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Applying Modern Camera Technology to Guide the Visually Impaired Persons in Society: The Power of Improved Orientation and Mobility Skills for Visual Impairment

Imam Yuwono[1*], Utomo[2], Agus Pratomo Andi Widodo[3]
Department of Special Needs Education, Faculty of Education and Teacher Training, Universitas Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia.

Corresponding Author: Imam Yuwono, Email: iyuwono442@gmail.com

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***Abstract* - Today, visual impairment is a condition that has been handled through improvised guided technology to minimize challenges faced by people with visual hinderances in life. With modern camera technology for visually impaired persons, there is use of advanced cane camera technology for orientation and mobility skills. This study examines the skills of trained visually impaired people in cane usage. The study was conducted with two visually impaired participants and two with normal sight taken as the study subjects. Two-centimeter-wide green labels were attached to their tight-fitting outfits to mark the ventral and lateral body points in a standing orientation. The subjects were tasked to make cane maneuvers in a technique that involve touching and sliding using three different cane types. The movement of the labels were video recorded to derive data on the cane and arm angles, the lateral limb shifting from the body midline, and the position of the cane handle relative to the body midline. Analysis of the data extracted was conducted using EMG Analysis Software from Motion Lab Systems. The experiment's results showed that the trained visually impaired participants were better than the untrained participants with normal eyesight in cane use techniques.**

Index Terms - Visual impairment, orientation & mobility (O&M), long cane, and cane techniques.

INTRODUCTION

People with visual impairment are bound to face more difficulty when traveling than people with normal eyesight [1]. Chang et al. [2] demonstrated that the speed at which the visually impaired walking was significantly slow when unaccompanied, and they moved even more slowly on difficult route. The use of the Electromyography (EMG) technique in examining the gait of the visually impaired when they are walking discovered that they exhibited hesitation in their gait with a slow broad base pace, marked by little to no arm swinging, and with their heads in a stoop position to the front [3].

Skills in Orientation and Mobility (O&M) for the visually impaired are of vital importance in addressing the above noted issues to ease the day-to-day movements of people with visual impairment. Practitioners have noted the possibility of improved self-confidence among the visually impaired with the ability to move around and travel independently as opposed to those who have to consistently assisted by others for mobility [4] [5]. Acquisition and proficiency in vital skills mobility and travel skills may increase and broaden one's possibility of getting into occupational life, which is crucial to personal independence and easier integration into communities [6], [7]. A visually impaired person with proficient O&M skills could be free from the feelings of embarrassment or being a liability to others by continuously depending on them [8].

It is crucial therefore, that people with visual impairments easily access good mobility knowledge and necessary materials that can assist then get around conveniently. Such knowledge can be through training in mobility skills and proper use of materials like aids and other accessories vital in the mobility of the visually impaired.

There is a broad range of items developed to aid the mobility of the visually impaired that work in various ways that may be mechanical, electrical, or electronic [9-13]. Much as such items aid visually impaired people in gaining easier mobility, they cannot be an effective replacement of their cognitive abilities that they have to perform in various activities of human daily life. The most iconic mobility aid of the visually impaired is the cane, which is instrumental in their movement ant travel [14]. Against the above insights, this study formulated a question to guide this study as thus:

- What is the possibility of improving the mobility of a visually impaired person through competence training in cane use techniques?
- This study aimed at examining the cane use skills of visually impaired people who are formally trained in the skill.

METHODOLOGY

The participants in this study taken as the subjects of study comprised of two persons with visual impairment and the other two subjects were individuals with normal eyesight. The participants with visual impairment had formal training in techniques of cane use. All the participants had the right-handed orientation. The traits of the participants are shown in Table 1 below.

TABLE I
POINT SIZES AND TYPE STYLES

Subjects	Sex	Age (years)	Height (cm)	Weight (kg)	Visual Acuity		O&M Training period
					R	L	
Adv. Visual impairment	Male	26	164	54	0	LP*	24 months
Adv. Visual impairment	Male	30	166	57	0.02	0.03	6 months
Normal Vision	Male	24	168	58	-	-	-
Normal Vision	Male	32	166	54	-	-	-

The experiment was carried out using video capture equipment (Canon XC10 4K camera) to record the participants' movement. The recorded video was transferred to a computer and analyzed using EMG Analysis Software from Motion Lab Systems. The participants dressed in body tight fitting garments, then two-centimeter-wide markers were attached to points on their ventral and lateral side if their body (Fig 1). A total of nine markers were attached to the participants.

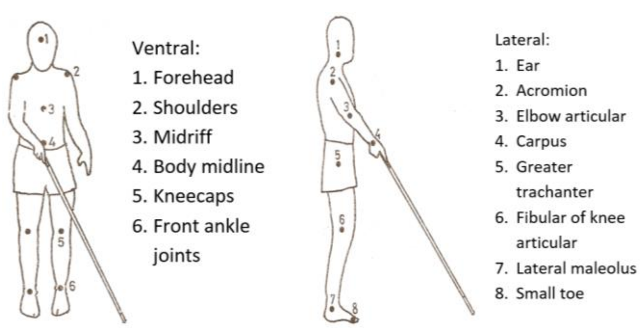

FIGURE 1
MARKERS ON THE VENTRAL AND LATERAL BODY PARTS

To mark the ventral side of their bodies, the following parts were marked: head, shoulders, body midline, the midriff.

Kneecaps and the front of the ankle joints. The lateral side was marked at the front of the ear opening, the shoulder sides, elbow, wrist joint, pelvis side, knee joint side, the ankles, and the side of the small toe.

In a standing posture, each subject was asked to operate 3 types of canes in touch and slide techniques. The participants tasked with maneuvering each cane type 100 times in specified ways. In order to maintain the rhythm of cane swing while using such tactics, a metronome was used and was positioned 3 meters in front of the participant. Two cameras were used to record the motions of the markers on the participant's bodies in order to collect data on the cane angle, arm angle, lateral hand movement from the mid bodyline, and the separation between the cane handle and the mid bodyline (Fig. 2). The front side of one camera was 6.4 meters away from the experiment's line of sight, while the side of the second camera was 4.5 meters away. After recording, the data was examined using EMG Analysis

Software from Motion Lab Systems. Camera arrangement was as illustrated in Figure 3.

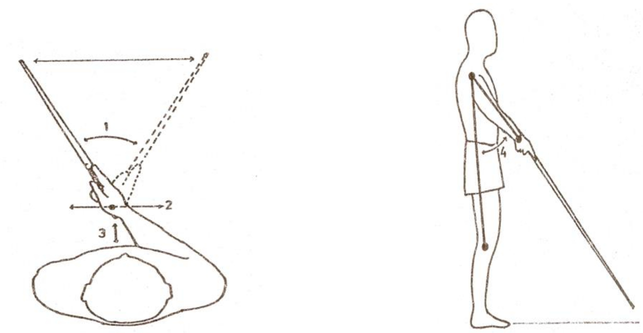

FIGURE 2
MEASURING POINTS

The measuring points sought (as in Figure 2) were to measure the cane angle, the lateral hand movement, the space between the cane handle and body midline, and the arm angle.

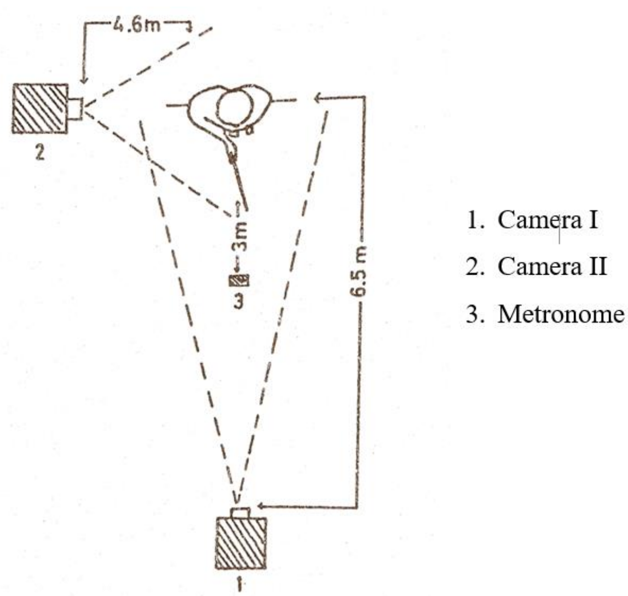

FIGURE 3
CAMERAS AND METRONOME ARRANGEMENT IN THE EXPERIMENT

RESULTS AND DISCUSSION

In 100 trials using 3 different cane kinds, the participant's cane angle curves were calculated. The long cane angle (28.08°) was bigger than the short cane angle (23.21°) or the correct cane angle (23.27°), as shown by the graph. Figure 5 illustrates how the cane angles of the sighted subject (28.73° to 52.33° in touch, 26.62° to 65.07° in slide techniques) were broader than those of the patients with visual impairment (22.98° to 28.09° in touch, 24.87° to 36.36° in slide techniques).

All participants' lateral hand movements (6.72 to 15.07 cm for touch and 5.81 to 15.76 cm for slide methods) from the mid-sagittal plane showed that they were larger than the patient with vision impairment (4 .21 to 9.68 cm in touch, 1 .82 to 11.71 cm in slide techniques). This shows that when using the cane methods, the participants with normal eyesight moved their hands rather than their wrists.

All of the visually impaired participants' arm angles for the touch method (34.25° to 40.24° in touch, 33.06° to 37.98° in slide techniques) were higher than their counterparts' with normal eyesight (28.50° to 32.54° in touch, 28,28° to 35.22° in slide techniques). The cane location was determined by measuring these angles. The cane is held in a downward posture if the arm angle is small. the distance between the body's midline and the cane's handle.

All of the visually impaired participants' arm angles for the touch method (34.25° to 40.24° in touch, 33.06° to 37.98° in slide techniques) were higher than their sighted counterparts' (28.50° to 32.54° in touch, 28,28° to 35.22° in slide techniques). The cane location was determined by measuring these angles. The cane is held in a downward posture if the arm angle is small. the distance between the body's midline and the cane's crook. The gap between individuals with visual impairment and those with normal vision was higher (15.19–17.14 cm for touch and 10.20–17.26 cm for slide methods) (7 .81 to 14.45 cm in touch, 7 .46 to 17.29 cm in slide techniques). This indicates that when using cane methods, the individuals with normal vision held their hands closer to their bodies than the ones who were visually impaired.

Body height and cane length, arm length and cane length, and body height and arm length are all correlated. Figure 9 displays a positive association (r=0.61) between body height and cane length. Although there is no association between arm length and cane length (r=0.10), body height and arm length do have a positive correlation (r=0.59).

The participants with visual impairment had a better position than the participants with normal eyesight in these aspects, according to the relationship between the mean and standard deviation of the cane angle, lateral hand movement, arm angle, and the distance between cane handle and body midline in the touch technique.

CONCLUSION

In conclusion, O&M training is crucial for those who are visually impaired. Good O&M abilities help the visually impaired person not only move freely, but also increase his possibilities for job and independent life in the society. The results of the trial demonstrated that while using the cane skills, the blind person outperformed the sighted person outperformed the sighted person. Additionally, the length of the cane must first be adjusted to the user's body height before engaging in cane skill training. The O&M profession has never seen an inquiry like this one. Longer-term follow-up research should be undertaken on this issue in order to have a deeper understanding.

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