Development of a Pole that Provides Information Using Color of Light

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ABSTRACT

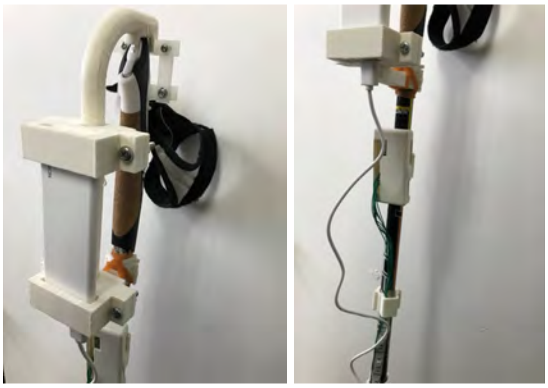
Walking sticks and poles have been widely used by the handicapped elderly, and the optically challenged to assist walking. In healthy subjects, poles have been used to move the body with more ease, such as in climbing and Nordic walking. We consider that the poles would be able to perform instructions in how to move better using LED lights and sensors. In this study, we affixed a small microcontroller, 9-axis sensor, and LED light tape to a pole using anchorages created by a 3D printer. We then devised an algorithm that changes the color of the LED depending on how the pole is moved, and we carried out the operation in an experiment.

1. INTRODUCTION

Walking sticks and poles are widely used by the handicapped elderly, and the optically challenged to assist walking. In healthy subjects, poles are used to move the body with more ease, such as in climbing and Nordic walking. For example, different behaviors by skilled persons and novices have been observed in the movements of their poles while climbing or Nordic walking[1][2]. We consider that the poles can be able to perform instructions in how to move better using LEDs and sensors[3]. In this study, we affixed a small microcontroller, 9-axis sensor, and LED light tape onto a pole using anchorages created by a 3D printer. We then devised an algorithm that changes the color of the LED depending on how the pole is moving, and we carried out the experiment.

2. System

Figure 1 shows the system we developed that we attached to a Nordic walking pole. Our system uses a Raspberry Pi Zero W microcomputer, LED tape (FLEXIA YN5050RGB-12), 9-axis sensor module (InvenSense MPU-9250), a small mobile battery, and a portable Wi-Fi. The system configuration is shown in Figure 2. It is operable using only the power supplied from the mobile battery. The mobile battery is confirmed for more than one hour of operation. We designed the anchorages for the system components using 3D CAD and a 3D printer. The anchorages can be used in correspondence with the various poles. The components are small enough so the system does not inhibit the movement of the pole. The Raspberry Pi can receive the information from the sensor about every 0.01 seconds. The Raspberry Pi automatically starts the program when powered on, and the color of the LED changes based on the sensor information.



(a) (b)

Fig.1 The appearance of the system. (a) The mobile battery is attached to the top of the Nordic walking poles. (b) Raspberry Pi Zero W, 9-axis sensor, and the LED tape are attached under the mobile battery.

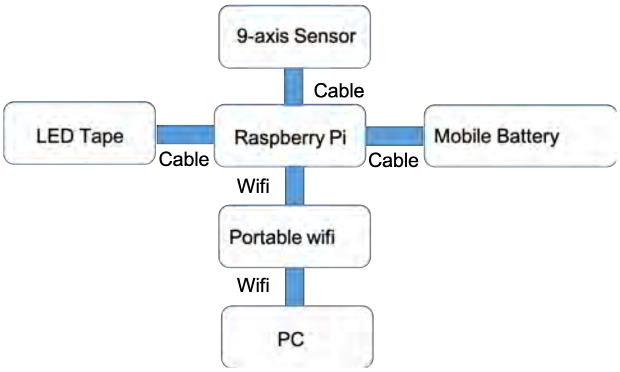


Fig.2 The system configuration.

The 9-axis sensor has the respectively three axes of an acceleration, a gyro, and a geomagnetic sensor. We attached the sensor to detect the direction of acceleration X-axis that is moved back and forth by the pole, and the direction of rotation of the gyro Z-axis that is shaken back and forth. The orientation of the pole is calculated from geomagnetic X-axis and Z-axis. Portable Wi-Fi is used to remotely control the Raspberry Pi through SSH from external PC. A remote control is not required for the LED and control of the sensor, because they are carried out in the Raspberry Pi.

3. Experiments and Discussion

A beginner walker using the Nordic walking pole equipped with this system evaluated the sensor information during walking. Figure 3 shows a graph of the original acceleration X-axis of the pole (blue) and the moving average (orange) that was performed 10 times for 2 seconds at that time. The moment where the values in the original acceleration jumped is when the pole poked on the ground. It can be seen to have been performed once in about 1 second. The fluctuation and instantaneous poked noise in the original acceleration could be removed by calculating a moving average of the 10 times. From the walking data, the acceleration X-axis was found to have values from -1 g to 1 g after the moving average. Also, the gyro Z-axis showed a range from -30° to 30°. Furthermore, the orientation of the user could be determined using an inverse trigonometric function based on the results of the geomagnetic X-axis and Z-axis.

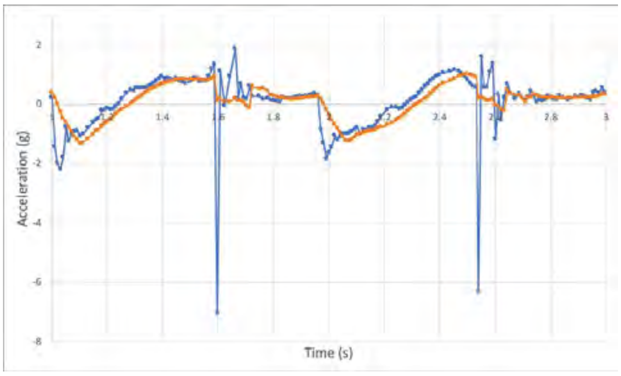


Fig 3. The graph of the original acceleration X-axis of the pole for 2 seconds (blue) and the moving average after 10 times (orange) in the beginner's Nordic walking.

Based on these results, Red LED deviates from 30% to 100% by the value of the acceleration X-axis, Green LED deviates in the same range by the gyro Z-axis, and Blue LED deviates by the orientation calculated from the value of the geomagnetic X-axis and Z-axis. It was possible to change the color of the LED based on the movement of the pole (Figure 4).

4. Conclusion

We developed a portable system to change the color of the LED tape in accordance with the 9-axis sensor information based on walking. In the future, we will carry out this experiment in actual use situations, such as Nordic walking.

Fig 4. The moment the pole flashed blue by moving it.

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