this study hopes to contribute to using a depth camera on Kinect to evaluate body posture when users do office work.

This study aims to develop a posture assessment application and provide suggestions for posture improvement for sitting work within tasks: writing, typing, writing while sometimes looking at a cheat paper besides, and typing while sometimes looking at a cheat paper beside the Subject. Room brightness, seat height, and types of tasks become independent variables.

2. Method

This section describes the developed method using an empirical approach to compute the skeleton data for RULA calculation. This study uses room brightness, chair height, and types of tasks as independent variables. The experiment aims to test the difference between the results of RULA estimation from the proposed application and RULA calculated by an ergonomist as a reference. We named the proposed application *KV2RULA*.

There are two types of experiments: the room brightness experiment's effect and the seat height and types of tasks experiment's impact on *KV2RULA*. The first experiment used one Subject; the Subject in this test had body anthropometry: height 170 cm, weight 65 kg and aged 21 years. The Subject was asked to demonstrate a predetermined static posture and held for a few seconds to be analyzed by *KV2RULA*.

The effect of the chair height and types of tasks experiment (second experiment) was assisted by eight volunteer subjects: three women and five men. The average height of the subjects was 168 cm, the average body weight was 60 kg, and the average age was 21 years. In this second experiment, an analysis was carried out on the estimated value given by *KV2RULA*. The value was calculated manually through observation and a *RULA Worksheet*; both carried out by ergonomists. The worksheet was adopted [11] and downloaded via *the Cornell University Ergonomics Web* [22]. In this second experiment, two null hypotheses (H0) were tested, namely:

- First null hypothesis: There is no difference between the estimated value of *KV2RULA* and the calculation by ergonomists at each seat height tested.
- Second null hypothesis: There is no difference between the estimated value of *KV2RULA* and the calculation by ergonomists on the type of task tested.

The experimental procedure is explained in the section below.

RULA assessment

RULA assessment using Ergonomic Assessment Works Sheet (EAWS) form 1.3.5 based on [11]. In this study, we used a systematically simplified table based on [23] illustrated in Fig.1.

The sequence of RULA assessments is illustrated in Fig.2. The line of work is divided into two groups, namely group A, which consists of the upper arm, lower arm, wrist, and wrist twist, and group B, which includes the neck, trunk, and leg. Groups A and B are written as Table A and Table B in the single-page worksheet of RULA, respectively. Group A and B assessments are performed using Kinect except for Wrist Twist, which cannot be assessed with Kinect and is filled in manually in the program. Meanwhile, Muscle and Force/Load are filled in manually through the results of consultation with our ergonomist in the application before the application is run. Finally, Table C is used to determine the final RULA score. In our application, the final score has a range of values of 1-7 levels indicating the necessary action, including:

1-2: the risk is negligible, the posture is still acceptable,
3-4: Low risk, needs further investigation,
5-6: Moderate risk. It is necessary to carry out further investigation and immediate change of posture, and
7: High risk, have to make a change of posture now.

The experimental procedure on room brightness as a variable.

The indoor experiment was carried out with two levels of lighting using 8 watts and 4 watts of LED room lamps, with an intensity of 60 lux and 32 lux, respectively. The illustration of Kinect placement and Subject position is described in Fig.3; *Kinect* has placed 2m away from the Subject and 100 cm from the ground. One Subject attempted four postures, i.e., *standing upright*, *standing above head*, *sitting upright,* and *sitting above head,* taken from EAWS form 1.3.5. These are postures 1, 2, 7, and 9 in EAWS form [24]. These postures are illustrated in Fig.4. RULA results from the application are compared with RULA calculation results from an ergonomist.

The experimental procedure on chair height and types of tasks as variables.

There are three levels of chair heights, i.e., 50cm, 45cm, and 40cm. Each Subject performed four tasks: 1)writing, 2)typing, 3)writing while sometimes looking at a cheat paper besides, and 4)typing while sometimes looking at a cheat paper besides. The number of trials is three for each task. The administering of experiment conditions is within subjects. The experiment was designed using a Latin-square level sequence. Fig. 5 illustrates the four levels of tasks and the height of the seats on each task.

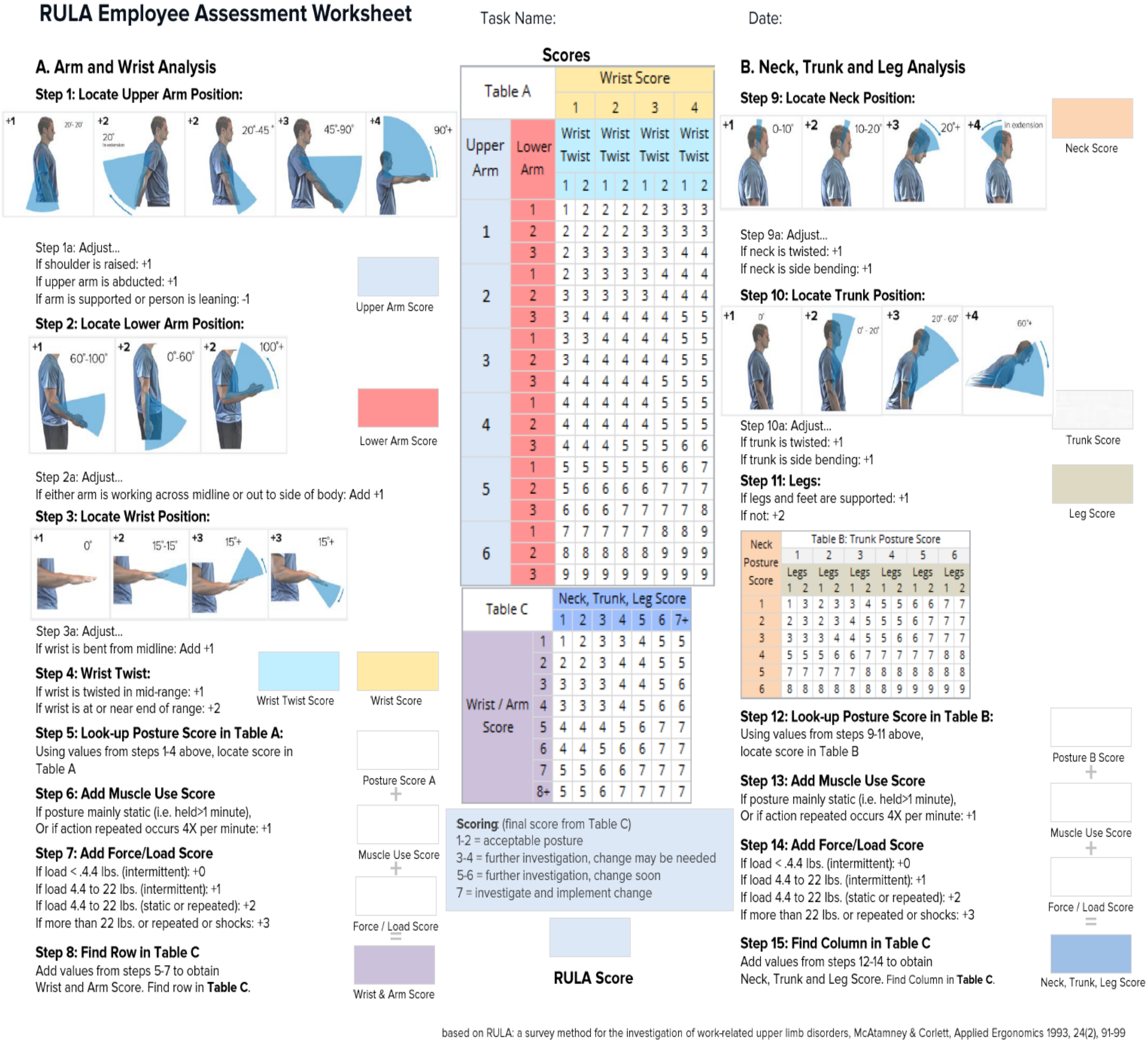


Fig. 1. A single-page worksheet of RULA [23]

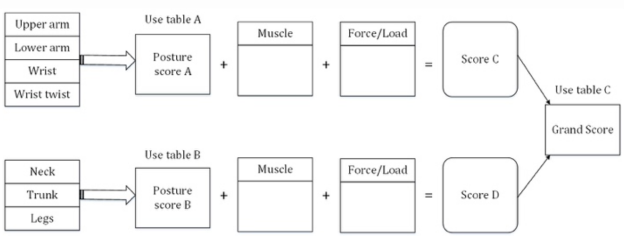


Fig. 2. The RULA scoring sheet

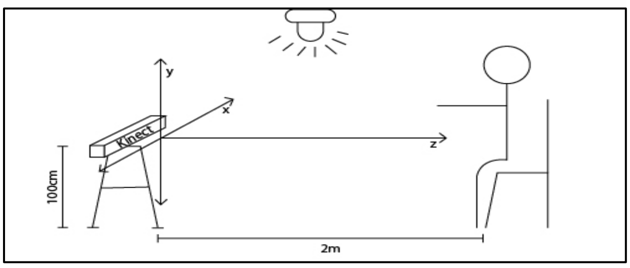


Fig. 3. The illustration of Kinect and subject position in room brightness experiment

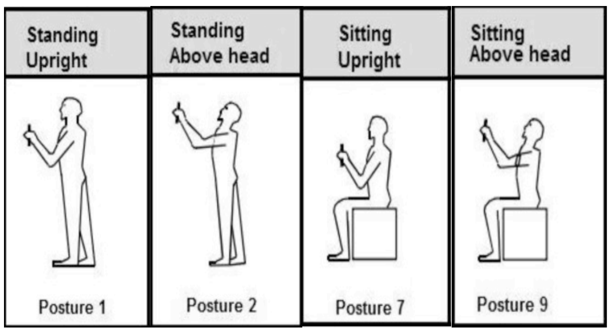
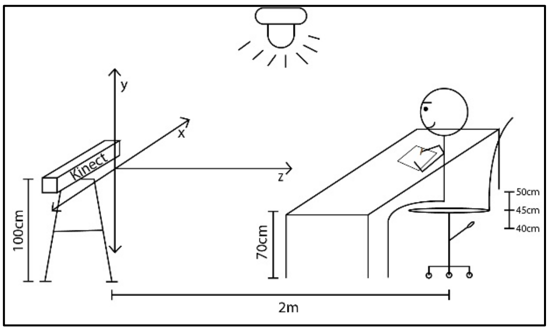


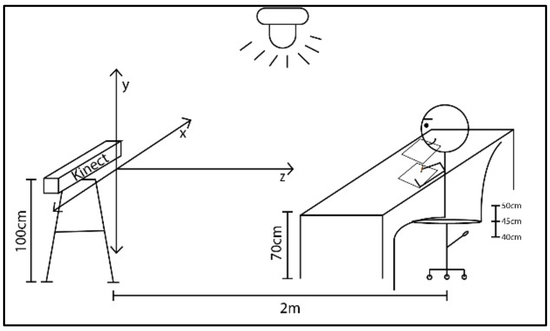
Fig. 4. The posture used during the room brightness experiment indicated in *EAWS form 1.3.5* as posture 1, 2, 7, and 9.

The apparatus

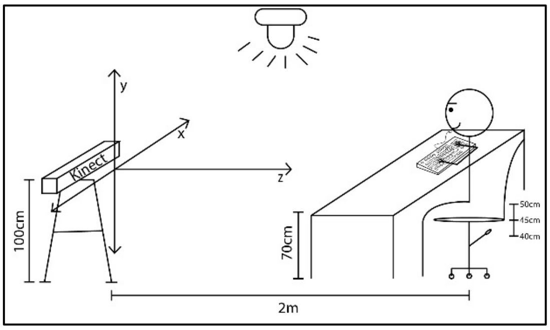
The instruments used were the Kinect V2, a desktop-based application built using C# with WPF libraries, an Ergonomic Assessment Worksheet v.1.3.5, and a digital lux meter Smart Sensor AS80.



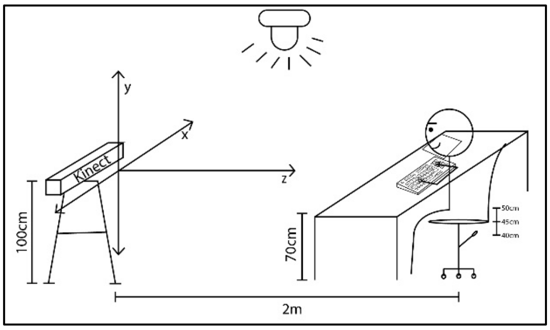
(a) Writing



(b) Writing while sometimes looking at a cheat paper besides.



(c) Typing



(d) Typing while sometimes looking at a cheat paper besides.

Fig. 5. Illustration during chair height and tasks variation experiment

3. Results

The application GUI is displayed in Fig.6. The experiment results with the variable of brightness are shown in Fig.7. It was seen that at both light intensities (32 lux and 60 lux), there was no difference between the results of the RULA estimation and the ergonomist calculation results.

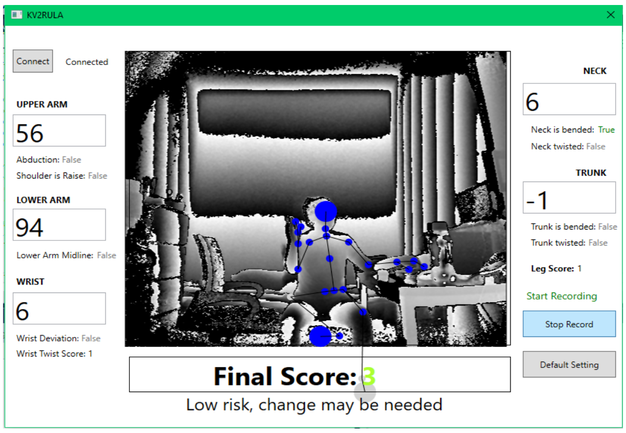
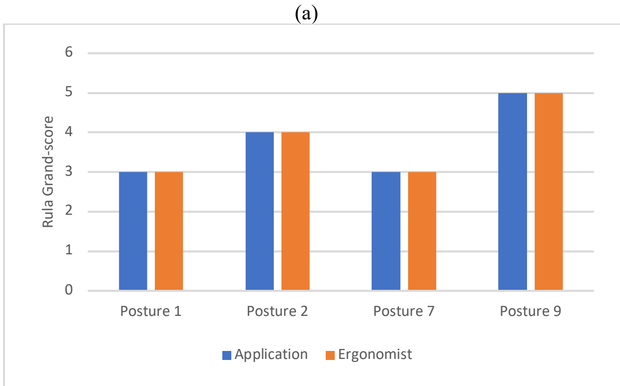
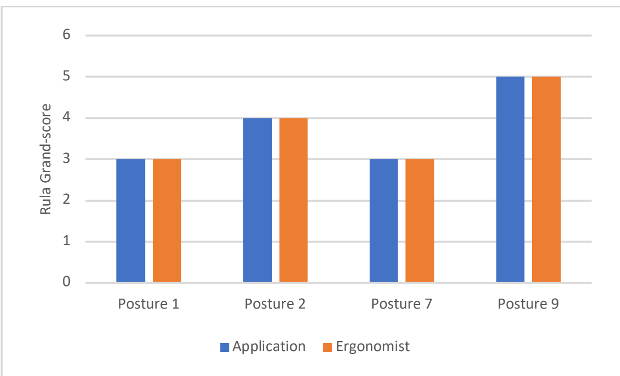


Fig. 6. Application GUI display during room brightness effect experiment.



(a)



(b)

Fig. 7. Comparative results of RULA testing between application and the ergonomist assessment for four test postures: a) at 32 lux room lighting and b) at 60 lux room lighting

The second experiment was to determine the effect of seat height on the RULA estimation provided by the application. The test data is displayed in Tab.1. The first step is to test the normality of the data using the Shapiro-Wilk Test against all three seat heights. It was obtained that the distribution of data was not normal ($p < .05$) as in Tab.2. The next step is to perform a different test using a Friedman non-parametric method. Friedman Test results showed no significant difference between the application's RULA estimate and the ergonomist's RULA result calculation ($p > 0.05$) as in Tab.3. Figure 8 shows a picture of the chair height effect experiment. While Fig.9 shows a static GUI to enter muscle and force/load values manually.

The following statistical test we did on the data was a different test to determine the effect of the type of work variable based on the second null hypothesis. The first step is to perform a data normality test using the *Shapiro-Wilk Test*. The *Sig* value for the four jobs is $p<0.05$, so it can be concluded that the data is not normally distributed as in Tab.4. The next step is to perform a difference test because using a within-subject design, the *Friedman Test* is used. Table 5 shows the different test results with the Friedman Test (*p<0.05*), meaning a significant difference exists between the estimated KV2RULA and the manual/expert calculation of the four tasks tested. The second null hypothesis is rejected because these results indicate the difference between the proposed system and the results of ergonomist calculations. The next step is to conduct *Post-Hoc Test* using *Wilcoxon Signed-Rank Test* against the four tasks. There are six possible Wilcoxon difference tests, namely: 1) The difference test between writing and writing with a cheat sheet; 2) Writing and typing; 3) Writing and typing with a cheat sheet; 4) Writing with a cheat sheet and typing; 5) Writing with a cheat sheet and typing with a cheat sheet; 6) Typing and typing with a cheat sheet. Table 6 shows the test results with Wilcoxon obtaining three test groups in which the *Asymp* value *Sig(p)* was less than 0.05. These three groups include writing and writing with a cheat sheet, writing with a cheat sheet and typing, and writing with a cheat sheet and typing with a cheat sheet.

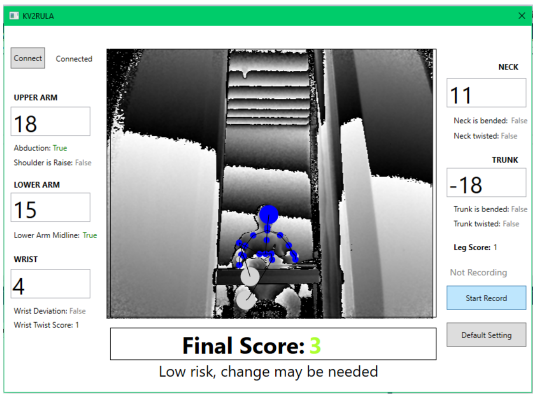


Fig. 8. Application GUI display during chair height effect experiment

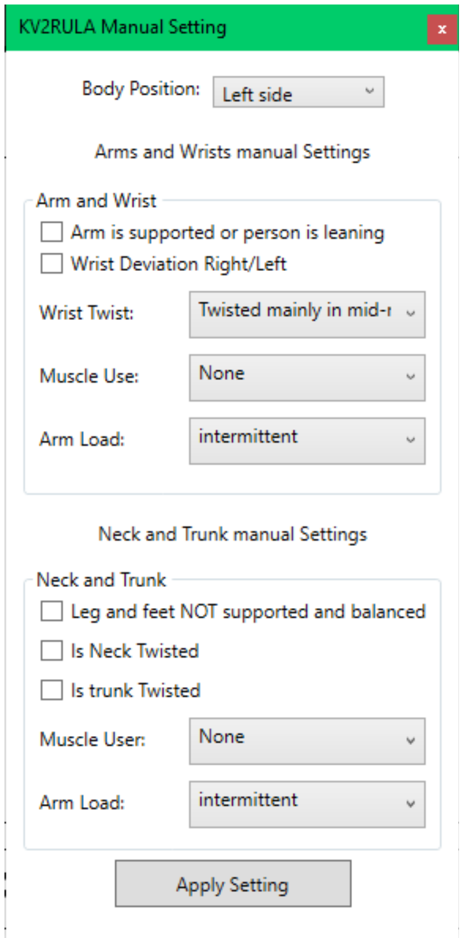


Fig. 9. A static GUI display for manually entering muscle and force/load values

Table 1. Complete Data of Test Results

Subject	Task	Trials	Chair height								
			40 cm			45 cm			50 cm		
			E	R	S	E	R	S	E	R	S
1	Writing	1	5	4	1	3	3	0	4	4	0
		2	5	4	1	3	3	0	4	4	0
		3	5	4	1	3	3	0	4	4	0
	Writing with a cheat paper beside	1	3	3	0	5	5	0	4	4	0
		2	4	3	1	6	5	1	4	4	0
		3	4	3	1	6	5	1	4	4	0
	Typing	1	3	3	0	3	3	0	3	2	1
		2	4	3	1	3	3	0	3	2	1
		3	3	3	0	3	3	0	3	2	1
	Typing with a cheat paper beside	1	3	3	0	3	3	0	3	3	0
		2	3	3	0	3	3	0	3	3	0
		3	3	3	0	3	3	0	3	3	0
2	Writing	1	4	4	0	3	3	0	3	3	0
		2	4	4	0	3	3	0	3	3	0
		3	4	4	0	3	3	0	3	3	0
	Writing with a cheat paper beside	1	3	3	0	5	5	0	4	5	1
		2	3	3	0	5	5	0	4	5	1
		3	3	3	0	5	5	0	4	5	1
	Typing	1	2	2	0	3	2	1	3	3	0
		2	2	2	0	2	2	0	3	3	0
		3	2	2	0	3	2	1	3	3	0
	Typing with a cheat paper beside	1	3	3	0	3	3	0	4	4	0
		2	3	3	0	3	3	0	4	4	0
		3	3	3	0	3	3	0	4	4	0
3	Writing	1	3	3	0	5	4	1	3	4	1
		2	3	3	0	5	4	1	3	4	1
		3	3	3	0	5	4	1	3	4	1
	Writing with a cheat paper beside	1	5	4	1	5	4	1	6	5	1
		2	5	4	1	5	4	1	6	5	1
		3	6	4	2	5	4	1	6	5	1

Subject	Task	Trials	Chair height								
			40 cm			45 cm			50 cm		
			E	R	S	E	R	S	E	R	S
	Typing	1	3	3	0	3	3	0	5	3	2
		2	3	3	0	3	3	0	4	3	1
		3	3	3	0	3	3	0	4	3	1
	Typing with a cheat paper beside	1	5	3	2	5	4	1	6	5	1
		2	5	3	2	5	4	1	6	5	1
		3	5	3	2	5	4	1	6	5	1
4	Writing	1	3	3	0	3	3	0	3	3	0
		2	3	3	0	3	3	0	3	3	0
		3	3	3	0	3	3	0	3	3	0
	Writing with a cheat paper beside	1	3	3	0	3	4	1	4	3	1
		2	3	3	0	3	4	1	3	3	0
		3	3	3	0	3	4	1	3	3	0
	Typing	1	3	3	0	3	3	0	2	3	1
		2	3	3	0	3	3	0	2	3	1
		3	3	3	0	3	3	0	3	3	0
	Typing with a cheat paper beside	1	3	3	0	3	4	1	3	3	0
		2	3	3	0	3	4	1	2	3	1
		3	3	3	0	3	4	1	3	3	0
5	Writing	1	3	4	1	3	4	1	4	4	0
		2	3	4	1	3	4	1	4	4	0
		3	3	4	1	3	4	1	4	4	0
	Writing with a cheat paper beside	1	4	4	0	3	4	1	4	4	0
		2	4	4	0	4	4	0	4	4	0
		3	4	4	0	3	4	1	4	4	0
	Typing	1	3	3	0	3	3	0	3	3	0
		2	3	3	0	3	3	0	3	3	0
		3	3	3	0	3	3	0	3	3	0
	Typing with a cheat paper beside	1	3	3	0	3	3	0	3	3	0
		2	3	3	0	3	3	0	3	3	0
		3	3	3	0	3	3	0	3	3	0
6	Writing	1	3	3	0	4	4	0	4	4	0
		2	3	3	0	4	4	0	4	4	0
		3	3	3	0	5	4	1	4	4	0
	Writing with a cheat paper beside	1	5	4	1	3	4	1	4	4	0
		2	5	4	1	3	4	1	4	4	0
		3	5	4	1	3	4	1	6	4	2
	Typing	1	3	3	0	3	3	0	3	2	1
		2	3	3	0	3	3	0	2	2	0
		3	3	3	0	3	3	0	2	2	0
	Typing with a cheat paper beside	1	3	3	0	3	3	0	3	3	0
		2	3	3	0	5	3	2	3	3	0
		3	3	3	0	5	3	2	3	3	0
7	Writing	1	3	3	0	3	3	0	4	3	1
		2	3	3	0	3	3	0	3	3	0
		3	3	3	0	3	3	0	3	3	0
	Writing with a cheat paper beside	1	3	4	1	3	4	1	3	4	1
		2	3	4	1	3	4	1	5	4	1
		3	3	4	1	3	4	1	4	4	0
	Typing	1	2	2	0	3	3	0	3	3	0
		2	2	2	0	3	3	0	3	3	0
		3	2	2	0	3	3	0	3	3	0
	Typing with a cheat paper beside	1	3	4	1	4	4	0	3	3	0
		2	3	4	1	4	4	0	3	3	0
		3	5	4	1	4	4	0	3	3	0
8	Writing	1	3	3	0	3	4	1	3	4	1
		2	3	3	0	3	4	1	3	4	1
		3	3	3	0	3	4	1	3	4	1
	Writing with a cheat paper beside	1	5	4	1	3	3	0	4	6	2
		2	5	4	1	3	3	0	6	6	0
		3	6	4	2	3	3	0	4	6	2
	Typing	1	3	3	0	3	3	0	2	3	1
		2	3	3	0	3	3	0	3	3	0
		3	3	3	0	3	3	0	3	3	0
	Typing with a cheat paper beside	1	3	3	0	3	3	0	3	3	0
		2	3	3	0	3	3	0	5	3	2
		3	3	3	0	3	3	0	3	3	0

Notes:
E = The application gives an estimated value.
R = Manual/ergonomist calculation analysis value.
S = |E-R| = Absolute of the difference between the application estimated value and ergonomist calculations.

Table 2. Test normality of data on seat height experiment

Tests of Normality

	Chair height	Shapiro-Wilk Statistic	df	Sig.
Data	40cm	.604	96	.000
	45cm	.658	96	.000
	50cm	.664	96	.000

[a]Lilliefors Significance Correction

Table 3. *Friedman Test* results on seat height

.

Test Statistics[a]

	Data
N	96
Chi-Square	.899
df	2
Asymp. Sig.	.638

[a.] Friedman Test

Table 4. Test normality of data on the effect of the type of work experiment

Tests of Normality[a]

	Task types	Shapiro-Wilk Statistic	df	Sig.
Data	Writing	.587	72	.000
	Writing with a cheat paper beside	.751	72	.000
	Typing	.485	72	.000
	Typing with a cheat paper beside	.587	72	.000

[a]Lilliefors Significance Correction

Table 5. *Friedman Test* results on the type of work

Test Statistics[a]

	Data
N	72
Chi-Square	27.282
df	3
Asymp. Sig.	.000

[a] Friedman Test

Table 6. Summary of *Wilcoxon Signed-rank test*

Testing Group	Asymp. Sig (p)	Summary
Writing – Writing with a cheat paper	.001	Significantly different
Writing – Typing	.083	Not significantly different
Writing – Typing with a cheat paper	.702	Not significantly different
Writing with a cheat paper – Typing	.000	Significantly different
Writing with a cheat paper – Typing with a cheat paper	.001	Significantly different
Typing – Typing with a cheat paper	.075	Not significantly different

4. Discussion

Educating workers about a good and correct sitting position is essential. Considering that workers' health and welfare costs are essential, it is necessary to implement policies to minimize the risks included in work-related musculoskeletal disorders. Work-related musculoskeletal disorders include "all forms of ill-health ranging from light, transitory disorders to irreversible, disabling injuries" [25]. Best practices that can be applied to prevent work-related musculoskeletal disorders consist of the evaluation of risk factors in the workplace concerning the ergonomic side and the rearrangement of the workplace for improved posture while working. A direct method that is relatively expensive, time-consuming, and less convenient for workers is to use data from sensors attached to the worker's body [21].

With this semi-automatic application, as in this study, ergonomists are no longer needed in the field at every moment. Alternatively, semi-automatic applications assist ergonomists and improve the standardization of assessments that are not restricted by particular geography [13], [20]. Although occlusion is the main issue of using cameras on semi-automatic systems, applications with cameras are still often used considering the practicality and no hassle to the user, in the sense that there are no sensors installed on the body as in [9], [26].

The use of this semi-automatic application is required. The expert fills in the muscle and energy scores so it is more efficient in posture evaluation. In the first experiment, testing was carried out on the application using four postures, such as in Fig. 4, against two brightness levels. The investigation was carried out without occlusion-blocking monitoring of the upper and lower body. The experimental results showed that the RULA assessment from the developed application was equal to the calculation results by ergonomists. So based on this test, we think the results obtained follow the research conducted by Zennaro et al. [27]. In the second experiment, an application estimate value test was carried out with three variations in seat height. The test results showed that, statistically, there was no significant difference between the application estimation and the ergonomist calculation. From this, it can be concluded that the seat height in the 40-50cm range does not affect the estimates made by the application.

The following experiment was to test *KV2RULA* by analyzing four types of tasks. Three pairs of significantly different tasks were obtained based on the *Wilcoxon Signed-Rank post hoc test*. The three pairs of tasks are writing and writing with a cheat sheet, writing with a cheat sheet and typing, and writing with a cheat sheet and typing with a cheat sheet. One variable, the writing variable with a cheat sheet, always appears in the three existing tests. The next step is to check the *Ranks* table for each *Wilcoxon Test* on three significantly different pairs (as shown in Tab.7). The *Mean Rank* value in the writing variable with a cheat sheet is more remarkable than other variables, for example, writing and typing. In this case, it can be assumed that the difference between the estimated *KV2RULA* and ergonomic calculations has a higher error in writing with cheat sheets than other variables.

Table 7. Summary of *the Rank* table for task pairs that differed significantly in Tab. 6.

Ranks

		N	Mean Rank	Sum of Ranks
Writing with a cheat paper - Writing	Negative Ranks	9[a]	18.50	166.50
	Positive Ranks	30[b]	20.45	613.50
	Ties	33[c]		

	Total	72		
Typing – Writing with a cheat paper	Negative Ranks	37[j]	23.43	867.00
	Positive Ranks	8[k]	21.00	168.00
	Ties	27[l]		
	Total	72		
Typing with a cheat paper – Writing with a cheat paper	Negative Ranks	25[m]	15.98	399.50
	Positive Ranks	6[n]	16.08	96.50
	Ties	41[o]		
	Total	72		

a. Writing with a cheat paper < Writing
b. Writing with a cheat paper > Writing
c. Writing with a cheat paper = Writing
j. Typing < Writing with a cheat paper
k. Typing > Writing with a cheat paper
l. Typing = Writing with a cheat paper
m. Typing with a cheat paper < Writing with a cheat paper
n. Typing with a cheat paper > Writing with a cheat paper
o. Typing with a cheat paper = Writing with a cheat paper

4.1 Limitation

Even though there is an advantage to using the Kinect for RULA calculation, some of the significant limitations to the experiments will be described. The limitation of this study can be analyzed from several factors that cause discrepancies in estimates given by *KV2RULA.* We analyzed the results of calculations carried out by *KV2RULA* when the discrepancy between the estimated and ergonomist results found that the torso part was often *underestimated*. In addition, during the experiment, occlusion was usually found in the torso and palms of the hands, potentially causing discrepancies in the RULA estimation by *KV2RULA.* Occlusion of the torso and palms also often occurs in testing other tasks, so in these tests, there are also inappropriate *KV2RULA* estimates even though the number is not as much as in writing work with a cheat sheet. In addition, we did not find any other factors that could cause excessive statistical discrepancies. So we conclude that occlusion in the torso and palms is a limitation of this study that causes degraded estimation accuracy.

4.2 The Study's Implications

This study has provided an overview of depth cameras used for semi-automatic work-posture evaluation. By minimizing the effect of occlusion, as reported in the limitations section of this study, the practical issue of overcoming the scarcity of ergonomists is a feature that has been achieved through the use of a depth camera on Kinect. The practical implication of this study is the hope of increasing awareness of occupational health in overcoming musculoskeletal disorders. At least this proposed system assists workers in getting warnings for their work posture so that they can correct if there is a wrong work posture from the beginning.

5. Conclusion

A semi-automatic application for posture assessment of office sitting work and providing suggestions for posture improvement has been successfully created. Based on the RULA assessment, the application works semi-automatic, where manual calculation of RULA is no longer needed. However, some parameters are entered manually by ergonomists just once, such as Muscle and Force/Load. The study resulted that the value of RULA estimation is robust to changes in room brightness. The result is obtained from the estimated value of semi-automatic applications compared to calculations by ergonomists, showing no significant difference. The second result was that the RULA value on testing the 40-50cm seat height variation in the sitting position job showed no significant difference with the calculation by the ergonomist. The experiment of four types of office work tasks shows that the system has difficulty estimating the position of the palm due to occlusion, so this is a direction for future work to find filters and methods for evaluating the part of the palm. This research makes posture assessment easier for sitting position and provides suggestions for posture improvement. In addition, automation of posture assessment using a depth camera helps provide evaluations and recommendations for improving posture while working sitting. However, the development of depth camera hardware and its application program interfaces must be a concern when creating semi-automatic applications in the near future.

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