RunPlay: Action Recognition Using Wearable Device Apply on Parkour Game

Shi-Yao Wei
National Taiwan University
Institute for Information Industry
Taipei, Taiwan
sywei@iii.org.tw

Chen-Yu Wang
National Taiwan University
Taipei, Taiwan
benben994@hotmail.com

Ting-Wei Chiu
National Taiwan University
Taipei, Taiwan
s8803111@gmail.com

Yi-Ping Lo
Institute for Information Industry
Taipei, Taiwan
twmaypl@gmail.com

Zhi-Wei Yang
National Taiwan University
Taipei, Taiwan
r04922169@ntu.edu.tw

Hsing-Man Wang
Institute for Information Industry
Taipei, Taiwan
hmwang@iii.org.tw

Yi-Ping Hung
National Taiwan University
Taipei, Taiwan
hung@csie.ntu.edu.tw

ABSTRACT

In this paper, we present an action recognition system which consists of pressure insoles, with 16 pressure sensors, and an inertial measurement unit. By analysing the data measured from these sensors, we are able to recognised several human activities. In this circumstance, we focus on the detection of jumping, squatting, moving left and right. We also designed a parkour game on a mobile device to demonstrate the in-game control of an avatar by human action.

Author Keywords

Action recognition; activity identification; Inertial measurement unit (IMU); Pressure insole; Internet of things.

ACM Classification Keywords

B.1.1. Control Structures and Microprogramming (D.3.2): Control Design Styles; J.3. Life and Medical Sciences; J.7. Computers in Other System (C.3): Command and control; K.8.0. Personal Computing: General

UIST'16 Adjunct, October 16-19, 2016, Tokyo, Japan
ACM 978-1-4503-4531-6/16/10.
http://dx.doi.org/10.1145/2984751.2985731

INTRODUCTION

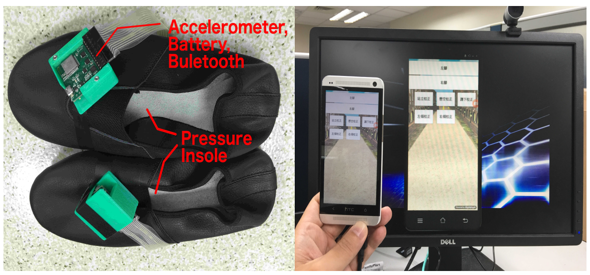
The most widely used methods for capture human activities are the motion capture systems, such as OptiTrack and VICON. These systems track human skeleton by using several InfraRed cameras to track the reflective markers attached on body. These require the reflective markers to be attached at precise location, in order to obtain the accurate results. However, precise placement of reflective markers requires experienced and professional technicians. Furthermore, these systems are not portable, they can only be used in particular spaces which the systems have been set up. Thus, these kind of motion capture systems are not suitable for daily activities monitoring.

Since the electric circuits and integrated circuits have decreased in size and in manufacturing cost, wearable devices are able to be developed rapidly. Wearable devices have been widely applied in various fields including physiological data collection from human body (see for example [5]). Furthermore, these devices have also been utilised on human activities recognition [7, 3, 6, 8, 4]. These devices use either/both inertial measurement units or/and pressure sensors to measure data; by analyzing these data they build action recognition algorithms and activities models of the user. These personal models are able to be used for disease detection and accident prevention. For example, when a user changed his normal walking gait, this may results from the diabetes [2].

To the best of our knowledge, the existing action recognition algorithms are not very efficient on jumping and squatting recognition. Therefore, in this paper, we propose new activities recognition algorithms which will focus on jumping and squatting. Furthermore, we also present recognition methods for other activities, including moving to the left and right, to complete the actions we need in the demonstration.to complete the actions we need in the demonstration, including moving to the left and right.

ACTION RECOGNITION DEVICES

A pair of pressure insoles are attached on shoos (see Figure 1a). Each pressure insole consists of 16 pressure sensors and a motion sensor which includes an accelerometer, a gyroscope, and a magnetometer. The data measured from pressure and motion sensor are transferred to mobile phone wirelessly via Bluetooth connection (Figure 1b).



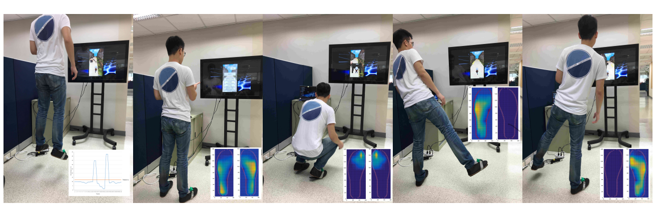
(a) (b)

Figure 1: Photo of the system. (a) The pressure insole with accelerometer attached on shoos. The pressure sensors are placed at the bottom of the shoos. (b) The mobile app and the extension monitor (for demonstration).

ACTION RECOGNITION TECHNIQUES

Jumping detection

The jumping action is detected using the accelerometer. First, the reference axis is determined as the opposite direction of the gravity when standstill. Then acceleration vectors, the values of acceleration in three directions obtained during the movement, are projected on the reference axis. If the projection acceleration was larger than a threshold (we set at 12 m/s^2), then the action is identified as jumping (see Figure 2a).



(a) (b) (c) (d) (e)

Figure 2: Action recognition techniques for (a) jumping (b) standing and (c) squatting. Jumping is identified using acceleration on reference axis and squatting is identified by the pressure distribution on feet.

Squatting detection

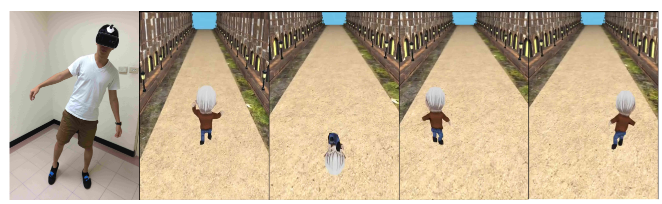
By comparison of the pressure distribution when standstill and squatting (Figure 2b & 2c), the pressure are mainly located at the front of both feet rather than the whole feet surface. However, the pressure distributions are similar when squatting and moving centre of mass to the front, therefore, in order to avoid misjudgement, the squatting action is identified by not only pressure located at the front of both feet and also the main pressure point locates at the big toe (Figure 2c).

Moving detection

In this demonstration, we also design the movement actions, move to the left and right (See Figure 2d & 2e). These are also identified by pressure distribution on both feet. When moving to the left, the pressure on the right foot will drop to zero as the right foot has been risen; simultaneously, the pressure on the left increased to reach approximately the equivalent of the total amount of pressure on both feet when standing. Conversely, raising the left foot will result in moving to the right.

DEMONSTRATION

We developed a intuition Parkour game both on mobile devices and Gear VR based on “3D infinite runner toolkit” from unity [1]. Figure 2 and 3a show that user uses wearable devices to play Parkour game on mobile phone and Gear VR. The avatar is running on a track to collect the coins and there are several kind of obstacles appeared. In order to pass through the obstacles, the four actions, jumping, rolling, move to the left lane and move to the right lane are applied (see Figure 3b – 3e.). These actions are controlled by the actions introduced in previous section.



(a) (b) (c) (d) (e)

Figure 3: The screen shot of the action in the game. (a) Jumping, (b) rolling, (c) move to the left, and (d) move to the right.

CONCLUSION

We present a action recognition system using wearable devices, which consist of pressure insole and inertial measurement unit. In this paper, we focus on the actions including jumping, squatting and moving to the left or right. Jumping is determined by the data from accelerometer in the IMU and squatting, moving to the left and right are determined by the pressure distribution on the pressure insole. We developed a intuition Parkour game to demonstrate the correctness of the action recognition algorithms.

ACKNOWLEDGMENTS

This study is conducted under the "III Innovative and Prospective Technologies Project" of the Institute for Information Industry which is subsidised by the Ministry of Economy Affairs of the Republic of China.

We thank Chih-Chun Ma, Mr. for assistance and comment with left and right movement recognition techniques, and Ying Chen, Miss for proofreading the manuscript.

REFERENCES

1. 3D infinite runner toolkit, 2014.
2. Brach, J. S., Talkowski, J. B., Strotmeyer, E. S., and Newman, A. B. Diabetes Mellitus and Gait Dysfunction: Possible Explanatory Factors. *Physical Therapy. 88*, 11 (2008), 1365–1374.
3. Choudhury, T., Hightower, J., Lamarca, A., Legrand, L., Rahimi, A., Rea, A., Hemingway, B., Koscher, K., Landay, J. a., Lester, J., and Wyatt, D. An embedded Activity Recognition system. *IEEE Pervasive Computing 7*, 2 (2008), 32–41.
4. Dong, B., and Biswas, S. Wearable networked sensing for human mobility and activity analytics: A systems study. *2012 4th International Conference on Communication Systems and Networks, COMSNETS 2012* (2012), 1–6.
5. Patel, S., Park, H., Bonato, P., Chan, L., and Rodgers, M. A review of wearable sensors and systems with application in rehabilitation. *Journal of NeuroEngineering and Rehabilitation 9*, 1 (2012), 21.
6. Peng, Z., Cao, C., Liu, Q., and Pan, W. Human walking pattern recognition based on KPCA and SVM with ground reflex pressure signal. *Mathematical Problems in Engineering 2013* (2013).
7. Sugimoto, C., Tsuji, M., Lopez, G., Hosaka, H., Sasaki, K., Hirota, T., and Tatsuta, S. Development of a behavior recognition system using wireless wearable information devices. In *2006 1st International Symposium on Wireless Pervasive Computing* (2006).
8. Wang, Y., Jiang, X., Cao, R., and Wang, X. Robust Indoor Human Activity Recognition Using Wireless Signals. 17195–17208.