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An Initial Mathematical Model for Quantifying the Accuracy of Handheld Application Usage

Amalina Farhi Ahmad Fadzlah

Department of Applied Sciences, School of Computing, College of Arts and Sciences,
Northern University of Malaysia, Malaysia
amalina@uum.edu.my

Abstract. This study aimed at developing a mathematical model for quantifying the accuracy of handheld application usage. Specifically, this study is designed to elaborate and enhance previous accuracy model by achieving two major objectives: constructing accuracy formula and prioritizing accuracy analysis. This model would function as a comparative and predictive accuracy measurement tool of handheld application usage.

Keywords: accuracy, model, measurement, evaluation, technique, mathematical

1. Introduction

Past studies have shown the works that address how to relate the accuracy with handheld application usage [1, 2, 3]. These works have shown to be lack of systematic approach that can show the focus of the efforts towards the most sensitive parts of the handheld application usage itself [4]. Examining mathematical modeling could bring together a mathematical representation of some phenomenon in order to gain a better understanding of that phenomenon [5]. However, mathematical-based model for quantifying the accuracy of handheld application usage has not been extensively studied.

With this background, the issues of developing an accuracy model with mathematical equations will have to be addressed. However, none of works have given any systematic mathematical model regarding quantifying the accuracy of handheld application usage. Therefore, the main contribution of this study is the development of a mathematical model for quantifying the accuracy of handheld application usage. This model would function as a comparative and predictive accuracy measurement tool of handheld application usage.

2. Methods

Previously, a study on developing a preliminary model for measuring the accuracy of handheld application usage has been conducted. As a result, a model namely Handheld Accuracy Model was developed in which outlined nineteen accuracy measures in three different hierarchy levels of metrics, attributes and criterion (Refer to Fig. 1). This work has been chosen as a basis for developing a mathematical-based model for quantifying the accuracy of handheld application usage.

3. Handheld Accuracy Formula

As to construct formulas and further to measure the accuracy of handheld application usage, three stages were involved. This brings together the formula for measuring the metrics, formula for measuring the attributes as well as formula to measure the overall accuracy of handheld application usage.

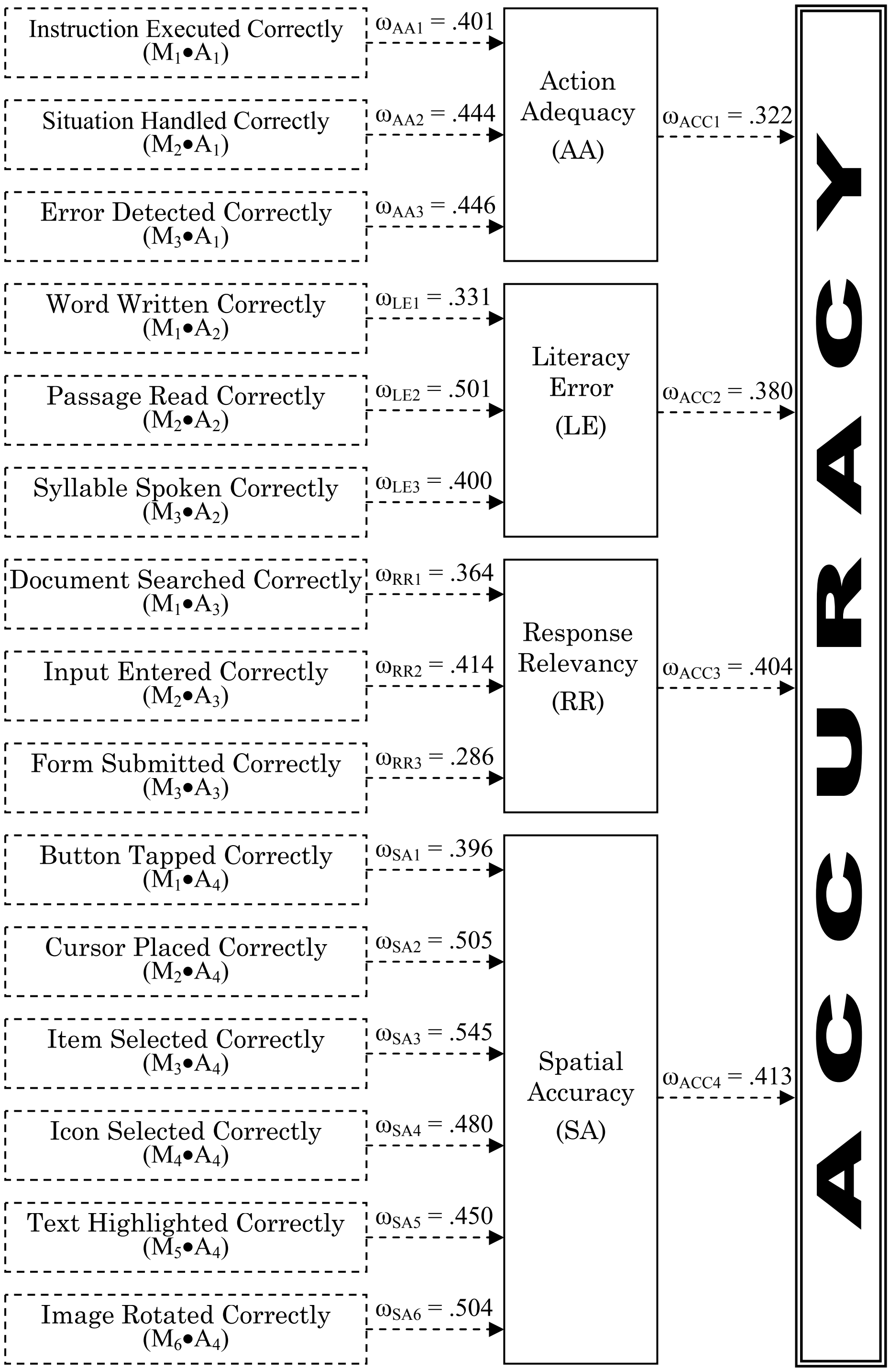

Fig. 1 Handheld Accuracy Model

3.1 Measuring Metrics

Scores for each metrics can be calculated generally as the proportion of the number of activities accomplished correctly out of the total number of activities accomplished. Detail representations for measuring each of the accuracy metrics thus can be referred as

$$\text{Instruction Executed Correctly } (M_1 \bullet A_1) = \frac{\text{Number of instructions executed correctly}}{\text{T number of instructions executed}} \quad (1.1)$$

$$\text{Situation Handled} = \text{Number of situations handled correctly} \quad (1.2)$$

Correctly ($M_2 \bullet A_1$) T number of situations handled

$$\text{Error Detected Correctly } (M_3 \bullet A_1) = \frac{\text{Number of errors detected correctly}}{\text{T number of errors detected}} \tag{1.3}$$

$$\text{Word Written Correctly } (M_1 \bullet A_2) = \frac{\text{Number of words written correctly}}{\text{T number of words written}} \tag{1.4}$$

$$\text{Passage Read Correctly } (M_2 \bullet A_2) = \frac{\text{Number of passages read correctly}}{\text{T number of passages read}} \tag{1.5}$$

$$\text{Syllable Spoken Correctly } (M_3 \bullet A_2) = \frac{\text{Number of syllable spoken correctly}}{\text{T number of syllable spoken}} \tag{1.6}$$

$$\text{Document Searched Correctly } (M_1 \bullet A_3) = \frac{\text{Number of documents searched correctly}}{\text{T number of documents searched}} \tag{1.7}$$

$$\text{Input Entered Correctly } (M_2 \bullet A_3) = \frac{\text{Number of inputs entered correctly}}{\text{T number of inputs entered}} \tag{1.8}$$

$$\text{Form Submitted Correctly } (M_3 \bullet A_3) = \frac{\text{Number of forms submitted correctly}}{\text{T number of forms submitted}} \tag{1.9}$$

$$\text{Button Tapped Correctly } (M_1 \bullet A_4) = \frac{\text{Number of buttons tapped correctly}}{\text{T number of buttons tapped}} \tag{1.10}$$

$$\text{Cursor Placed Correctly } (M_2 \bullet A_4) = \frac{\text{Number of cursors placed correctly}}{\text{T number of cursors placed}} \tag{1.11}$$

$$\text{Item Selected Correctly } (M_3 \bullet A_4) = \frac{\text{Number of items selected correctly}}{\text{T number of items selected}} \tag{1.12}$$

$$\text{Icon Located Correctly } (M_4 \bullet A_4) = \frac{\text{Number of icons located correctly}}{\text{T number of icons located}} \tag{1.13}$$

$$\text{Text Highlighted Correctly } (M_5 \bullet A_4) = \frac{\text{Number of texts highlighted correctly}}{\text{T number of texts highlighted}} \tag{1.14}$$

$$\text{Image Rotated Correctly } (M_6 \bullet A_4) = \frac{\text{Number of images rotated correctly}}{\text{T number of images rotated}} \tag{1.15}$$

3.2 Measuring Attributes.

Scores for each attributes can be calculated generally as the proportion of the accumulated products of each attribute weight and its contributing metric value out of the total accumulated weights of attributes. Detail representations for measuring each of the accuracy attributes thus can be referred as

$$\text{Action Adequacy (AA)} = \frac{\omega_{AA1}(M_1 \bullet A_1) + \omega_{AA2}(M_2 \bullet A_1) + \omega_{AA3}(M_3 \bullet A_1)}{\omega_{AA1} + \omega_{AA2} + \omega_{AA3}} \tag{2.1}$$

$$\text{Literacy Error (LE)} = \frac{\omega_{LE1}(M_1 \bullet A_2) + \omega_{LE\,2}(M_2 \bullet A_2) + \omega_{LE\,3}(M_3 \bullet A_2)}{\omega_{LE\,1} + \omega_{LE\,2} + \omega_{LE\,3}} \tag{2.2}$$

$$\text{Response Relevancy (RR)} = \frac{\omega_{RR1}(M_1 \bullet A_3) + \omega_{RR\,2}(M_2 \bullet A_3) + \omega_{RR\,3}(M_3 \bullet A_3)}{\omega_{RR\,1} + \omega_{RR\,2} + \omega_{RR\,3}} \tag{2.3}$$

$$\text{Spatial Accuracy (SA)} = \frac{\omega_{SA1}(M_1 \bullet A_4) + \omega_{SA2}(M_2 \bullet A_4) + \omega_{SA3}(M_3 \bullet A_4) + \omega_{SA4}(M_4 \bullet A_4) + \omega_{SA5}(M_5 \bullet A_4) + \omega_{SA6}(M_6 \bullet A_4)}{\omega_{SA1} + \omega_{SA2} + \omega_{SA3} + \omega_{SA4} + \omega_{SA5} + \omega_{SA6}} \tag{2.4}$$

3.3 Measuring Overall Accuracy.

Scores for overall accuracy can be calculated generally as the proportion of the accumulated products of each accuracy weight and its contributing attribute value out of the total accumulated weights of accuracy. Detail representations for measuring the overall accuracy thus can be referred as

$$\text{Overall Accuracy (ACC)} = \frac{\omega_{ACC1}(M_{1\ldots m}\bullet A_1) + \omega_{ACC2}(M_{1\ldots m}\bullet A_2) + \omega_{ACC3}(M_{1\ldots m}\bullet A_3) + \omega_{ACC4}(M_{1\ldots m}\bullet A_4)}{\omega_{ACC1} + \omega_{ACC2} + \omega_{ACC3} + \omega_{ACC4}} \quad (3.1)$$

4. Handheld Accuracy Analysis

In measuring the accuracy of handheld application usage, analysis can be done by converting the values into words or sentences with which the evaluator from various background and understanding can interpret the information accurately and comprehensively. This brings together the accuracy levels, accuracy thresholds as well as overall accuracy analysis.

4.1 Accuracy Level

Prioritizing accuracy level is possibly important to relate the absence or existence of accuracy requirements of handheld applications usage. Accuracy level was categorized into five distinct classifications in which determined by the score of each accuracy measure of 0.000 to 1.000 (Refer to Table 1).

Table 1 Prioritizing Accuracy Level

Score (U_{score})	Level	Description
$0.000 \leq U_{score} < 0.200$	Level 1	Most badly absence or shortage of a desirable usage accuracy that attains level of unable to perform comprehensively
$0.200 \leq U_{score} < 0.400$	Level 2	Lack of a desirable usage accuracy that attains level of the least excellent
$0.400 \leq U_{score} < 0.600$	Level 3	Average of a desirable usage accuracy that can be tolerable to consider good enough
$0.600 \leq U_{score} < 0.800$	Level 4	Complete the specific requirements of a desirable usage accuracy that achieves level of almost in a state of being practical
$0.800 \leq U_{score} \leq 1.000$	Level 5	Fulfill all the requirements of a desirable usage accuracy that achieves level of very high distinction of proficiency

4.2 Accuracy Threshold

Prioritizing the accuracy threshold is possibly important to relate the feeling of contentment towards handheld applications usage. Accuracy threshold was categorized into three distinct classifications in which determined by the score of each accuracy measure of 0.000 to 1.000 (Refer to Table 2).

Table 2 Prioritizing Usability Threshold

Score (U_{score})	Threshold	Description
$0.000 \leq U_{score} < 0.333$	Low	Below an acceptable accuracy satisfaction that derives threshold in a state of being frustrate
$0.333 \leq U_{score} < 0.667$	Medium	Ordinary extent of an acceptable accuracy satisfaction that derives threshold in a state of being moderate
$0.667 \leq U_{score} \leq 1.000$	High	Above an acceptable accuracy satisfaction that derives threshold in a state of being content

4.3 Overall Accuracy Analysis

Prioritizing the impact and pose associated with both usage accuracy as well as accuracy satisfaction should be noticed. Determined by intermingle two different usage elements of quality and satisfaction, the amount of effort needed for reconstruction progress as well as the state for decision making and problem solving process were extremely important for improving the degree of goodness and the feeling of contentment towards handheld applications usage. The matrix that mapped the highest accuracy level and accuracy threshold should always have the strongest priority. In turn, matrix that has the lowest accuracy level and accuracy threshold should always have the weakest priority (Refer to Table 3).

Table 3 Accuracy Matrix

Accuracy Threshold	Usability Level				
	Level 1	Level 2	Level 3	Level 4	Level 5
Low	Weak	Weak	Weak	Moderate	Moderate
Medium	Weak	Weak	Moderate	Moderate	Strong
High	Weak	Moderate	Moderate	Strong	Strong

The matrix defined by the relationship between level and threshold, thus can be categorized into three distinct classifications of overall accuracy analysis (Refer to Table 4).

Table 4 Prioritizing Overall Accuracy Analysis

Accuracy Analysis	Description
Weak	Critical condition which need greater effort for reconstruction progress that indicates rating in a state of crucial decision making towards enhancing usage accuracy as well as increasing accuracy satisfaction of the handheld application
Moderate	Medial condition which need less effort for reconstruction progress that indicates rating in a state of uncertain decision making towards enhancing usage accuracy as well as increasing accuracy satisfaction of the handheld application
Strong	Stable condition which need no reconstruction progress that indicates rating in a state of firmly established that not involve further decision making towards enhancing usage accuracy as well as increasing accuracy satisfaction of the handheld application

5. Conclusions

For the future, it is recommended to improve further this mathematical accuracy model. It is recommended to evaluate cases against actual handheld environments. With extensive experiments, the validity and the reliability of the model might be obtained. Therefore, the model developed need to be refined practically through many applications in the real work environment.

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