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Path Mapping of Shape Drawings Using Double Integration Technique

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Abstract

A preliminary path tracking experiment was done and a mapping system was developed in this study. Data collection of human activities in this study was focused on different shape of hand drawings. Five subjects were required to draw three types of shapes (circle, square and triangle) according to their convenience pace. A sensor consists of accelerometer, gyroscope and compass was attached firmly on subject's wrist with special designed holder. PCA and double integration technique were used to process and analyze the data. The tracking path was mapped and presented in GUI developed by MATLAB. The developed GUI is capable to display the tracking with animation starting from the first stroke until the end. The GUI is managed to trace the upper-limbs tiny motion accurately and presented well in graphic form.

1. Introduction

Human motion analysis especially path mapping requires lot of data and computation algorithms. Kalman filter is among the famous operator used to track and trace a path. This algorithm combine the accelerometer data with angular matrix with multiplication for a real world coordinates (Ching Yee Yong et al., 2011).

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Double integration technique was proposed to determine the real path of a drawing shape from subject by mapping out the tracks. Accelerations from sensor were double integrated for distance data. Gyroscope data were used to determine the heading and direction of the following steps.

The proposed technique aims to investigate and trace the consequences path of the drawing. A tracing and mapping system was developed using MATLAB software. A user-friendly GUI was developed to increase the availability of the system to other types of data analysis.

2. Project review

2.1. Distance

Distance or called as farness is a term to describe how far apart both objects are in numerical approach. In physics, distance refers to estimation length from an origin. In a 2D plane with x and y axes, distance is calculated using Euclidean theorem. The formula is derived by square root and adding the difference square of both x and y coordinates (Deza et al., 2006; Blumenthal, 1953).

2.2. Heading

Heading or generally called direction facing is a technique needed for path mapping. The direction of a heading is normally written as an arrow. For example, forward motion is indicated by an upward arrow and backward motion is indicated by an downward arrow. Heading is determined and specified by rotational angle (Federal Aviation Administration, 2009; Ching Yee Yong et al., 2013a).

2.3. Double Integration

Integration together with its inverse, differentiation in mathematics is fundamental concept of calculus operations. Double integral is a positive function of two variables over a region (Thong et al., 2004; Kudryavtsev, 2001).

3. Methodology

Five persons were selected randomly in campus for taking part in this gait motion study. Three male and two female students with right hand as dominant limb for performing normal life activities were requested to perform a gait motion according the circle, square and triangle shapes as shown in Figure 1.

A 3-space sensor integrated with accelerometer, gyroscope and compass was attached on the right upper-limb of the subjects for data collection. A special holder was designed to attach the sensor firmly to the skin to avoid jolting as shown in Figure 2.