A Safe Walking App for Pedestrians

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ABSTRACT
People are inseparable with smart mobile devices with the convenience and popularity of them. People often use mobile devices during fragmented time such as sitting or standing. There is a trend that users are texting while walking. In this situation, the mobile device would block most of vision of users resulting some accidents happened. Although texting while walking is dangerous, it is impossible to avoid it. Therefore, this paper proposes an App utilizing mobile devices G-sensor and camera to detect unsafe roads to help people to avoid the above accidents. The experimental results demonstrate that the detecting rate of the proposed App is over 95%. The proposed system is a good alternative for safe walking.

KEYWORDS
Smart Phone, Safe Path, G-sensor and Camera.

1 INTRODUCTION
It’s a trend that more and more people flick their smart phones while they are walking. This behavior would make jobs more efficient. This situation also generates a lot of unexpected events, because users focus on the screen when they walk. The mobile device screens block most of the view. Especially, there is a growing trend in the current mobile device screens such as the latest iPhone. It has a 4-inch big screen. HTC’s One Max has 5.9 inch big screen. And Samsung's Galaxy Tab has 8-inch large screen. In this case, the user will easily collide with an obstacle or fall down by undulating terrain. In October 2013, there was a girl who lived in Shiyan City passed away in an accident. Because when she was playing the mobile device, she was walking at night. She did not notice the surrounding environment and fell into the pit. Unfortunately, she died after she was sent to hospital. The Japan NTT Docomo Company recently launched advertising in major stations to remind users the risk of using mobile device while walking on the street [1].

Japan NTT Docomo Company developed an App in order to resolve this issue. Whenever the App conscious of users using mobile devices while moving, it will automatically show a warning to remind the user. This App’s conception is good, but the utilization rate is not high. Mainly due to the wisdom of this App is not enough. Because walking and slipping mobile devices is inevitable trend. This App will warn the users when it detects the mobile devices moving event. It would bring about great inconvenience to the users to lead to the users close this App. A useful App not only to detect the users using mobile devices when walking, but also to determine user will encounter dangerous or not in the front of the road. If there is an obstacle on the road, uneven pavement, etc. When the user will encounter the dangerous road, APP will show a warning screen. To design a "smart" App is this paper research goal.

To design a smart App, there are two issues that need further study. The first one is how to efficiently and accurately determine walk and slide mobile devices this event. And the second is how to efficiently and correctly detect users will encounter dangerous roads. Using the mobile device axis accelerometer is provided to solve the first question. The second problem can be solved by mobile devices camera to do the analysis. It has been a very hot research topic for how to use the information of three-axis accelerometer on the
mobile devices to determine the user's behavior [2-13]. But in this paper, just only want to detect the walking and slipping event to mobile devices. On the other hand, using the video processing techniques to detect the dangerous road is also a hot research topic [14-19]. Previous researches used this technology in the computer to help blind people find safe path. This research paper topic extends to looking dangerous on the road. The difference between the two studies is in the use of different platforms and immediacy (Real Time) requirements. In this paper, the computing power of mobile devices is less than most computers. But the dangerous road warnings need to be completed within two to three seconds. Therefore, it makes traditional way to find safe path algorithm does not apply in this paper. Fortunately, finding the safe path problems are more complex. It will lead to safety hazardous road conditions is relatively limited. In other words, the object of this paper to be detected is easier than the blind find safe path. It makes the feasibility of this paper increased. However, how to find danger of the road immediately on mobile devices still need further study. This paper will divide the dangerous road into two levels. The risk of the first stage (the most dangerous) situation is using mobile device while walking in the low light environments. The second level of danger is that there are the stairs or threshold in front of the road. The algorithm proposed in this paper will give priority to detect dangerous first stage road immediately and show the warning on the screen. Then, process the second stage deal with dangerous roads.

The remainder of this paper is organized as follows: Section 2 describes the related works in safe path detections; Section 3 describes the technology for safe walking; Section 4 shows the experimental results of the proposed App; Section 5 gives the conclusions and future works.

2 Related Works

The following introductions describe the use of three-axis accelerometer information to determine the user's behavior and the use of video processing techniques to detect the users will have encountered dangerous road.

How to use the information of three-axis accelerometer on mobile devices to determine the user's behavior has been a very hot research topic [2-6]. In the literature [2], the scholars mentioned gravity sensor data collection should be 15-16HZ in the Nyquist rate. The maximum rate permitted by the signal frequency is 8Hz. It is considered to be adequate representation of the human body activity. And there are four frequency modes in the Android operating system: general mode (5Hz), interface mode (15Hz), game Mode (50Hz) and high speed mode (100Hz). So the best frequency to analyze the human body is 15Hz. If the frequency is too low, you may ignore a lot of important changing information; on the contrary, if the frequency is too much, the false positive rate will be increased by the unnecessary data. In literature [3], Davide Anguita et al proposed to extract 17 kinds of characteristic values from triaxial sensor on the smart devices. Utilizing these characteristic values to use Support Vector Machine (SVM) classifier to identify 15 kinds of basic human activities.

In addition to the Information of three-axis accelerometer can determine the user's behavior outside. It is also widely used as the fall detection [7-13]. Especially for senior citizens, many studies can divided into two ways: one is fixed the mobile devices’ direction, and the other one is to put any place on the body. Yi He who proposed to plug in the waist area to calculate the amount of change in the three-axis head-on the mobile device screen (Signal magnitude Area SMA) as the switching threshold of human activities, and then after SVM classification triaxial sensor features a variety of activities [7]. In literature [9], Yabo Cao et al proposed a fall detection system E-FallD. Users must enter their basic information. Such as body weight, age, emergency contact number. The system will be adapted the appropriate threshold value according to these data. Use the value of the three-axis sensor to separate current state of the user via SVM classifier. If the user falls down, the system will distribute the newsletter to the corresponding emergency contact phone.

Using video processing technology to find secure path to help blind can be divided into the following two categories: The first category is the three-dimensional spatial structure reconstruction method, the second is the object identification method. For the Reconstruction method in three-dimensional structure, SFM (Structure From Motion) technology is one of the most commonly used. The method found in the corresponding objects from multiple images. These objects using the corresponding Epipolar Geometry basis three-dimensional space, and then the other images in accordance with the method described above to find the corresponding article continued
adding visual information. The accuracy of this method although relatively high, but it takes a lot of computing costs. In the year 2007, Davison, AJ et al MonoSLAM (Monocular Simultaneous Localization and Mapping) [14], so that the operator can instantly SFM, and Engin Tola and other scholars use the camera dynamic photography to restore the actual scene of the three-dimensional space [15], the use of RANSAC-based F-matrix to extract the displacement of each of the images from the F-matrix in each of the image is converted into a relative of the projection matrix, use the matrix 3D reconstruction of the scene objects. And R. Alberto other scholars use the dual camera 3D scene reconstruction, this study area before using the camera to normal road inclination of the axis accelerometer to calculate the resulting filter out the background and does not touch the obstacle, you can reduce the amount of image processing, come to the SFM concept, with multiple images in a row than to the relative position of each video image, SURF algorithm using images taken at the corresponding position, the algorithm with respect to the SIFT algorithm much faster, in the feature point extraction time can save a lot of time, although the relative ratio of the feature points make a slight deviation, but have the ability to identify the location corresponding to the coordinates, SURF algorithm used to identify the feature points of each image, in accordance with the feature points of the sub narrative similarities to the corresponding feature points, using a linear combination of the image capture to identify the corresponding transformation matrix H, then each image matrix H is calculated using real world scenarios, such that each pixel value with the coordinates of the three-dimensional space, after obtaining the pixel coordinates, the use of flat road pavement of coordinate values may be calculated, and then determine whether there is an obstacle on the road.

3 Proposed Schemes

Unlike traditional three-axis accelerator information to determine the user's behavior and fall detection, this paper is relatively simple to detect events, walk and only want to detect mobile devices to slip. This paper will first detect whether the user is currently using a mobile device, users can take advantage of this event to detect touch events on mobile devices offer, if this touch event starts too often, the user has been identified as in the slide mobile devices, the next will be to determine whether the user is walking.

In this paper, the use of three-axis accelerometer characterized by changes in the amount of total power (Gval) the change of the subject to detect whether the user is walking events. Axis accelerometer of the mobile device will generally provide X-axis, Y-axis and Z-axis of the acceleration values, so that it corresponds to the value of Xval, Yval and Zval, is calculated by the following formula Gval

\[ Gval = \sqrt{Xval^2 + Yval^2 + Zval^2} \] (1)

Under normal circumstances, the mobile device has been suffering from the effects of gravity, so Gval value will equal 9.8 Newton (N), when the mobile device by external influences Gval value will change, this paper will use to detect changes in the value Gval whether the user is walking, standing below the first for the user to walk up stairs, down the stairs, take the elevator up and take the elevator down to situational analysis numerical status Xval, Yval, Zval and Gval’s.

The experimental analysis of the above-described display, via a change in the value Gval of the current user can detect the vibration of the force generated by the use of changes in the value Gval can detect whether the user is walking. When a user sitting or standing use of mobile devices affected only by gravity, Gval numerically stable at about 9.8N, when the shock when walking the user will have the force of others, these forces would generate shock value of Gval and when the user down the stairs or take the elevator when external force acts suffered different, leading to different distributions Gval value, the paper plans to use Support Vector Machine (SVM) classifier numerical classification Gval, when the mobile device the current value is SVM classifier Gval categorized as when walking, and the user touch event start times greater than a Threshold value, the proposed system will determine the user is walk and slip your mobile device.

For dangerous road to walk and slide mobile devices of this paper is divided into two levels, the risk of which the first stage (the most dangerous) situation is bad when the surrounding light is still walk and slide when a mobile device, the second level of danger in front of the obstruction of stairs or threshold. Detection of the road because of the danger of immediate needs, so when the walk and slip out of your mobile device event is detected, the algorithm proposed in this
paper will first detect the first level of dangerous road, if the first-class road hazard is detected, the system will generate a warning screen immediately, otherwise referred to in this paper detection algorithm and then the second stage dangerous roads. The following instructions were both dangerous road of detection algorithms.

When bad when the surrounding light is still walk and slip a mobile device is the most dangerous, poor light is the biggest feature of this situation, this paper will use this feature to detect this dangerous road. Mobile devices because of the capture of the original video signal to RGB, RGB Domain under less likely to make the light signal strength detection, this paper will convert RGB to YUV signal signals, RGB signals Y-Channel Signal transfer formula is as follows:

$$Y = 0.299R + 0.587G + 0.114B$$  \hspace{1cm} (2)

Then averaging the resulting Y-Channel signals, if the average value is less than a threshold value, it is determined that this time the poor light, the system will alert the user to produce the picture.

Obstacles in front of this paper is currently locked for a second level of danger on the road stairs or threshold, the proposed algorithm will detect whether the action of the video capture device stairs or threshold, Scale Invariant Feature Transform (SIFT) technique and Speeded Up Robust Features (SURF) technology are two frequently used algorithms to find a particular item, which is a SIFT feature points extracted from the image than to identify the location of the corresponding algorithms, which feature points have the main characteristic feature of the anti-image size, angle and brightness changes in the scale space (scale space) among the Gaussian function difference (Difference of Gaussian, DOG) extracted feature points in the image; and SURF technology is the use of the integral image (integral images), the image with a Gaussian second order differential filtering operation converted to simple addition and subtraction, and according to Hearst matrix (Hessian matrix) to calculate the approximate value of the feature point response, response can be carried out when the pair of feature points image comparison.

4 Experimental Results

In this study, the computer is equipped with ASUS X550V processor Intel Core i5-3230M, 2.6GH memory image Fps 4G operating system Win 8, flat mobile devices recorded approximately 29 In this study, the numerical count of triaxial acceleration through SVM model users currently used to determine the context in which the SVM using LibSVM as judged by the context of the use of libraries, since the library easy call, will be used to effectively classify context, and in part using OpenCV image processing of the Java Native Interface (JNI) to write program.

Figure 1 for the computer simulation of the back film, the figure to the left of the image for the video image, the picture in the middle of the obstacle edge image, the edge of the white pixels is an obstacle, the green outline of the figure of the previous two for obstacle detection of range, round whom the picture to the right, to alert the user if there is an obstacle in front of the current ambient light is dim or, if dangerous situations can cause the user to a red circle will inform the user as Figure 1 (a ), whereas the green circle to inform the user places the current front-lit environment without obstacles and as Figure 1 (b).

![Figure 1](image)

**Figure 1** Examples of a computer simulation.

To verify this study walk and slip algorithm correctness of mobile devices, set in front of the camera to record the user is currently doing for the five individual test subjects will walk and slide mobile devices in a lab environment, while using mobile devices after the image for about 1 to 2 minutes, the film speed 29 images per second, the correct way to judge the rate of the number of exposures have been among the judge how much do the correct percentage based on the number of
sheets, test results are shown in Table 1, average number 1970 per image data sheets, images are no obstacles for the safety of the images averaged 961; 1009 dangerous road, there are images, to determine the correct rate for the calculation of the program, so when you calculate the road safety program to determine the safety and the program to determine the risk of dangerous road dividing the number of images in the program can get the correct rate, the data show that this system has a 95.08% rate of correct and efficient algorithms to determine the obstacles.

Table1. Experimental results

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<th>Danger Pavement</th>
<th>Program sentence Breaking safety</th>
<th>Program sentence OFF danger</th>
<th>Program sentence Breaking safety</th>
<th>Program sentence OFF danger</th>
<th>Wrong frame</th>
<th>Correct rate</th>
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<td>946</td>
<td>31</td>
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5. Conclusions
This paper proposes the use of mobile devices to remind obstacle warning system, so that users can feel at ease using mobile devices in the side walk. The system can effectively use accelerometer values to determine whether the user is running the current situation, and the use of images processing techniques to detect the user in front of the road if there is danger of the situation.

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