Advanced Science and Technology Letters
Vol.140 (GST 2016), pp.115-120
http://dx.doi.org/10.14257/astl.2016.140.23

Assured Data Device with Airports and Public Wheelchair Fall Prevention System

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Abstract. The structure of the wheelchair is primarily, is fallen front, it is possible to safety accident of the passenger occurs. Terrain, if the wheelchair posture is not correct in accordance with the feature, it is impossible to ensure the safety of the rider. Wheelchair passenger using an acceleration sensor in order to safely use, was to be able to display the value of the ACR in real time. In this study, we use the algorithm of SDD (Safety Data Device) was developed it is possible to output and early detection of the wheelchair of attitude data.

Keywords: Wheelchair, Safety data device, Sensor Module, Accelerometer.

1 Introduction

Aging society means a society in which the elderly population increases with the development of medical technology. For the safety of people with disabilities and many elderly with weak physical body similar conditions, the interest in medical equipment such as wheelchairs has increased. In particular, in the uphill, the wheelchair fall accidents, such as arms, legs, fractures or concussions, small chin and obstacles wheelchair overturned by the occupying a large part. As this is one of the biggest factors hurting the wheelchair unstable posture. When you cross the ramp in a wheelchair or on uneven roads, the state of its own and its occupant so unstable, and soon, the greater the probability lead to a fall. So by using the acceleration sensor measurement data, and proposed an algorithm that can early detect a fall risk of elderly who use wheelchairs. By early to recognize the danger and warning, passengers should prepare themselves to be aware of the risks. In addition, it will be able to get help when people work around airports and public facilities [1].

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ISSN: 2287-1233 ASTL

2 Paper Preparation

2.1 The Structure of Wheelchair

The left part is a schematic diagram showing the motion of the electric wheelchair. The wheelchair's motion is determined by the two rear wheel rotations, Θ_R and Θ_L, determined by the passenger. In this figure, b is the width of the wheelchair, and e is the vertical distance from the wheelchair width center to the center of gravity. Motion state of the wheelchair can be accurately described by Φ_P, and the coordinates X and Y represents the position of the center of gravity, P indicates the direction proceeding wheelchair. The relationship between these variables is determined by Equations 1 to 4, and the following assumptions apply to the derivation of these equations.

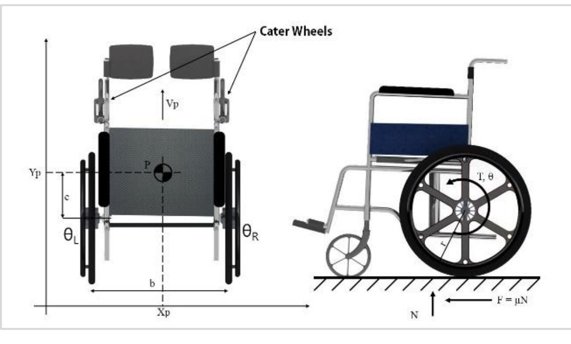
$$\dot{x}_p(t) = v(t)\sin\varphi_p \tag{1}$$

$$\dot{y}_p(t) = v(t)\cos\varphi_p \tag{2}$$

$$\dot{\varphi}_p(t) = \frac{\dot{\theta}_R - \dot{\theta}_L}{b}\mathrm{r} = \frac{\dot{\omega}_R - \dot{\omega}_L}{b}\mathrm{r} \tag{3}$$

$$v(t) = \frac{\dot{\omega}_R + \dot{\omega}_L}{2}\mathrm{r} \tag{4}$$

In the above equation, V(t) is the speed of the wheelchair, ω_R and ω_L are the rotational speed of the left and right rear wheels, and r is the radius of the rear wheel, respectively. By Θ_X and Θ_Y will have rear-wheel rotational angular speed, ω_R and ω_L. The speed of the wheelchair are determined by the equation 4, all values of the state variables are determined, (X_p, Y_p, Φ_p) representing the motion of the wheelchair therefrom.



Many disabled people are using wheel chair, especially low cognitive ability people spend too much time using wheelchair. As can be seen, All geographical features is not optimized for people. In unpredictable area, people who use wheelchair run a risk of a overturn or damage. Therefore, we want to protect them from unpredictable geographical features. In order to measure the geographical features such as uphill road, It is measured using a acceleration sensor. The acceleration sensor is used to measure instantaneous inclination due to law of inertia when the wheelchair move.

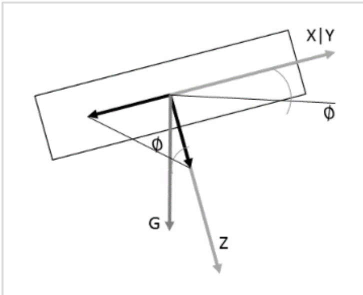


Fig. 2. The acceleration sensor structure

Figure 2 is the structure of the measuring device the accelerometer, we will measure the angle of the clockwise direction as negative based on the point O. Based on the absolute angle with respect to the ground and perpendicular to the surface, the angle of the acceleration sensor is obtained with respect to the ground and each of the horizontal plane. Thus, 90°(π/2) should be subtracted from the angle calculated from the acceleration sensor. Finally, considering this two condition, (5), (6) are demonstrated.

$$\Phi = -\tan^{-1}(-z/x) - \pi/2 \quad (5)$$

$$\Phi = -\tan^{-1}(-z/y) - \pi/2 \quad (6)$$

Using the above equation, the output angle, but it is not possible to measure the correct value due to noise. In this dissertation, using a Kalman filter to measure the angle. When using only the acceleration sensors, although the value of the sensor output is fast, but a lot of noise occurs in the fine vibration. For a Kalman filter, the output speed is somewhat slow, and outputs the value of high accuracy [2].

3 SDD (Safety Data Device)

3.1 ACR (Attitude Control RMS) Algorithm

ACR value is calculated using the formula, x, y, z means each axis. ACR values are higher the more urgent motion big changes. In particular, in the case of falling, the value can be recognized because of the risk of rapidly changeable.

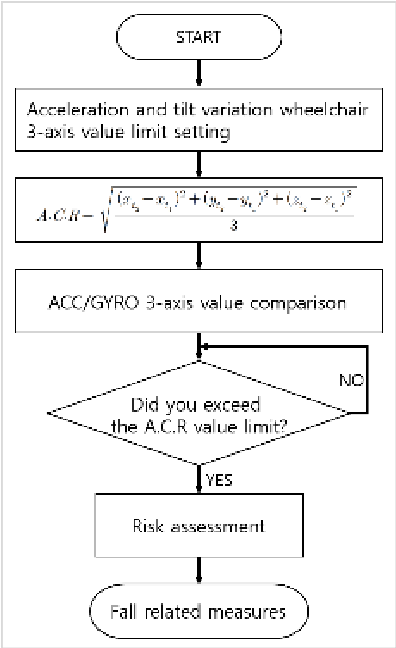


Fig. 3. SSD algorithm

SDD (Safety Data Device) will determine the amount of change in acceleration and tilt the wheelchair. A comparison of the ACR value of the acceleration sensor, and then, if it is greater than the threshold it is determined as dangerous and informs them [3][4].

4 Conclusion

4.1 SDS (Safety Data Device) Danger Zone Detection Using Algorithm

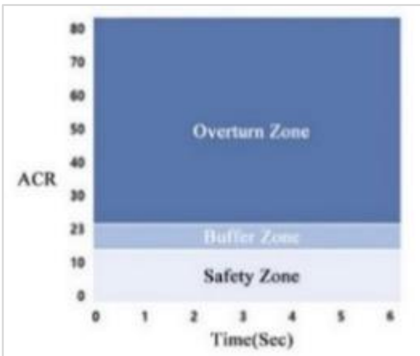


Fig 4. SSD segment-specific graphs.

Figure 4 is a top display section based on the acceleration value ACR. On average, the measurement signal detected when moving in the daily life by a value 0 to 17 belong to the normal zone. 18 and 25 is a buffer region, the value is measured when the center of the wheelchair changes in order to avoid falling or unsteady. After the 25, falling zone, the values measured when fully wheelchair fell down.

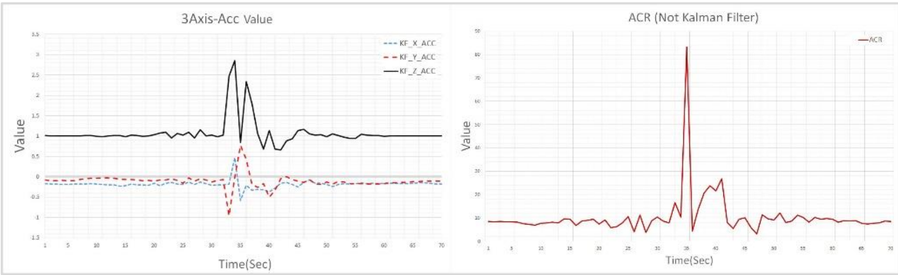


Fig. 1. Acceleration and inclination of workaday ACR

Figure 5 is a graph of the ACR value obtained by measuring the acceleration and the inclination is measured in daily life. And the acceleration change amount can be sure that almost does not exceed the daily interval. Figure 6 will apply the Kalman filter in the ACR data, the rapidly changing ACR value that makes the output is stable. A section where the output using the Kalman filter, the resulting data as it passes through the bumps in the flat.

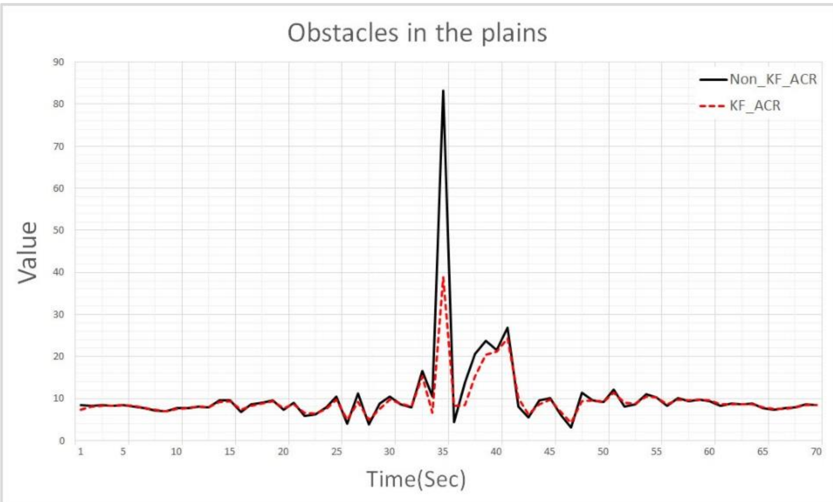


Fig. 2. Comparison of the data and the Kalman filter

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