Implementation of a Smart Ward System in a Hi-Tech Hospital by Using a Kinect Sensor Camera

Jyothilakshmi P[a], K R Rekha[b], K R Nataraj[ab]
Research Scholar, Jain University, Bangalore, India. *jyovkit@gmail.com*
Professor, Dept. of Electronics & Communication, SJBIT, Bangalore, *India.rekha.sjbit@gmail.com.*
Professor and Head of Department, Dept. of Electronics & Communication, SJBIT, *Bangalore, India.rekha.sjbit@gmail.xom*

Abstract:-With the evolution of sophisticated image capturing device, the potential charecteristics of image processing are being harnessed in various commercial applications. This paper presents a unique idea of using image processing in the field of health monitoring system. Research have been carried out in communication and networking for the design of Smart Ward Systems used in Health Monitoring System that empowers hospital staff to focus more on patient's dynamic movement by enabling the collection of data at the bedside and remove the need for duplication and double-handling. The proposed work is designed for detecting and recognizing the gesture obtained through the Kinect camera. The training includes data collection and feature extraction. The trained data is then classified using *k*-nearest neighbors, support vector machines and artificial neural networks. To adopt the best classifier, this paper compares the accuracy of all the above techniques. Mode selection operation has been tested with three different classifiers and support vector machine is proven to be best out of them. The evaluation is done based on various performances metrics like classification effectiveness, accuracy and recognition rate.

Keywords: *ANN, Health monitoring system, Kinect camera, KNN, Smart Ward System, SVM.*

*****

1. Introduction

Recent technological advances can provide interesting opportunities for improving the quality of life of disabled people. At present, the smart phones or any other computing devices are controlled using hardware device or by mechanical means. However, there is a constant effort to make the Quality of Experience much better. In this regards, gesture recognition has enabled human to communicate with the machine, naturally without any mechanical devices [1]. Using gesture recognition, it is feasible to map the movement of palm to act as input system for certain controls [2] [3] [4] [5]. However, there are various research challenges and impediments towards gesture recognition to be used in regular commercial applications e.g. scene multifaceted nature (e.g., occlusions, clutter, interacting objects, illumination changes) and the unpredictability of human activities (non-rigid objects, action variability). On the other hand, regardless of previous work, consistent vision-based hands gestures recognizable methods proofs far from satisfactory in real time applications [5], [6] and [7]. The Kinect camera sensor could find application in Health Monitoring System (HMS) for the treatment of patients suffering from paralysis stroke [8]. The test-bed of the proposed system can be seen in Fig.1 that uses a gesture recognition technique.

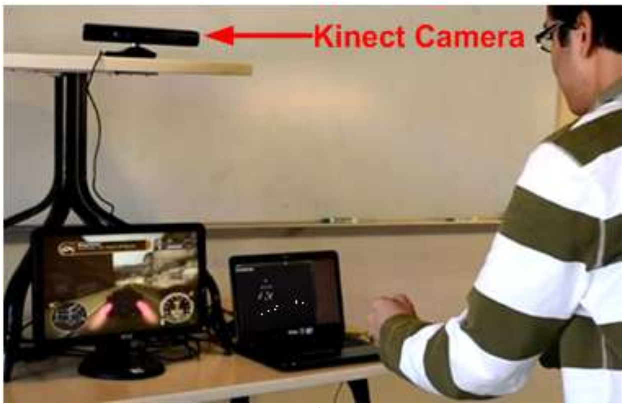


Figure.1 Test bed of Proposed System

This proposed work deals with the implementation of the Smart Ward System (SWS) in a Hi-Tech Hospital by using a Kinect Sensor Camera, where all the automation is integrated in one system. It will also provide interactive display to the patient for ease of operation. This paper introduces a technique to solve the security issues over data storage in cloud. Section 2 discusses about the proposed method and the performance of three different classifiers Artificial Neural Networks (ANN), Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) are compared. Section 3 discusses about result and tabulations. Finally Section 4 summarizes the paper.

2. Proposed Method

The Kinect camera is installed on top of opposite wall of patient bed and it is connected with all electrical appliances, alarms and RF transreceiver. The RF receiver is installed at patient bed which will adjust bed as per control signal. Fig.2 shows the block diagram of proposed system.

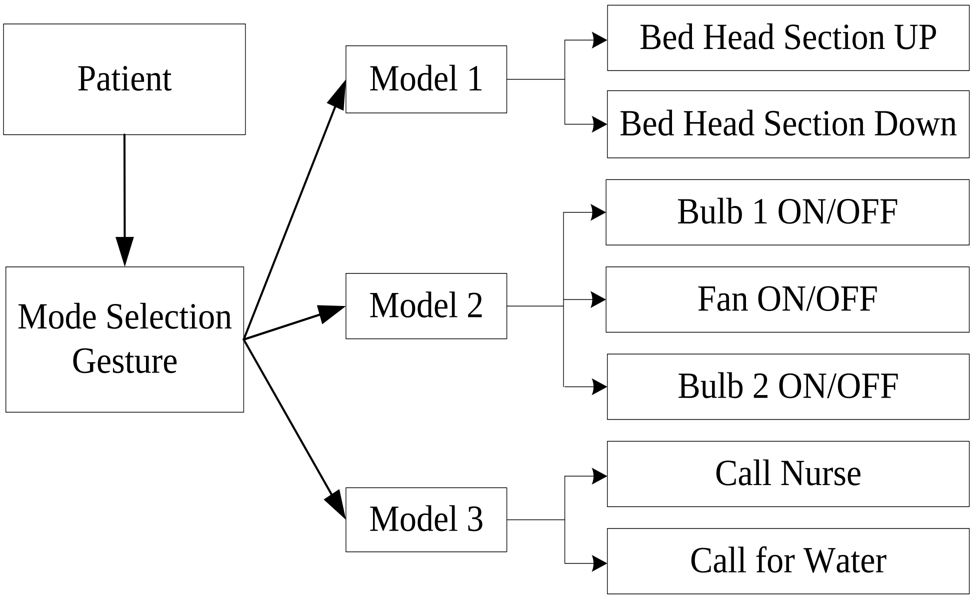


Figure.2.Proposed System Block Diagram

The proposed methods can be divided into three modules 1) System enable and disable 2) Mode selection 3) selected mode operation.

2.1 System Enable Disable

The major problem with integrated system is to avoid false matching. For example if user is in mode selection stage and wants to exit the system immediately then he should be able to do "system disable" operation instantly. However that should not mismatch with mode selection gestures. Hence a unique gesture is designed for enable and disable of gesture. In order to enable the system, the user has to point their hand towards camera for 3 seconds. To check that gesture, the system takes normalized 3D coordinates for the skeleton which is available in "Joint World Coordinates" property of depth metadata of kinect object. Then the height of right hand is compared with hip centre if the right hand is well above hip centre then the system checks another condition i.e. *z* distance of right hand with shoulder centre. If the distance is more than threshold then the systems starts or increment the counter. If count is more than count threshold then system identifies the gesture as enable/ disables gesture. Here the count threshold depends on frame rate and speed of the system hence it has to be decided based on experiments.

2.2 Mode Selection

Once the system is enabled by patient, patient has to select the mode to get particular service or control particular device. The system defines three modes viz. 1) Head section adjustment of patient bed 2) electrical appliances control 3) patient assistance system. First the system takes skeleton coordinates from "Joint Image Indices" properly from metadata of depth camera. This skeleton coordinates are mapped according to image resolution. Here user has 3 choices of gestures as shown in Fig.3.

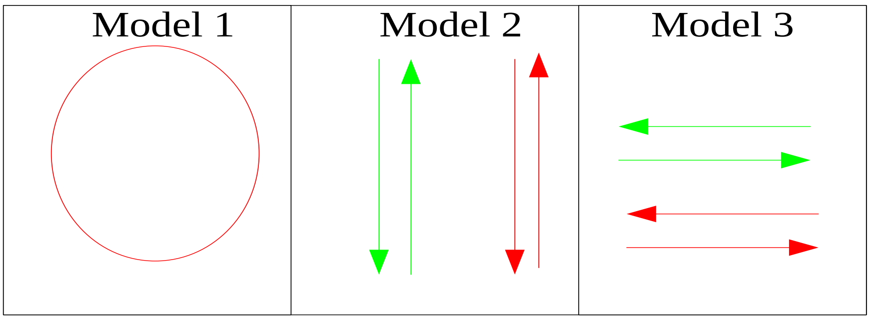


Figure.3 Gestures for Mode selection

In Fig.3, red line shows the movement of right hand and green line shows the movement of left hand. If patient moves his right hand in circular manner then mode 1 is enabled, if patient waves his both hands in vertical manner than he/she is willing to enable mode 2. For mode 3 patients has to wave hands in horizontal manner.

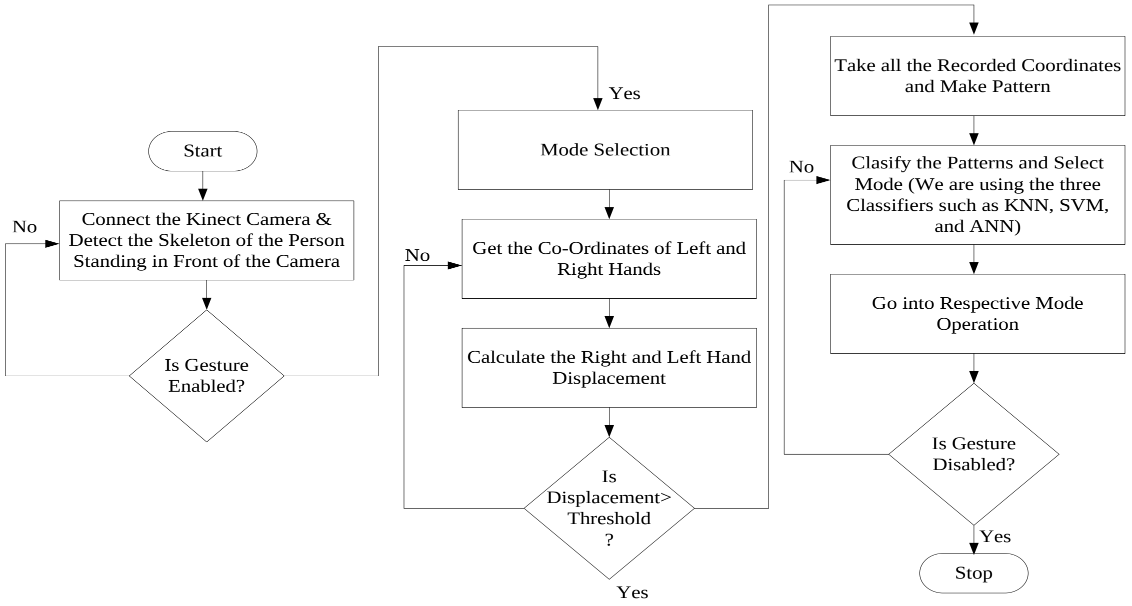


Figure.4. Flow Chart for Mode Selection

These mode selection gestures falls under dynamic gesture category. The major problem with dynamic gesture is to decide the start and stop points of gesture. The flow chart of mode selection system is shown in Fig.4. The system uses a novel approach to determine start and stop point of gesture. Naturally when a user wants to draw a pattern he/she stops for instance and start drawing the pattern in air. After drawing the pattern user again stops for an instance. The system uses left and right hand joints displacement to determine whether the hand is moving or static. To avoid any false detection the system also calculates number of readings. If number of readings is less then threshold then system discards the gesture as invalid. Feature extraction followed by classification has been used to classify above gestures. When user waves his hands the system records x and y coordinates of hands and creates binary image where the tracked points are made to value 1. After that system calculate features such as, orientation, eccentricity, solidity and compactness on binary image. These features are then classified using classifier. In this work we have used three classifiers such as support vector machine, artificial neural network, and k-nearest neighborhood for analysis. Out of three classifiers support vector machine gave best output. The system will then enter into respective mode of operation.

2.3 Mode Operation

As mentioned earlier we have three modes

- Mode 1: Head section adjustment of patient: The flow chart of mode 1 operation is shown in Fig.5. In this mode the system takes input only if both hands are above hip center. The system also has to take care of false gesture recognition. Mode 1 enables patients to adjust head section by simply moving hand up or down.

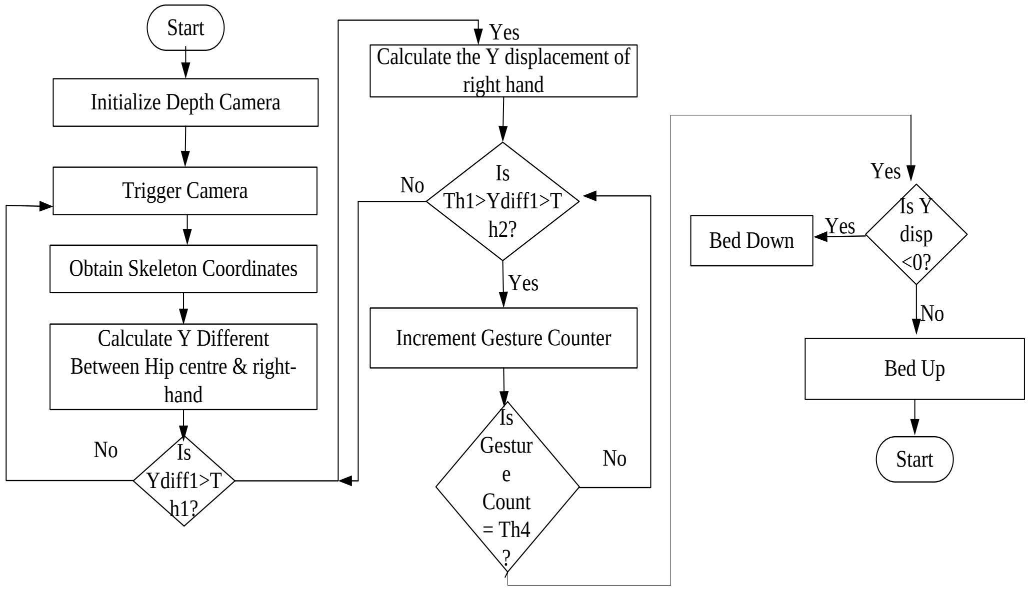


Figure.5. Flow Chart for Mode 1 Operation

- Mode 2 & 3: Graphical interface mode is used that is exhibited in Fig.6 for mode 2 & 3. Here a very simple method of Euclidean distance is adapted to help user interact with required object. Based on selected mode different icon representing corresponding operation have been embedded to live video stream. The user can move his/her hand to reach out to the icon which enable respective operation.

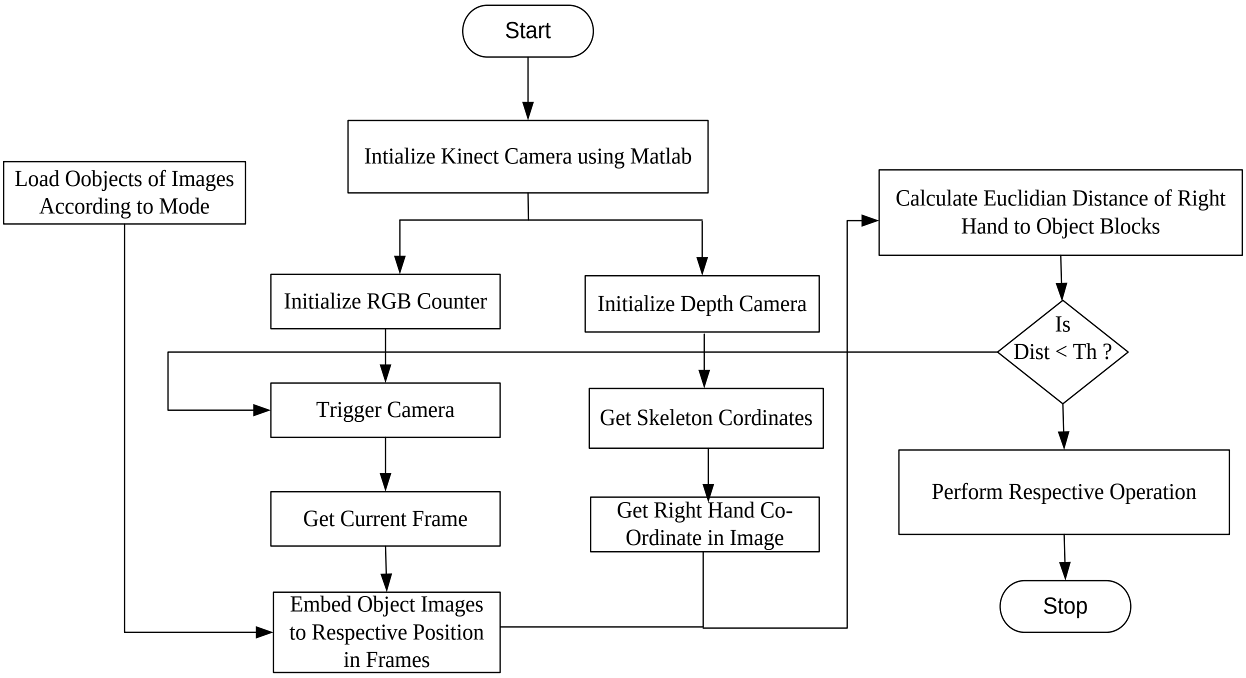
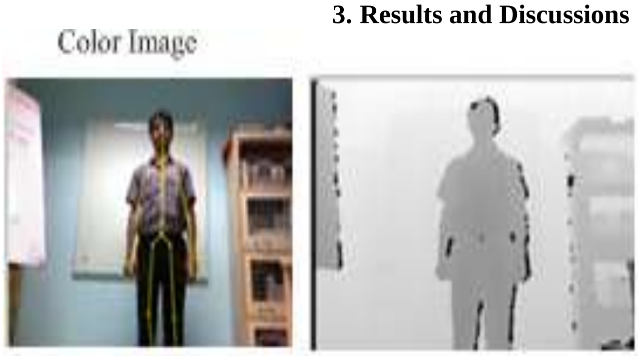


Figure 6. Flow Chart for the Mode 2 and Mode 3 Operations

As soon as user moves hand near or on the object icon the icon size increases indicating the selection operation. For appliance automation the color of icon also changes which shows the status (on/off) of appliances.

3. Results and Discussions



(a) (b)

Figure.7. Kinect Sensor Output Figure.8. Enable/ Disable Gesture.

There are two sensors in kinect camera namely RGB camera and Depth sensor. Fig.7 (a) show the color image acquired by RGB camera. Kinect camera also gives skeleton coordinates information which is plotted in yellow line. Fig.7 (b) show depth map of the image which helps camera to detect skeleton. The most important feature of our system is to enable or disable the system at any point of time. Fig.8 shows the gesture to enable or disable the system. User has to just point the finger to system for some definite time and the system will toggle between enable and disable state. The red dot on finger tip confirms the action. For mode selection, three classifiers have been tested. We have conducted 50 experiments for all gestures. Table 1 shows the confusion matrix for all classifiers. From table it is clear that SVM performs better than ANN and KNN.

Table.1. Confusion Matrix for all Classifiers

	Mode 1			Mode 2			Mode 3		
	SVM	ANN	KNN	SVM	ANN	KNN	SVM	ANN	KNN
Mode 1	50	50	50	0	0	0	0	0	0
Mode 2	0	0	0	49	45	46	1	5	4
Mode 3	0	0	0	2	6	3	48	44	47

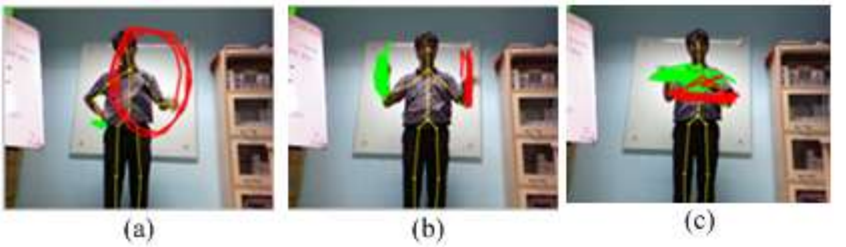


Figure.9. Mode Selection Gestures

Figure 8 shows the gestures for different modes. The tracking of the hands are accurate and the performance of the gestures are comfortable. In Fig.9 (a), gesture for mode 1 is shown where user has to rotate the right hand in circular manner. Fig.9 (b) shows the gesture for mode 2 selection, where user has to move both hands up and down. For mode 3 selection user has to move both hands horizontally left and right as shown in Fig.9 (c).

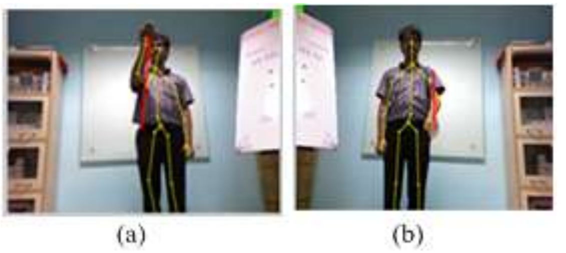


Figure 10. Mode 1 Operations

Once the user has selected mode 1, the window as shown in Fig.10 will appear where user can adjust the head section of bed. Here patient is considered as user. To adjust the head section user has to either move the hand upward to lift the head section as shown in Fig 10 (a) or move the hand downward to reduce the height of the head section as shown in Fig. 10 (b).

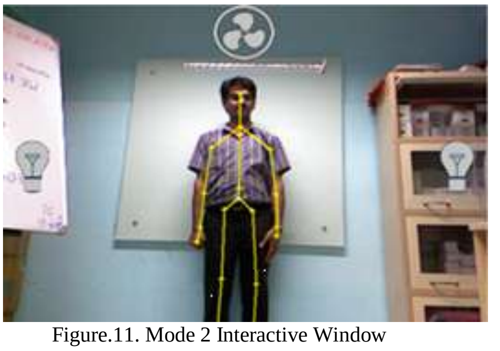


Figure.11. Mode 2 Interactive Window

Fig.11 show the interactive window for the user if user selects mode 2. The system is designed for three appliances such as fan, light 1 and light 2. However it can be designed for more appliances if required.

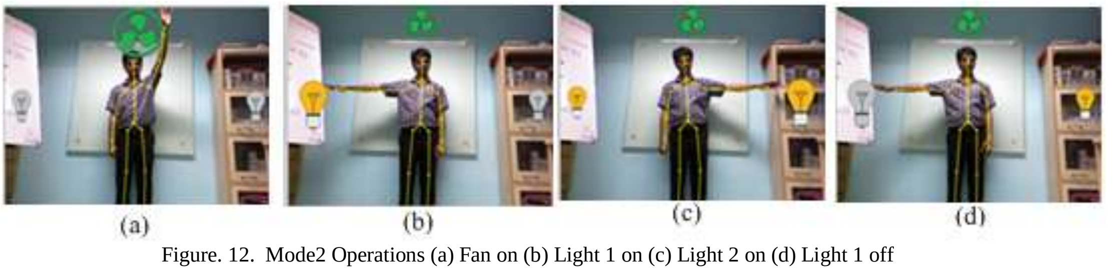


Figure. 12. Mode2 Operations (a) Fan on (b) Light 1 on (c) Light 2 on (d) Light 1 off

Few of mode 2 operations are shown in Fig.12. User has to point his hand to the device icon to turn on or off the device. The icon appearance represents the on or off state of the device as shown in figure.

Figure.13. Mode 3 interactive window

If user selects mode 3 then the interactive window shown in Fig.13 appears. In this mode user can call for nurse for any assistance or call for water. The real time video is embedded with respective icon hence it is easy to operate the system without prior training or knowledge. This mode can also be enhanced for multiple services.

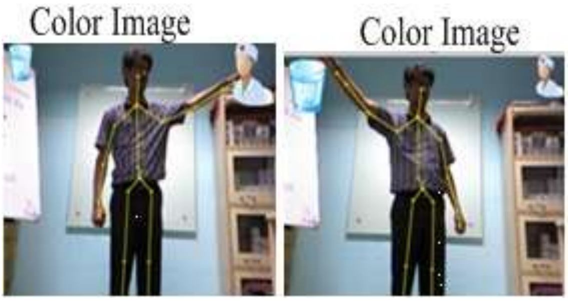


Figure.14 Mode 3 operations.

Fig.14 shows operations for mode 3. In this mode the size of icon increases, when selected, to confirm the selection of the action. Figure 13 (a) and (b) shows actions of calling nurse and asking for water respectively.

4. Conclusion

In this proposed work, we have implemented a Smart Ward system enabling the system to work in three modes such as Mode1 where bed controlling operation is performed. In mode 2 electrical appliances automation is performed. In the mode3, smart assistant system is demonstrated by enabling the menu objects on the interactive window. Mode selection operation has been tested with three different classifiers and support vector machine is proven to be best out of them. In future we can include some entertainment programs for patient where patient can play the games by hand or surf the internet or play videos.

5. References

[1] J. P. Wachs, M. Klsch, H. Stern, and Y. Edan, Vision-based hand-gesture applications, Communications of the ACM, vol. 54, pp.60–71, 2011.

[2] Z. Ren, J. Yuan, and Z. Zhang, Robust hand gesture recognition based on finger-earth mover's distance with a commodity depth camera, In Proc. of ACM Multimedia, 2011.

[3] Jyothilakshmi P, Dr. K R Rekha, Dr. K R Nataraj, A Frame work for Human-Machine Interaction using Depthmap and Compactness, In proc. of Second IEEE Conf. on Emerging Research in Electronics , Computer Science and Technology, Dec-2015.

[4] C.-Y. Chang, B. Lange, M. Zhang, S. Koenig, P. Requejo, N. Somboon, A. Sawchuk, and A. Rizzo, Towards pervasive physical rehabilitation using microsoftkinect, In Proceedings of the 6th International Conference on Pervasive Computing Technologies for Healthcare, pp. 159-162, 2012.

[5] E. Foxlin, Motion tracking requirements and technologies Handbook of Virtual Environment Technology, pp. 163–210, 2002

[6] C. Chua, H. Guan, and Y. Ho, Model-based 3d hand posture estimation from a single 2d image, Image and Vision Computing, vol. 20, pp.191 – 202, 2002.

[7] N. Shimada, Y. Shirai, Y. Kuno, and J. Miura, Hand gesture estimation and model refinement using monocular camera-ambiguity limitation by inequality constraints, In Proc. of Third IEEE International Conf. on Face and Gesture Recognition, 1998.

[8] B. Stenger, A. Thayananthan, P. Torr, and R. Cipolla, Filtering using a tree-based estimator, In Proc. of IEEE ICCV, 2003