

A JAVA Implementation of modified Rapid Upper Limb Assessment

Yaoyao Huang, Dr. Li Bai, Dr. Zdenka Delalic: College of Engineering, Temple University

Dr. Judith E. Gold: College of Health Professions, Temple University

1947 N. 12th St,

Philadelphia, PA 19122

215-204-6616

yaoyao.Huang@temple.edu, l.bai@temple.edu, joan@temple.edu, Judith.gold@temple.edu

Abstract

Work-related musculoskeletal disorder has become a common distress among students and office workers who sit in front of the computer for extended periods of time every day. The person diagnosed with a musculoskeletal disorder suffers notably symptoms of low back pain, neck pain, upper limbs pain, and fingers pain. The Rapid Upper Limb Assessment (RULA) method was originally developed by Dr. Lynn MacAtamney and Professor E. Nigel Corlett, ergonomists at the University of Nottingham in England, to estimate the risks of work-related upper limb disorders. The RULA method investigates the exposure of individual workers to risk factors associated with work-related upper limb disorder. Most of office workers and students typically sit in front of a computer with a prolonged sitting position for a period of time each day, and the risk of musculoskeletal disorder is very high in this group of people. A modified RULA method implemented in JAVA environment is a useful tool in assessing the musculoskeletal disorder risk for the office workers and students. In this research, we developed a software benchmark for surveying the modified RULA data collection procedures.

Key words: Upper Limb Assessment, musculoskeletal disorder, RULA method

Introduction:

Work-related musculoskeletal disorder has become common distress among students and office workers who sit in front of the computer for extended periods of time every day. The person who diagnosed a musculoskeletal disorder suffers notably symptoms of low back pain, neck pain, upper limbs pain, and fingers pain. The Rapid Upper Limb Assessment (RULA) method was originally developed by Dr. Lynn MacAtamney and Professor E. Nigel Corlett,

ergonomists at the University of Nottingham in England to estimate the risks of work-related upper limb disorders. RULA method investigates the exposure of individual workers to risk factors associated with work-related upper limb disorder [1]. Most of office workers and students usually sit in front of a computer with a prolonged sitting position for a period of time is a day. The risk of musculoskeletal disorder is very high in this group of people. A modified RULA method implemented in JAVA environment would be a useful tool in assessing the musculoskeletal disorder risk for the office workers and students [2].

The software development procedure of the modified RULA survey method would be described in this paper. Some major functions of the modified RULA survey method would be introduced. An implementation example would be illustrated to feather explain the function of modified RULA survey method. A conclusion would be provided in the end of this paper.

Implementation:

Software development flow chart:

The modified RULA survey method implemented in JAVA environment follows the following four steps as shown in Figure 1:

Step 1: Develop Graphical User Interface (GUI) consists of “Buttons”, “Checkboxes”, “Labels” and “Text Area”.

Step 2: Write an Action Listener to define what actions is taken and when a certain operation, such as press/release, was performed by a user.

Step 3: Create a “Thread” to compute a final score.

Step 4: Generate a XML file and save it to data logger using Datalogger.

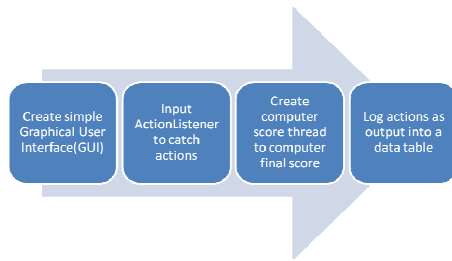


Figure 1: Procedure (4 steps)

Major Functions:

This developed JAVA code completes the modified RULA survey method in the following four functions illustrated in Figure 2:

Function 1: Activate and record actions such as press/release icons and checkboxes.

Function 2: Compute the score automatically. That is the most complex function of this JAVA application. The arm and wrist score were obtained from a look-up table shown in Figure 3-A. The trunk & leg score were obtained from a look-up table shown in Figure 3-B.

Function 3: Record all the input activities and store XML files into a database as an output.

Function 4: Plot a time chart. The time of last activity would be recorded for each icon.

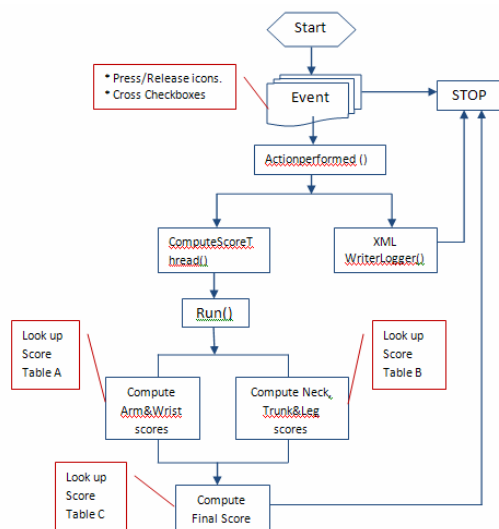


Figure 2: JAVA Codes Process Flow

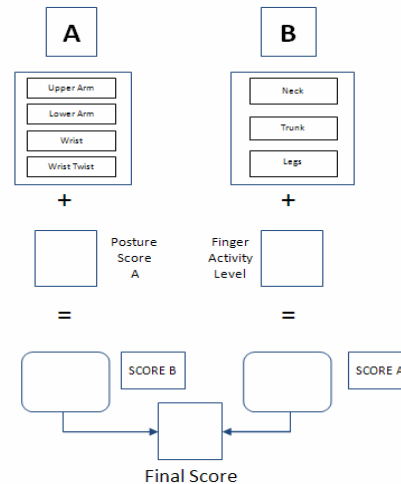


Figure 3: RULA Score Sheet Application

Compile/Run:

Figure 4: Modified RULA Data Survey Chart

The RULA survey datasheet would be shown in Figure 4, as the GUI of the JAVA application.

“Icons and Checkboxes”: The icon highlighted in black was represented as it has been pressed. Different checkboxes could be selected in result of different score based on the RULA score rule.

“Start Button”: When the “Start” button was pressed, the first icon of each group would be set to “pressed” as default.

A user can change the update frequency value in the update box. The default setting is “1” and the final score in the “calculate RULA score” box would be updated every minute. Consequently the update value of 0.1 would change the updated time to every 6 seconds.

“Stop Button”: The final score would be calculated after the “stop” button has been pressed.

“Reset Button”: If the “Reset” button was pressed, the interface would be reset.

Plot:

There are 7 plot buttons in the RULA survey datasheet. They correspond to the Left Upper Arm, Left Lower Arm, Left Wrist, Right Upper Arm, Right Lower Arm, Right Wrist, and the Neck. When the first Plot Button was pressed, “RULA Chart Left Upper Arm” plot would be appeared as shown in Figure 5. The different color symbolized the different icons that have been activated. The horizontal text bar displayed the time stamp of the action. For example, if the mouse pointer was inside the BLUE section, it would display exactly how long the corresponding icon was held in press before the next one was pressed. The plot chart can also be enlarged by sliding the mouse over the sections, as shown in Figure 6. The BLUE section (the 3rd icon of the Left Upper Arm as shown in Figure 4) was enlarged to demonstrate the time interval.

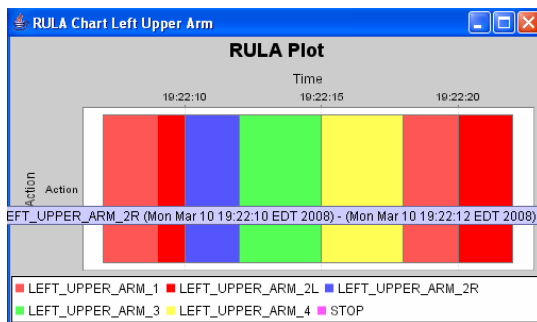


Figure 5: Plot Chart of Left Upper Arm

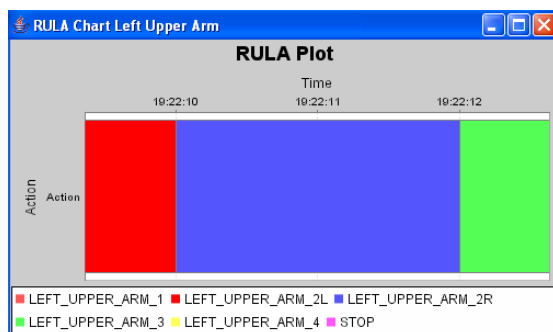


Figure 6: Enlarged Plot Chart of Left Upper Arm

XML Output:

“Datalogger.xml” was saved in path “c:\” as shown in Figure 1. Data Logger writes the XML text file into a database table as an output. Microsoft Excel would display all the recorded action data of the XML file. A data table contained 5 attributes shown in Figure 7. Each attribute could be sorted using “key word” pull-down manual. For example, the position section with a red circle was

sorted by “left” and “right” in pull-down manual, as illustrated in Figure 8.

	A	B	C	D	E
1	Action	position	bodypart	detail	time
2	LEFT_UPPER_ARM_1	Left Upper	Arm	-15_to +15_Degree_icon	2008-03-10 19:22:07
3	LEFT_LOWER_ARM_1	Left Lower	Arm	+45_to +90_Degree_icon	2008-03-10 19:22:07
4	LEFT_WRIST_1	Left	Wrist	0_Degree_icon	2008-03-10 19:22:07
5	LEFT_WRIST_4_OFF	Left	Wrist	icon	2008-03-10 19:22:07
6	left_wrist_twisted_in_mid-range	Left	Wrist	CheckBox	2008-03-10 19:22:07
7	RIGHT_UPPER_ARM_1	Right Upper	Arm	-15_to +15_Degree_icon	2008-03-10 19:22:07
8	RIGHT_LOWER_ARM_1	Right Lower	Arm	+45_to +90_Degree_icon	2008-03-10 19:22:07
9	RIGHT_WRIST_1	Right	Wrist	0_Degree_icon	2008-03-10 19:22:07
10	RIGHT_WRIST_4_OFF	Right	Wrist	icon	2008-03-10 19:22:07
11	right_wrist_twisted_in_mid-range	Right	Wrist	CheckBox	2008-03-10 19:22:08
12	NECK_1		Neck	0_to +10_Degree_icon	2008-03-10 19:22:08
13	TRUNK_1		Trunk	0_to +10_Degree_icon	2008-03-10 19:22:08
14	legs_and_feet_supported & balanced		Legs	CheckBox	2008-03-10 19:22:08
15	LEFT_Sporadic_motion_1_finger	Left	Finger_1	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
16	LEFT_Sporadic_motion_2_fingers	Left	Finger_2	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
17	LEFT_Sporadic_motion_3_fingers	Left	Finger_3	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
18	LEFT_Sporadic_motion_4_fingers	Left	Finger_4	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
19	LEFT_Sporadic_motion_5_fingers	Left	Finger_5	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
20	RIGHT_Sporadic_motion_1_finger	Right	Finger_1	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
21	RIGHT_Sporadic_motion_2_finger	Right	Finger_2	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
22	RIGHT_Sporadic_motion_3_finger	Right	Finger_3	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
23	RIGHT_Sporadic_motion_4_finger	Right	Finger_4	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
24	RIGHT_Sporadic_motion_5_finger	Right	Finger_5	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
25	LEFT_UPPER_ARM_2L	Left Upper	Arm	-15_Degree_icon	2008-03-10 19:22:09
26	LEFT_UPPER_ARM_2R	Left Upper	Arm	+15_to +45_Degree_icon	2008-03-10 19:22:10
27	LEFT_UPPER_ARM_3	Left Upper	Arm	+45_to +90_Degree_icon	2008-03-10 19:22:12
28	LEFT_UPPER_ARM_4	Left Upper	Arm	+90_Degree_icon	2008-03-10 19:22:15
29	LEFT_UPPER_ARM_1	Left Upper	Arm	-15_to +15_Degree_icon	2008-03-10 19:22:18
30	LEFT_UPPER_ARM_2L	Left Upper	Arm	-15_Degree_icon	2008-03-10 19:22:22
31	STOP	STOP	STOP	STOP	2008-03-10 19:22:22

Figure 7: XML

	A	B	C	D	E
1	Action	position	bodypart	detail	time
4	LEFT_WRIST_1	Left	Wrist	0_Degree_icon	2008-03-10 19:22:07
5	LEFT_WRIST_4_OFF	Left	Wrist	icon	2008-03-10 19:22:07
6	left_wrist_twisted_in_mid-range	Left	Wrist	CheckBox	2008-03-10 19:22:07
9	RIGHT_WRIST_1	Right	Wrist	0_Degree_icon	2008-03-10 19:22:07
10	RIGHT_WRIST_4_OFF	Right	Wrist	icon	2008-03-10 19:22:07
11	right_wrist_twisted_in_mid-range	Right	Wrist	CheckBox	2008-03-10 19:22:08
15	LEFT_Sporadic_motion_1_finger	Left	Finger_1	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
16	LEFT_Sporadic_motion_2_fingers	Left	Finger_2	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
17	LEFT_Sporadic_motion_3_fingers	Left	Finger_3	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
18	LEFT_Sporadic_motion_4_fingers	Left	Finger_4	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
19	LEFT_Sporadic_motion_5_fingers	Left	Finger_5	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
20	RIGHT_Sporadic_motion_1_finger	Right	Finger_1	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
21	RIGHT_Sporadic_motion_2_finger	Right	Finger_2	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
22	RIGHT_Sporadic_motion_3_finger	Right	Finger_3	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
23	RIGHT_Sporadic_motion_4_finger	Right	Finger_4	Sporadic_Motion_CheckBox	2008-03-10 19:22:08
24	RIGHT_Sporadic_motion_5_finger	Right	Finger_5	Sporadic_Motion_CheckBox	2008-03-10 19:22:08

Figure 8: Filtered XML

Conclusion

The RULA Data Survey sheet was validated and evaluated by the Public Health Department of Temple University. The practical results have shown its promise. More than 20 students from the Tech Center would be selected randomly as participants during the spring break, 2008, to re-evaluate the RULA Data Survey sheet. Their upper limb postures which include “Upper/Lower Arm”, “Fingers”, “Wrist”, “Wrist Twist”, “Neck”, “Trunk” and “Legs” would be recorded every 20 seconds when they are sitting in front of the computers as a pre-test. In the near future, this RULA Data Survey Method would be used to test more students and researcher volunteer in the school.

Some improvement in this JAVA code would be feather developed in the future. The display screen resolution would be improved to be adjusted fit any screen size. Today, the examiner still need to carry a portable tester with the RULA Data Survey sheet software installed to perform the musculoskeletal

disorder exam. To improve the mobility of the RULA Data Survey sheet, a JAVA Applet will be anticipated to be created with internet connection capability. The examiner then could perform the musculoskeletal disorder exam using web based RULA Data Survey sheet via internet.

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