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Hand Gesture Recognition and Interaction Prototype for Mobile Devices

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ABSTRACT

An algorithmic framework is proposed to process acceleration and MATLAB signals for gesture recognition. It includes a novel segmentation scheme, a score-based sensor fusion scheme, and two new features. A Bayes linear classifier is utilized in the framework. In addition, a prototype system, including a wearable gesture sensing device (embedded with a three-axis accelerometer) and an application program with the proposed algorithmic framework for a mobile phone, is developed to realize gesture-based real-time interaction. With the device worn on the forearm, the user is able to manipulate a mobile phone. Results suggest that the developed prototype responded to each gesture instruction within 300 ms on the mobile phone, with the average accuracy of 95.0% in user-dependent testing and 89.6% in user-independent testing. Such performance during the interaction testing, along with positive user experience questionnaire feedback, demonstrates the utility of the framework.

Index Terms: ***Accelerometer, gesture recognition, human–computer interaction.***

INTRODUCTION:

Sensing and identifying gestures are two crucial issues to realize gestural user interfaces. The use of camera is an early developed tech-nology to sense gestures but it has not been applied in most mobile. Accelerometers and surface electromyography (MATLAB) sen-sors provide another two potential technologies for gesture sensing. Accelerometers can measure accelerations (ACC) from vibrations and the gravity, therefore, they are good at capturing noticeable. MATLAB signals designed for interactions. Various kinds of interaction solutions can be developed using its programming interface.

Since both accelerometers and MATLAB signals have their own ad-vantages in capturing hand gestures, the combination of both sensing approaches may improve the performance of hand gesture recognition. Although studies that utilized both MATLAB and ACC signals, few combined them to realize a gesture-based interaction system. In our pilot studies[8], a series of promising applications with gestural interfaces relying on portable ACC and MATLAB signals were developed, including sign language recognition and human–computer interaction. We further designed a wearable gesture-capturing device and then re-alized a gesture-based interface for a mobile phone to demonstrate the feasibility of gesture-based interaction in the mobile application [2]. In that preliminary work, MATLAB and ACC signals were not actually fused together in that interface, and only nine gestures were supported.

In this paper, a wearable gesture-based real-time interaction proto-type for mobile devices using the fusion of ACC and MATLAB signals is presented. As an extension to [2], there are main contributions.

1) A small, lightweight, and power-efficient wireless wearable de-vice to capture gestures records three-channel ACC and a-channel MATLAB signals from forearm.
2) A novel real-time recognition scheme that is based on the fusion of MATLAB and ACC signals is proposed. The algorithms are designed to be computationally tractable with high recognition

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accuracy.

3) An active segmentation scheme, overcoming the difficulties in ACC signal segmentation and the synchronization of active seg-ments in MATLAB and ACC signals, is presented.

An evaluation with a gesture-based interaction application on a mobile phone demonstrates the feasibility of the proposed interface.

SYSTEM ARCHITECTURE

This gesture-based interaction prototype enables operating a mobile phone without touching it. It consists of a custom-wearable gesture-capturing device and an interaction application program running on a smart phone. the gesture-capturing camera records MATLAB and ACC signals, and sends them to the phone through a wireless connection. The interaction application program processes these signals, translates each gesture into instructions, and then provides feedback.

Both the measured ACC and MATLAB signals are digitized simultaneously by a 12-bit A/D convertor that is embedded with the microcontroller (MCU, C8051F411) at a sampling rate of 600 Hz, and then sent out via Bluetooth 2.0 using a Bluetooth serial port module

BLOCK DIAGRAM:

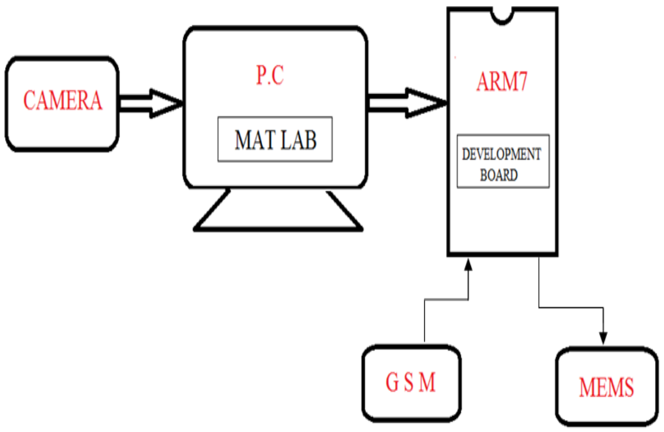

Fig: Block Diagram

CLASSIFICATION

1) Gesture-Scale Classification:

None of the gesture employs all the six features mentioned previously. For example, ACC segmentation and ACC feature extraction can be omitted if a motion is classified as a small-scale gesture. Therefore, small-scale options are picked right after MAT lab segmentation by a threshold classifier in order to speed up the processing. That is, if the amplitude of ACC signals exceeds the given threshold, it is a large-scale gesture, and vice versa. Considering that ACC signals are often very smooth, only 32 sampling points (written as Sec (n) , c = 1, 2, 3, n = 1, 2, . . . , 32) picked from CAAS using uniformly sampling are enough to quantify the amplitude (written as Am). Then, small-scale and large-scale gestures are Recognized using different algorithms

$$Am = \frac{1}{96}\sum_{n=1}^{32}\sum_{c=1}^{3}\left|Se_c(n) - \frac{1}{32}\sum_{i=1}^{32} Se_c(i)\right|.$$

2) Small-Scale Gesture Classification:

A Bayes linear classifier,which is able to classify samples in a linear feature space, was employed in this study for small-scale gesture classification. It has also been reported by previous studies on MATLAB-based gesture recognition [2] that the Bayes linear classifier can achieve high accuracy with low computational complexity. Thus, this classifier is appropriate for real-time systems. Here, the classifier should be trained before use because of the randomicity of MATLAB signals. After some pretests, we found that 32 repeats of each gesture are enough to train a classifier to reach stable and satisfactory classification performance.

3) Large-Scale Gesture Classification:

MATLAB is an interactive system whose basic data element is an array that does not require dimensioning. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or FORTRAN.

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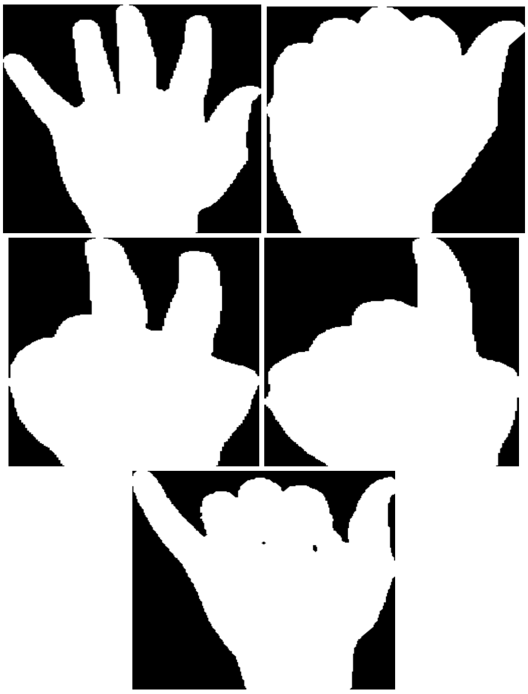
MATLAB features a family of add-on application-specific solutions called toolboxes. Very important to most uses of MATLAB, toolboxes allow you to learn and apply specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M – files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

The MATLAB gestures are shown below



These are the gestures stored in the data base. Firstly axis must be created in the MATLAB to develop the output frame as

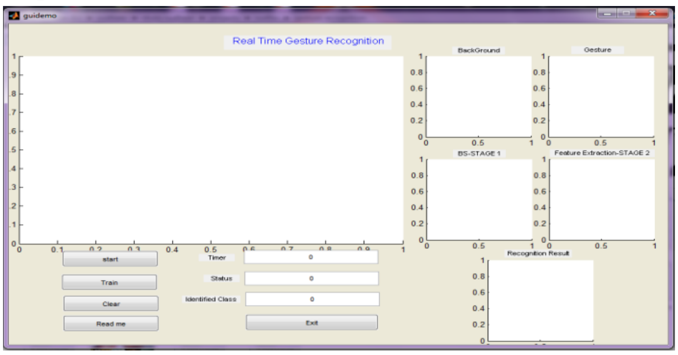


Fig: Output Frame

ACCELERATION

The logic involved in the programming was

Switch
{
Case A: Mob no:1
switch{
Case a: Operation 1 (dail a call)
Case b: Operation 2 (call accept)
Case c:Operation 3 (call reject)
Case d:Operation 4 (sent msg)
}
break
Case B: Mob no:2
switch{
Case a:Operation 1 (dail a call)
Case b:Operation 2 (call accept)
Case c:Operation 3 (call reject)
Case d:Operation 4 (sent msg)
}
break
Case C: Mob no:3
switch{
Case a:Operation 1 (dail a call)
Case b:Operation 2 (call accept)
Case c:Operation 3 (call reject)
Case d:Operation 4 (sent msg)
}
break
Case D: Mob no:4
switch{
Case a:Operation 1 (dail a call)
Case b:Operation 2 (call accept)
Case c:Operation 3 (call reject)
Case d:Operation 4 (sent msg)
}
break
}

This is the way that switching between the different numbers was done. In the place of operations done by the accelerometer is replaced with their corresponding functions.

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CONCLUSION

A wearable gesture-based interaction prototype demonstrates the feasibility of hand gesture interaction in mobile application that is based on the fusion of MATLAB and ACC signals. A wireless wearable gesture capture device is designed to acquire ACC and MATLAB signals, and an algorithm framework is proposed to realize gesture classification on mobile devices. An interaction program is developed for the mobile device to realize gesture recognition and to manipulate the mobile device taking recognition results as instructions. Our prototype supports 19 gestures, a large gesture vocabulary for mobile device-based systems. The experimental results from interaction testing show that gesture-based interaction is feasible and performs better with experienced users although its efficiency needs further improvement. A user experience questionnaire indicates that our prototype can be accepted by users. Because gesture-based interaction is intuitive and easy to learn, we expect this gesture-based interaction prototype to be accepted by mobile device users.

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REFERENCES

[1] M. K. Chong, G. Marsden, and H. Gellersen, “GesturePIN: Using discrete gestures for associating mobile devices,” in Proc. 12th Int. Conf. HumanComput. Interaction Mobile Devices Services, 2010, pp. 261–264.

[2] J. Wang and F. Chuang, “An accelerometer-based digital pen with a trajec-tory recognition algorithm for handwritten digit and gesture recognition,” IEEE Trans. Ind. Electron., vol. 59, no. 7, pp. 2998–3007, Jul. 2012.

[3] C. Zhu and W. Sheng, “Wearable sensor-based hand gesture and daily activity recognition for robot-assisted living,” IEEE Trans. Syst., Man,Cybern. A, Syst. Humans, vol. 41, no. 3, pp. 569–573, May. 2011.

[4] T. S. Saponas, D. S. Tan, D. Morris, and R. Balakrishnan, “Demonstrating the feasibility of using forearm electromyography for muscle-computer interfaces,” in Proc. SIGCHI Conf. Human Factors Comput. Syst., 2008,

[5] S. Vernon and S. S. Joshi, “Brain-muscle-computer interface: Mobile-phone prototype development and testing,” IEEE Trans. Inform. Technol.Biomed., vol. 15, no. 4, pp. 531–538, Jul. 2011.

[6] T. S. Saponas, D. S. Tan, D. Morris, J. Turner, and J. A. Landay, “Mak-ing muscle-computer interfaces more practical,” in Proc. SIGCHI Conf.Human Factors Comput. Syst., 2010, pp. 851–854.

[7] E. Costanza, S. A. Inverso, R. Allen, and P. Maes, “Enabling always-available input with muscle-computer interfaces,” in Proc. Comput. Hu-man Interaction, 2007, pp. 819–828.

[8] A. Hatano, K. Araki, and M. Matsuhara, “A Japanese input method for mobile terminals using surface EMG signals,” in Proc. 22nd Annu. Conf.Jpn.-Soc. Artif. Intell., 2009, pp. 5–14.

[9] S. M. Rissanen, M. Kankaanpa¨a,¨ M. P. Tarvainen, V. Novak, P. Novak, K. Hu, B. Manor, O. Airaksinen, and P. A. Karjalainen, “Analysis of EMG and acceleration signals for quantifying the effects of deep brain stimulation in Parkinson’s disease,” IEEE Trans. Biomed. Eng., vol. 58, no. 9, pp. 2545–2553, Sep. 2011.

[10] R. A. Joundi, J. Brittain, N. Jenkinson, A. L. Green, and T. Aziz, “Rapid tremor frequency assessment with the iPhone accelerometer,” Parkinson-ism Related Disorders, vol. 17, pp. 288–290, May. 2011.

[11] A. Fougner, E. Scheme, A. D. C. Chan, K. Englehart, and Ø. Stavdahl, “A multi-modal approach for hand motion classification using surface EMG and accelerometers,” in Proc. IEEE Annu. Int. Conf. Eng. Med. Biol. Soc., 2011, pp. 4247–4250.

[12] X. Zhang, X. Chen, Y. Li, V. Lantz, K. Wang, and J. Yang, “A framework for hand gesture recognition based on accelerometer and EMG sensors,” IEEE Trans. Syst., Man, Cybern. A, Syst. Humans, vol. 41, no. 6, pp. 1064–1076, Nov. 2011.

[13] Y. Li, X. Chen, X. Zhang, K. Wang, and J. Z. Wang, “A sign-component-based framework for Chinese sign language recognition using accelerom-eter and MATLAB data,” IEEE Trans. Biomed. Eng., vol. 59, no. 10, pp. 2695– 2704, Oct. 2012.

[14] R. Xu, S. Zhou, and W. J. Li, “MEMS accelerometer based nonspecific-user hand gesture recognition,” IEEE Sensors J., vol. 12, no. 5, pp. 1166– 1173, May 2012.

[15] A. Akl, C. Feng, and S. Valaee, “A novel accelerometer-based ges-ture recognition system,” IEEE Trans. Signal Process., vol. 59, no. 12,pp 6197–6205, Dec. 2011.

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