Gestures recognition as a new information input device for automatic system control

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Abstract - **This paper presents the up-to-date approaches to solve tasks of automatic systems control, which use hand motion analyzer as a new information input device.**

Keywords – **hand motion recognition, automatic systems, principal component analysis, independent components analysis**

This paper reported on the findings about the state of the art and analyzed the technologies applicable to hand motion processing. With the help of gesture recognition system it is possible to recover the underlying 3D human body structure which is particularly useful for analysis of athletic performance as well as medical diagnostics; to control consumer and industrial equipment; to control peripheral computer devices and program starting which give the opportunity to operate with automatic systems for human who cannot use traditional means of the human-machine interface

The availability of such devices largely depends on the enabling hand motion detection and processing technologies. The main goal of analyzing of the up-to-date approaches for solving automatic systems control tasks is the estimation of hardware and software implementation complexity as well as their application field.

Development of gesture-recognition systems is a complex task as far as there are certain features. At first, we must take into consideration that hand motion analyzers are restricted because they operate according to established programs. Therefore technical systems can't take into account the availability of all gestures variety. Gesture detection and recognition system has to extract and represent data against assigned tasks. It is necessary to involve learning process, i.e. we must "train" system to response on gestures, recognize and also to adapt them according to particular user hand motions. For these reasons there is a need for reliable gesture detection and recognition algorithms. As a result of training system receives the facility to gain step-by-step the desired response on external influences. System parameters and structure adjustment for better control quality in variable environment take place during adaptation period. Visual images of hands can be used as an object for training.

There are a lot of different motion detection methods, but unfortunately all of them have certain disadvantages. Optical methods require attaching of special markers or applying data glove (data input device, which perceives hand motions and transfers them into computer) and also certain camera placement.

can't determine absolute position in space without optical systems support. Mechanical systems are sufficiently complex, require periodic calibration and depend on certain size. Electromagnetic methods represent analog optical systems but they are less stable to external disturbances. If it is necessary to detect hand space position, it is better to use optical technology.

Non-contact multicamera recognition systems which are referred to optical technology are very convenient in use. Optical methods which involve special markers or data glove with sensors should be used for system training and model generating. The main advantage of these methods is the capability to operate in real-time mode and high noise immunity. The main disadvantage is a large dimensionality of hand pose space.

It should be stressed that hand poses recognition process consist of following stages: 1) hand area detection; 2) palm area detection; 3) finger division; 4) restriction of hand area; 5) calculating the 3-D position. Analysis of hand motion recognition process make possible to distinguish disadvantages of certain methods during different recognition stages.

The problem of hand model application is a large dimensionality of hand pose space. Large dimensionality causes considerable computational costs. Principle component analysis (PCA) has been proposed to reduce the dimensionality without information loss. Although PCA is efficient for dimensionality reduction, it has difficulty representing the intrinsic features, because its basis vectors represent global features. In order to solve this problem, Independent component analysis (ICA) is proposed to represent hand motions. First, PCA is performed to reduce the dimensionality. Then ICA is applied to extract intrinsic features. ICA is a generalized technique of PCA and has proven to be an effective tool of feature extraction.

REFERENCES

[1] E. Varga, I. Horváth, Z. Rusák, and J. J. Broek "Hand Motion Processing In Applications: A Concise Survey and Analysis Of Technologies", INTERNATIONAL DESIGN CONFERENCE - DESIGN 2004, Dubrovnik, 2004.

[2] Abe, K., Saito, H., Ozawa, S., "3-D Drawing System via Hand Motion Recognition from Two Cameras", Proceeding of the 6th Korea-Japan Joint Workshop on Computer Vision, 21-22 January 2000, pp. 138-143.

[3] Makoto Kato, and Gang Xu, Occlusion-Free Hand Motion Tracking by Multiple Cameras and Particle Filtering with Prediction, IJCSNS International Journal of Computer Science and Network 58 Security, VOL.6 No.10, 2006.

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