S. Lee, S. Kim, J. Jeon, J. Lee, S. Yim. ***A 3-dimensional model to detect dangerous situations in the use of a 4-wheeled walker.*** *Gerontechnology 2016;15(suppl):17s*; doi:10.4017/gt.2016.15.s.808.00 **Purpose** A 4-wheeled walker is designed to assist a walking person, but it cannot handle all situations. Moreover, Buurke et al.[1] reported that the postural sway of a patient group was higher than that of a control group when the subjects were placed in the same position with the same assistive device. Moreover, if the user is a disabled person or senior citizen and cannot master the walker under certain circumstances, s/he will be in danger. To preventing this danger, we should know under which circumstances a dangerous situation may arise. In this study, several states of a moving 4-wheeled walker are defined in relation to its user. Also, we suggest a model to classify both stable and dangerous states. **Method** In this research we used a standard 4-wheeled walker, and we assume that in a precarious situation the user will slow the speed of walking. The dangerous state is divided into four different status: (i) the distance between the walker and its user is too large; (i) The acceleration of the walker is too strong because of a steep incline; (iii) One or more wheels of the walker fall into a hole; and (iv) The wheels of walker drop down. The raw data, walker-user distance, frontal and horizontal angle, and acceleration, are collected to define dangerous states of the walker in a numerical way. Tyson[2] measured the subject's trunk movements and velocity as they walked using CODA, three-dimensional movement analysis system, which uses scanning techniques to detect the position of markers. We propose a model that discriminates between normal and dangerous situations by using raw data from two sensors accel-gyro sensor (mpu6050-GY521) and ultrasonic range finder (HY-SRF05). Accel-gyro sensor measured acceleration(A), horizontal degree(θ), and vertical degree(θ'). Ultrasonic range finder measured the real time distance(S) between user and 4-wheeled walker. The model is composed of three points (triangle) in a 3-dimensional space and is affected by distance, degree, and velocity. First, for calculating each point of the model, the center of range finder's cradle was set at ground level. Subsequently, the front and back of the user were set as x-axis, the left and the right as y-axis, and the up and down as z-axis. After assuming a width w of the 4-wheeled walker, we could set the first fixed point of the triangle as (0, w, 0). The other points are moving fluently. After we acquired their coordinates, the area of triangle has been calculated. One other point is the center of the user. This coordinate (s+0.5*a*t*t), 0, 0) moves following the x-axis. The final point is located opposite of the first point relative to the xy-plane. But this point (-w*tan(θ), -w, -w*tan(θ')) becomes to be far from ground level when the walker's frontal and horizontal symmetry has collapsed. Consequently, if the user faces a dangerous situation, the area of triangle will change according to distance, velocity and degree. Crosbie[3] distinguished gait pattern between the walking frame followed by right foot and followed by the left foot. This pattern classification was developed in our study, response to model with the combination of θ' and A. **Results & Discussion** In six kinds of abnormal situations, the area (m^2) of the triangle has been calculated iteratively by this model to identify dangerous situations. The area of the triangle is between 0.035 and 0.055m^2 in case all experimental conditions are stable (the normal situation). However, when the area of the triangle is larger than 0.080m^2, experimental conditions enter an abnormal situation. As a result, we state that it is dangerous when the area of the triangle is between 0.055 and 0.080m^2. Control of the wheels is needed in case the area of the triangle exceeds 0.080m^2. With these results, the status of a 4-wheeled walker may be assessed immediately to take the proper sequencing action for an elderly person who uses the walker.

References

1. Buurke JH, Hermens HJ, Erren-Wolters CV, Nene AV. The Effect of Walking Aids on Balance and Weight-Bearing Patterns of Patients with Hemiparesis in Various Stance Positions. Gait & Posture 2005;22(2):164-170; doi:10.1016/j.gaitpost.2004.09.003
2. Tyson S. Trunk kinematics in hemiplegic gait and the effect of walking aids. Clinical Rehabilitation 1999:12(5):295-300; doi:10.1191/026921598669871795
3. Crosbie J. Comparative Kinematics of Two Walking Frame Gaits. Journal of Orthopaedic & Sports Physical Therapy 1994;20(4):186-192; doi:10.2519/jospt.1994.20.4.186

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