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Two Wheels Mobile Robot Navigation by Using a Low Cost Dataglove (*GloveMAP)*

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ABSTRACT

A low cost wired glove system is developed by designing a new glove which has the similar function with the conventional dataglove and has been named as *GloveMAP*. The system involves the finger movements with some of activities to control the direction of the two wheels mobile robot. Flexible bend sensors are attached to the index and middle fingers to obtain the voltage changes from the different activities of fingers bending. The proposed systems successfully navigate the two wheels mobile robot by the combination of voltage changes from these two fingers to give the instruction for right, left, forward and backward directions.

INTRODUCTION

For any mobile device, the ability to navigate in its environment is one of the most important capabilities of all. Staying operational for example avoiding dangerous situations likes collisions and staying within safe operating conditions such as temperature, radiation and exposure to weather. Robot behaviors consist of obstacle avoidance, target seeking, speed control, barrier following and local minimum avoidance (Omid Reza Esmaeili Motlagh, 2006). In order to navigate a mobile robot where it can determine its own position in its frame of reference, the robot need to plan a path towards the goal location and it requires representation for example a map of the environment and the ability to interpret the representation (Tang Sai Hong, Danial Nakhaeinia and Babak Karasfi, 2012).

Here, researches have been conduct to build other version of “wired glove” that share similar purpose known as *GloveMAP*. *GloveMAP* is a low cost “wired glove” that is designed to capture all data when the fingers are bending and the sample data will transmit to *CoolTerm* software. In this project dataglove (*GloveMAP*) is used to navigate the two wheels mobile robot.

The outline of this research paper consists of materials and methods for section 2 to presents the methodologies of applied procedures and the results in the Section 3. The Section 4 includes of discussion of the experiment. Finally section 5 expresses the conclusions over the current research.

MATERIALS AND METHODS

A.Voltage divider:

Voltage divider is used in this project to get a low voltage signal proportional to the voltage to be measured. A voltage divider is created by connecting two electrical impedances in series. Z_1 and Z_2 is an element such as resistors, inductors and capacitors or any combination of these three elements. The relationship between the input voltage, V_{in}, and the output voltage, V_{out}, can be found by applying Ohm’s law.

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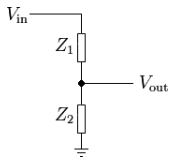

Fig. 1: Voltage divider circuit

$$V_{in} = I \cdot (Z_1 + Z_2) \tag{1}$$

$$I = \frac{V_{in}}{Z_1 + Z_2} \tag{2}$$

$$V_{out} = V_{in} \cdot \frac{Z_2}{Z_1 + Z_2} \tag{3}$$

Resistor of 22 KΩ is used as Z_2 and Flexible band as Z_1 for voltage divider circuit while V_{in} is the Flexible band supply voltage. The value of output voltage V_{out} from Flexible band will be the same as the value from calculation by theoretical equation (3).

A. Trigonometry Function:

The angle of fingers bending is decided based on trigonometry function. Trigonometry used in a calculation is Pythagorean Theorem and Point-Slope Equation as written in equation (4). Whereas (x_1, y_1) is known point, m is a slope of the line and (x, y) is any point on the line (M. Hazwan Ali *et al.*, 2013)

$$y - y_1 = m\,(x - x_1) \tag{4}$$

$$\frac{y-y1}{y2-y1} = \frac{x-x1}{x2-x1} \tag{5}$$

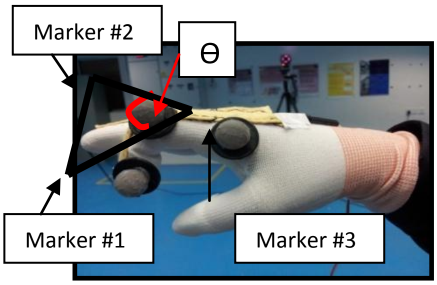

Fig. 2: Angle, Ө

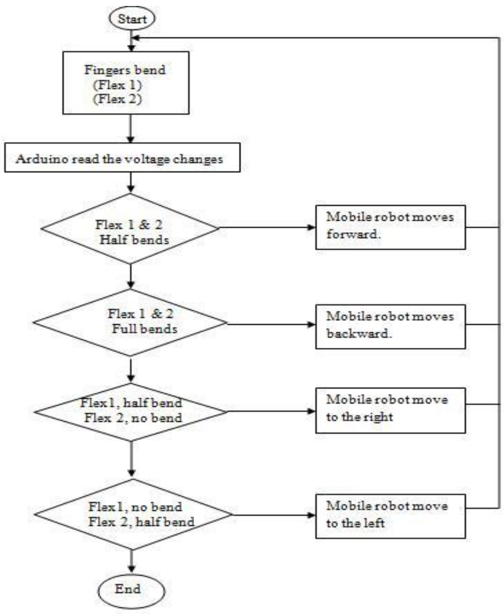

Fig. 3: Flowchart of the proposed works

Result:

A. Experimental Setup:

The angle of finger's bending will be recorded by using motion capture system which was Qualisys Track Manager (QTM) software as a medium to get the angle of finger's bending. QTM was built around set of advanced motion capture algorithms to ensuring high performance, accuracy and low latency .

Glove was setup as shown in Fig. 4. Small pockets were developed to attach the flexible band sensor to the index and middle fingers.

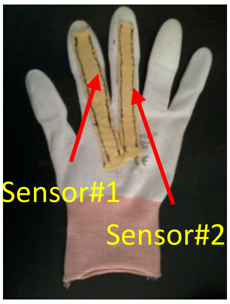

Fig. 4: The small pockets attached to the glove

In this project, there were a few of activities that involve in order giving the instruction to the mobile robot. Fig. 5 was shown the activities of fingers for both index and middle fingers.

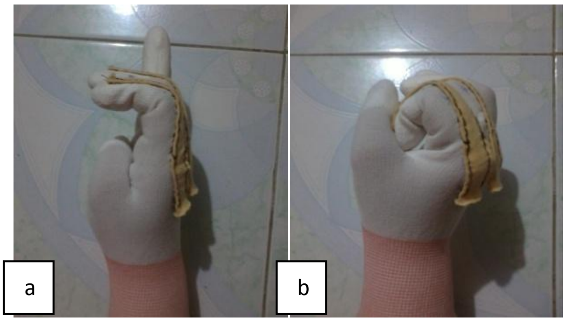

Fig. 5: Finger activities; (a) sensor#1 is half bend, sensor#2 is half bend (b) sensor#1 & sensor#2 are full bend.

Table 1: Activities trials for both fingers

Finger	No. Trial	Activities			
		Half bend		Full bend	
Index	2	HI_1	HI_2	FI_1	FI_2
Middle	2	HM _1	HM _2	FM_1	FM_2

The experiments were carried out twice for half and full bends, respectively. Each of the experiment takes 5s to complete data acquisition process.

B. Experimental Results:

HI_1 was the first trial for the half bend of index. Fig. 8 shows the result for the half bend of index and the angles movement ranges from 38.24o - 44.11o, while the voltage ranges from 3.05 V – 3.14 V.HI_2 was the second trial for the half bend of index. Figures 6 and 7 show that the fingers began to bend approaching 0.5 s for both trials and stopped at 4.2 s for the first trial and the second trial stopped at 3.5 s. The time taken for the fingers bend was different for each experiment because of different characteristic of subject.

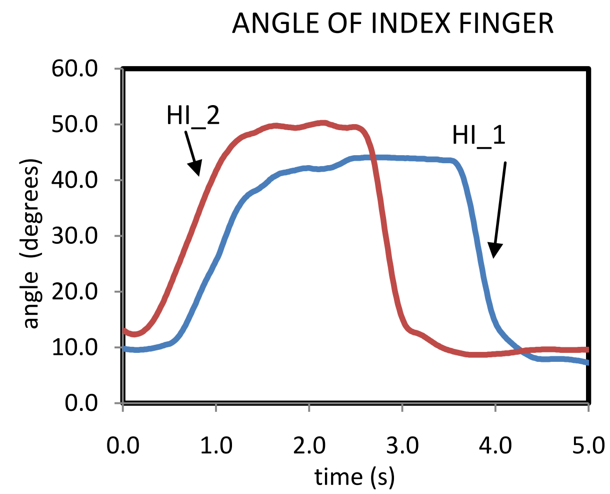

Fig. 6: Half bend of index

HM_1 and HM_2 were the first and the second trials for the half bend of middle. In the first trial, the angle movement ranges from 25.77° – 27.46°, while the voltage ranges from 3.09 V to 3.13 V. The angle movement ranges from 25.39° – 27.13° and the voltage ranges from 3.08 V to 3.12 V.

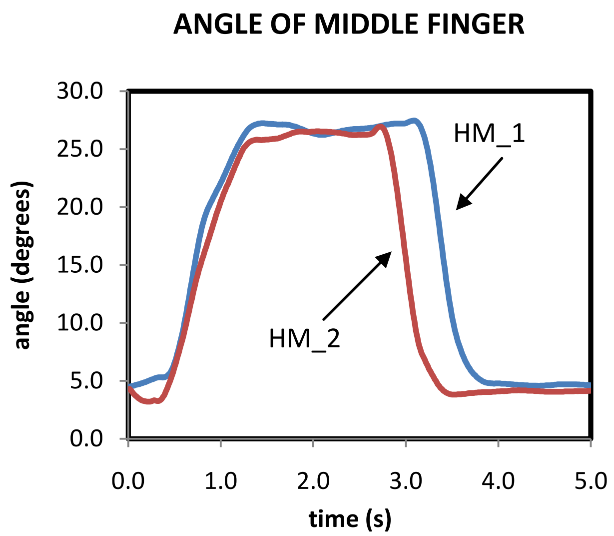

Fig. 7: Half bend of middle

In the full bend experiments, the angle of index ranges from 51° to 57.96° and 50.23° – 56.73° for the first and the second trials, respectively. On the other hand, the voltage ranges from 2.80V – 2.92 V and 2.71V - 2.89V for the first and the second trial, respectively. For the middle finger, the changes angle movement ranges from 38.88° – 40.47° and 39.13° – 40.21° for the first and second trial, respectively. On the other hand, the voltage ranges from 3.02V to 3.07 V and 3.0 V to 3.1V for the first and second trials, respectively.

Discuss:

Based on the experimental results, the ranges of finger bending had been used to program and navigate the mobile robot. The combination of voltages outputted from the sensor #1 and sensor #2 was used to navigate the mobile robot. The mobile robot moved forward without any bending of fingers while the backward direction requires half bend of the both fingers. The instruction to move left and right direction requires only one of the fingers to half bend while full bending of both fingers was used to stop the mobile robot from moving forward.

Conclusion:

From the experiment that had been conducted, the *GloveMAP* was capable to control the directions of the mobile robot by using the voltage ranges that obtain from the fingers bending activities. The combination of the voltages from index and middle fingers helps to give the instruction to the mobile robot. In the future we will develop a wireless control to navigate the mobile robot by using *GloveMAP*.

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