

Novel Way of Measuring Inter-Person Distance: A Study Involving an Ultrasonic Measurement Device

A new measurement technique called 'ultrasonic measurement device' is introduced concerning inter-person distances in order to be used in pedestrian movement experiments in the field of evacuation.

The quantitative characteristics of people movement that form the fundamental diagram have an important role in the field of Fire Safety Engineering regarding evacuation. The fundamental diagram indicates the relation between crowd speed and crowd density (or inter-person distance) or flow of crowd and crowd density. These correlations are used in designing the means of egress in buildings and also computer simulations of evacuation. For either cases, the data of people movement is needed which is collected from evacuation experiments. Measuring these parameters is difficult when using traditional methods, e.g., video cameras. In this study, a new way of measuring inter-person distance by using an ultrasonic measurement device is investigated. The aim of this study is to verify the accuracy of inter-person distance data collected using an ultrasonic measurement device. This type of system works according to the principle that ultrasonic sound is emitted from a speaker and the time until the sound bounces off an obstacle in front and reaches a microphone is measured. The time can then be used to calculate the distance to an obstacle (e.g. person) in front of the device (or person carrying the device). As this measurement technique is a novel technology that is used for people movement and it has not yet been properly calibrated and tested, individual and group experiments were performed in order to obtain data. These controlled walking experiments were carried out in a corridor with a certain number of participants while one person carried the device. The accuracy of data obtained from the ultrasonic measurement device had been verified up to a specific inter-person distance, i.e., 2 m. The essential outcomes from individual and group experiments are as follows, the study primarily shows that the ultrasonic measurement device gives accurate values when used for the distances up to 2 m in people movement experiments. In addition, the ultrasonic measurement device collects more reliable data while pointing at a solid surface since the sound bounced off hard surfaces better. The study also indicates that the data obtained from ultrasonic measurement device is from the obstacle directly in front. Moreover, the movement of the limbs of the person in front do not affect the results. Furthermore, the ultrasonic measurement device must be carried carefully during walking experiments in order to get accurate values. The results from individual and group experiments were mostly accurate with 5% of differences between actual inter-person distances and measured ones. Measurement, procedure and systematic errors that occurred while performing experiments can result in some measurement uncertainties. Moreover, the advantages of this newly measurement technique are that the ultrasonic measurement device is relatively cheap, the device is easy to be assembled and the device is practical to be used in pedestrian movement experiments. However, the procedure of experiments must be carefully applied. The accuracy of data obtained by ultrasonic measurement device regarding inter-person distances had been verified which is the purpose of this present study.