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Distance: A Moderator between Walking Activity and Pattern Classification

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Article Info	ABSTRACT
	The research of this paper is to investigate does distance will affecting the walking activity and the pattern for classification. This paper built a comprehensive picture of the human walking activity, programming language, workflow of the tool, features extraction and patterns classification method and captured the attitudes of the respondents. The subject was performed a range of walking activity in a controlled laboratory setting. The result of this study shows that the moderating effects of walking distance explains 15.80% (Gyroscope), 74.60% (Accelerometer) and 98.60% (Compass) of variance in research output. The result is expected to be beneficial and able to assist researchers and medical officers in analyzing human motion and its pattern classification.

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1.   INTRODUCTION

This paper details a project jointly funded by Ministry of Higher Education (MOHE) and Universiti Teknologi Malaysia (UTM) to produce a research in investigating the walking distance effect for the walking activity and its pattern classification.

The World Health Organization (WHO) reports that at least 60% of the world's population fails to achieve the minimum recommendation of 30 minutes of moderate intensity physical activity once a day[1]. Non-stoppable of increasing of the number of elderly patients suffering from chronic diseases was due to the rise in the elderly population and decline in physical activity [2].

This paper is divided into seven sections. The first section mainly introduces the whole study. It provides the general overview of the visualization tools in medical image processing. The second section includes the objectives of this study, which describes the aims that needed to be achieved. The third section discusses the background studies, literature review and the study implementation. A specification list of the research framework and thorough discussion on the developmental tool or processing and analysis on various medical images will be explained in section 4 and 5. Finally, the last two sections contain the results, conclusions, future developments and possible enhancement and improvement on this study.

2.   PROBLEM FORMULATION

The hypothesized function of the analysis of human motion psychophysical data is to provide the researchers with information about the informative details from the raw data in order to deliver useful information through the analysis with connection to the theory of signal information through processing. In this study, the practice item of signal processing was focused on MATLAB application.

Several imperatives were identified to be addressed by the survey:

- To discover the current human motion analysis practice in biomedical field.

- To discover the affecting factor (walking distance) in relationship between walking activity and its pattern classification.

A wide variety of signal processing techniques have been used in medical field for analysis. This employs a large number of physiological features, a fact which usually impedes the training process [3].

In this paper, an effective of moderator factor impacted between the relationships was presented through experiment result. Several aspects for example the number of subjects and attachment of sensor on human body were considered while the processing was being done. This project does not process only raw signal for analysis, but also important in managing the data effectively and providing scientific information about signal characteristics.

3.   LITERATURE REVIEW

An orientation sensor is a miniature and high precision attitude and heading reference system. The sensor is integrated with tri-axial accelerometer, gyroscope and a compass sensor. It is advanced on board filtering and processing algorithms to determine orientation relative to an absolute reference orientation in real time.

Orientation can be returned in absolute terms or relative to a designated reference orientation. The proprietary multi reference vector mode increases accuracy and greatly reduces and compensates for sensor error. The wireless system also utilizes a dynamic sensor confidence algorithm that ensures optimal accuracy and precision across a wide range of operating conditions.

There are many related literatures such as a wearable assistant sensor to monitor the time, swimming velocity, body balance and body rotation of a swimmer designed by Marcs and Killian [4]. Michael and Bernhard developed a football interaction and process model and a software system that can acquire, interpret and analyze this model [5].

- In this project, our plan is to investigate does walking distance will affect the human walking activity and its pattern classification.
- Digital signal processing has become such a broad area and sometimes it is very difficult to distinguish what might be considered as particularly useful to a non-specialist. The boundaries are become blurred and hence in this paper, we emphasize an analysis of digital signal processing that capable to embody all the core capabilities in scientific signal processing applications.

We have concluded the core capabilities into 5 major sections: signal utilities, signal filtering and transformation, signal compression, signal analysis and programming and data analysis environment. The first section includes file conversion, signal manipulation and signal display. It is an essential that a software package capable to convert a signal from one format to another since signal comes in such a raw data. Filtering and transformation include median filtering, averaging filtering, convolution, Fourier Transform, scaling, translation, morphological operations and other signal functions form. Signal compression is a demand for those who works with large signal that might require large amount of storage space. A standard signal compression utility provides signal database for storing and retrieving compressed signal. The main goal for signal analysis is to derive some useful information from a signal. Simple signal analysis tools like mean, standard deviation are powerful tools for gleaning important and unique information from a signal. Programming and data analysis environment provides a platform to develop new processing algorithm or interface with other signal processing techniques. It is also provides an environment for computation and iteration.

4.   RESEARCH METHOD

A number of steps were taken in order to realize these objectives and these including the design of a project framework, construction of the experiment and data receiving, transmitting and storing.

In this paper, a model regarding the effect of walking distance on the human walking activity and its pattern classification was proposed.

In Figure 1, the model was built up with walking as the main activity for human and three patterns of classification (gyroscope, accelerometer and compass). A moderator element (walking distance) was applied into the model to improve the fit of the model, given then main effects alone may not provide sufficient accuracy in prediction.
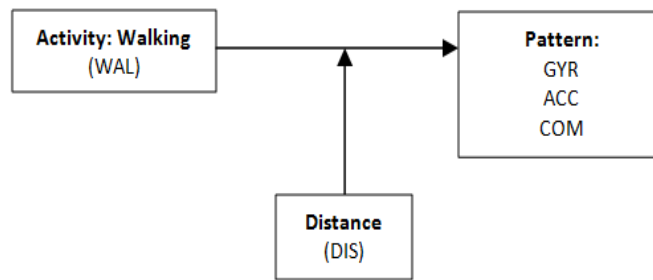
Figure 1. Research model overview

4.1. Research Model

A proposed model as in Figure 1 was proposed for implication on theory that provides information on the boundary conditions for the relationship. Moderated relationships provide more detail than main effect, and therefore give us a more fine-tuned picture of reality. Besides, it is also important to avoid erroneous conclusion about the absence of moderating effect.

All the data were then key into SPSS software for analysis.

4.2. Data Collection Framework

Data for the research are collected through a walking subject on a treadmill. A sensor integrated with gyroscope, accelerometer and compass was attached using a specially designed holder on the arm of the subject. The subject then being invited to perform his normal walk on a treadmill for 10m, 20m, 30m, 40m and 50m. Signal received from the sensor will directly transmit to the PC through Bluetooth dongle for a real time data feedback. The wireless transmission produces a higher mobility to the subject for a feasible walk.

5. RESULTS AND ANALYSIS

The result is mild and has been limited but not very disappointingly so because this study is still in a preliminary stage.

Table 1 shows the descriptive statistics for the three walking pattern classification ranging from 10m until 50m. it shows the number of samples, minimum, maximum, mean and standard deviation of the psychophysical data.

Table 1. Descriptive statistics (g)

	N	Min	Max	Mean	Std. Deviation
GyroW50	300	-2.8720	2.7857	0.145202	1.0327099
GyroW40	300	-2.6777	2.9861	0.087612	1.1030194
GyroW30	300	-3.2421	2.7845	0.059944	1.0785410
GyroW20	300	-3.1151	3.0435	0.089762	1.0774499
GyroW10	261	-2.6765	2.2726	0.044677	1.0395693
AccelW50	300	-0.9992	0.7292	-0.274955	0.5085224
AccelW40	300	-0.9993	0.8161	-0.277693	0.5070276
AccelW30	300	-0.9994	0.6828	-0.268837	0.5117942
AccelW20	300	-0.9961	0.6645	-0.283886	0.5035749
AccelW10	261	-0.9957	0.6058	-0.279217	0.5063135
ComW50	300	-0.7910	0.8203	-0.111417	0.5674442
ComW40	300	-0.7734	0.7580	-0.115112	0.5667038
ComW30	300	-0.7763	0.7896	-0.106818	0.5683308
ComW20	300	-0.7931	0.7412	-0.113004	0.5682137
ComW10	261	-0.7619	0.7852	-0.098990	0.5698936

Table 2 shows the model summary of the research. All the Sig. F Change values are less than 0.05 and it complies that walking distance does exist as a moderator and it affects the relationship between the human walking activity and the walking patterns classification. This result supports the presence of moderating effect. In other words, the moderating effects of walking distance explain 15.80% (gyroscope), 74.60% (accelerometer) and 98.60% (compass) of mean variance in research output.

Table 3 shows the moderating effect on human walking activity and walking patterns classification and Figure 2 summarized the information from the table using graphical method. From Figure 2, the slopes for three sections represent the reworking equations of gyroscope, accelerometer and compass. Compass has recorded as the steeper slope which covers a larger boundary (-3 to 2) than the others while accelerometer

data is on the opposition with a positive boundary from 0 to 3. This implied that the moderating effect has significantly affected the compass pattern. The changes of compass data bring sensitive significant to the walking activity of a human.

Table 4 shows the mean and standard deviation for gyroscope, accelerometer and compass. The descriptive statistical data was used in the reworking of equations.

Table 2. Model summary

Model	Unstandardized Coefficients		Mean Square		R	R Square Change	Adjusted R Square	Std. Error of the Estimate	F	Sig.	Partial Correlation	Collinearity Tolerance
	B	Std. Error	Regression	Residual					Regression	Regression		
Constant	0.122	0.060	10.938	0.910	0.398	0.158	0.145	0.954121	12.016	0.000	0.315	0.768
GyroW10	0.071	0.068										
GyroW20	0.081	0.065										
GyroW30	-0.014	0.066										
GyroW40	0.335	0.063										
Constant	-0.013	0.019	12.612	0.067	0.864	0.746	0.742	0.259190	187.743	0.000	0.299	0.241
AccelW10	0.199	0.070										
AccelW20	0.258	0.067										
AccelW30	0.150	0.069										
AccelW40	0.323	0.065										
Constant	0.002	0.004	20.638	0.005	0.993	0.986	0.985	0.068668	4376.676	0.000	0.855	0.089
ComW10	-0.011	0.049										
ComW20	0.002	0.009										
ComW30	0.351	0.053										
ComW40	0.663	0.025										

Equations Reworking:

GYR = 0.122 + 0.071 DIS + 0.081 (2) DIS − 0.014 (3) DIS + 0.335 (4) DIS
= 0.122 + 1.531 DIS

ACC = -0.013 + 0.199 DIS + 0.258 (2) DIS + 0.150 (3) DIS + 0.323 (4) DIS
= -0.013 + 2.457 DIS

COM = 0.002 - 0.011 DIS + 0.002 (2) DIS + 0.351 (3) DIS + 0.663 (4) DIS
= 0.002 + 3.698 DIS

Table 3. Moderating effect on activity towards pattern classification

Pattern	Low	High
GYR	-1.21450	2.05039
ACC	0.55346	2.67455
COM	-2.50232	1.69942

Table 4. Descriptive statistic for pattern classification

DIS	N	Minimum	Maximum	Mean	Std. Deviation
GYR	1461	-3.2421	3.0435	0.1933	1.06626
ACC	1461	-0.9992	0.8161	-0.2769	0.50745
COM	1461	-0.7931	-0.09899	-0.1091	0.56811

Gyro/GYR=gyroscope; Accel/ACC=accelerometer; Com/COM=compass; W=walking; DIS=distance
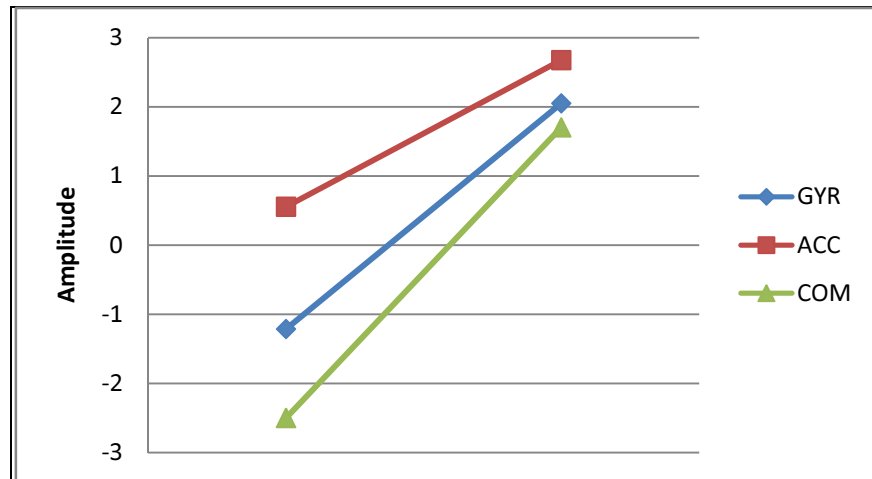
Figure 2. Graphical view for Table 3.

6. DISCUSSION

The study is ongoing and still in the primary stage, subject has shown great enthusiasm to give us comments and help us in testing. After testing, we found some drawbacks from the current experimental setup, likes the attached device is not comfortable enough to the subject especially when the subject was in a sweat. The sweat may bring errors to the sensitivity of the sensor.

In future, there will be more elements being counted in the testing such as increase the number of subject, attach more sensors onto different sites and conduct the experiment outside a building.

Research framework should be designed around four essential qualities: validity, reliability, impact and practicality. Validity is normally taken to be extent to which a processing can be shown to produce scores which are an accurate reflection of the image taken true level. Reliability concerns the extent to which processing results are stable, consistent and accurate, and therefore the extent to which they can be depended on for making decisions about the image processing. Impact concerns the effects, beneficial or otherwise, which an examination has on the processing using the package. Practically can be defined as the extent to which a processing is practicable in terms of the resources needed to produce and administer it.

7. CONCLUSION

This survey attempted to raise an interest of walking distance factor in affecting the human walking activity toward its patterns classification. The survey results are fairly depressing and there is plenty of work to be done. In medical psychophysical field, not many signal analyzing tools can be used and most of them are not easy being used. Hence, a development of a simple computer graphics such as histograms, bar charts and scatter plots by MATLAB package to manipulate and visualize matrices data is a need.

In future, this model will be upgraded and implemented more others affecting moderators to stabilize resources to provide the necessary infrastructure, supplies and materials needed to ensure every processing is achieving the signal analysis potential. This is important to increase the reliability and effectiveness of the analyzing steps.

A more detailed concept of model will be more useful in later analyzing stages. As in moderating flow algorithm, all the information is need to be incorporated on the direction of processing. Optimization in realization is very important for a optimize solution from the beginning.

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