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Boundary Value Method for Direction Recognition using Hand Movement

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Abstract: **Ondaily basis it can be observed during seminars based on Power Point Presentation either a person is required or the speaker has to change the slides. This creates an inconvenience for speaker. To solve this problem a Boundary Value Method (BVM) is proposed. By using BVM. approach speaker can change the slide, open and select a new power point slide by making human body as an input interface instead of keyboard or mouse. This method is implemented with the help of a depth sensor camera named Kinect.Kinect takes the RGB data and Depth data of human skeleton and gives the coordinates information of specific body joints.In this proposed technique the main focus is on the movement of right hand for direction recognition. This technique is based on boundary value such that ifleft hand crosses that certain range then SENDKEY stroke of that range is generated. This experiment was conducted several times with different user. On the whole an average time of 2.997 second is calculated for the recognition with average recognition rate of 97.37%. This technique can also be used with image slider, e-book reader,learning tool and gaming zone.**

Keywords—Human Computer Interaction; Hand Segmentation; Gesture Recognition; Pattern Recognition; Skeleton Tracking

I. INTRODUCTION

The real time recognition plays an important role in the Human Computer Interaction. HumanComputer Interaction is the interaction of human with computer without keyboard, mouse and any other input devices. Recognition can be performed in first way with classifier and second way is without classifier. Recognition performed with classifier gives better result but the complexity in calculation increases because it uses some constraints.

Hand Movement Recognition is based on Hand Segmentation.Hand segmentation is performed by taking the coordinates of hand in consideration from whole coordinates of joints as illustrated in figure 4. Microsoft launched its depth sensor camera kinect and its sdk. Kinect takes RGB data and depth data as an input. The main advantage of Kinect is capability of working in low light.

With the help ofKinect, twenty reference points are detected in human body joints which can be seen in figure 4. After detection of twenty points with the use of skeleton tracking algorithm the hand segmentation is applied i.e. point of left hand is only considered. After hand segmentation various types of algorithm based on hand posture and hand gesture are applied.

There are number of approaches for hand movement detection based on Direction Recognition. Some of them are based on static images, hand model [1] and hand posture [2] which are applied in sign language or to create a static gesture like call, greet[6] etc. They are not robust to serve distortion in hand shapes. To remove this distortion various approaches on dynamic recognition are proposed which includes Hand Written Digit Recognition [8], Fingertip Recognition [2] and Gesture Recognition [2],[4],[6]. Now there are some limitations like wrong recognition. To solve this problem of direction Recognition this paper proposes a technique called Boundary Value Method (BVM). TheBVM is based on boundary value such that if hand crosses that certain range then SENDKEY stroke of that range is generated. The main application of this recognition is in demonstration of power point presentation, image slider, e-book readerand learning tool.

II. LITERATURE SURVEY

This section describes about research work related to Hand Movement Recognition forfinding the various strategies and approaches.The major classifications in which these papers can be categorized as given as follows:

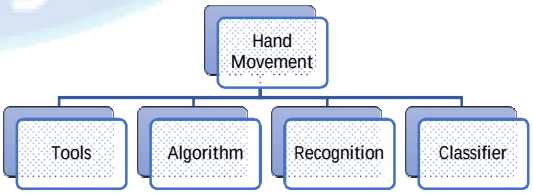


Figure 1. Categorization of Hand Movement

Tools Based: There are few types of tools which are used and they are Visual Studio and MATLAB. Kinect Sdk was released by Microsoft and a toolkit with C#, VB, C++ as a coding language which can be coded in Visual Studio [1] MATLABis a famous tool for non-programmer to create their code with very little coding knowledge [7].

Algorithm Based: This category is further divided into two categories as shown in the figure 2.

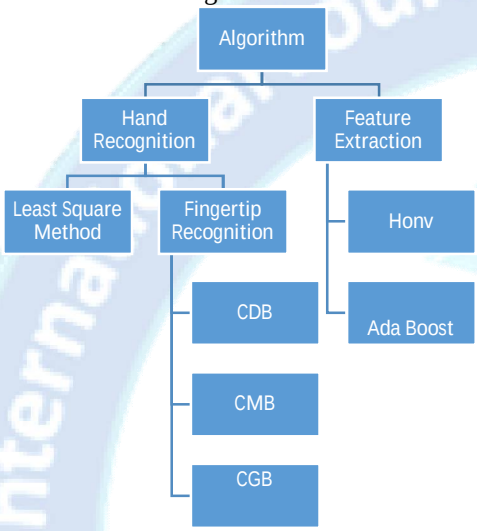


Figure 2.Sub-Classification according to Algorithm used

I Hand Recognition: For Hand Recognition there is mainly two categories are used.

i. **Least Square Method:** It is applied on the coordinate's value of 20 frames to find slope[8]. The change in slope is used to recognize the direction of hand movement and a message is generated which specifies direction i.e. left, right, up and down.

ii. **Fingertip Recognition:** In this method find the convex point in contourand then these three methods is used[2].

- **CBD:**Convexity Defect Based(CDB) method in which non relevant convexity defects are removed
- **CMB:**Convexity Mass based(CMD) focuses on center of mass and calculated on basis of cosine law
- **CGB:**Convexity Geometry based (CGB) focus on the polygon contour and it can correctly identify fingertip irrespective of orientation of hand.

II Feature Extraction: When Input data is largethen it becomes infeasible so it is reduced into small features

i. **AdaBoost:** It uses decision tree method which benefits weak learners [3].

ii. **HONV:** It is an enhancement algorithm used for dimension reduction [3].

Classifier Based: There are mainly four classifier used in our research are SVM, MLP, Hybrid and RFD. SVM stands for support vector machine and is used to find optimal separation plane (separation plane which provides the greatest margin between two classes). [6], [7] MLP stands for multi-layer perceptron and it separates any plane that separates the classes]. Hybrid uses SVM with MLP and it reduces error rate [7]. Radial Basis Function also separates any plane [7].

Recognition Based: Recognition is performed by using the techniques of computer vision and image processing. There are mainly four models and they are as follows

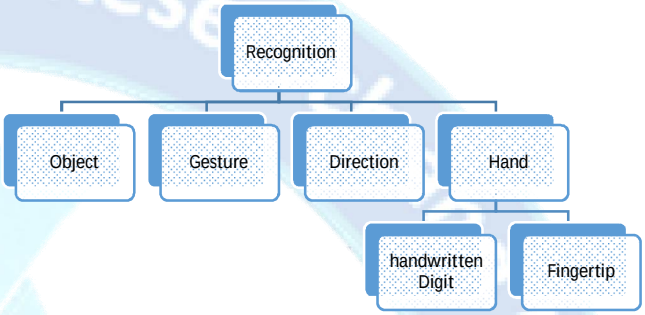


Figure 3. Sub-Classification According to Recognition

Object: in the paper[1] only object tracking and recognition is performed.

Gesture: It is any specific movement and action to perform some task. [2], [4],[6]

Hand: this method is again sub divided into two parts

- **Fingertip Detection:**tip of finger is calculated with the help of histogram and then movement of tip is tracked[8]
- **Handwritten Digit Recognition:**a standard database called NIST is used which consist of handwritten digits. This technique is used for detection of handwritten zip code[9].

Direction Recognition: four directions are taken as up, down, right, left [8]. These four directions are recognized and a message is displayed on the screen.

III. PROPOSED BVM (BOUNDARY VALUE METHOD) TECHNIQUE

Step1: Preprocessing: The kinect get RGB data and depth data as an input. The coordinate's information about the twenty points as shown in figure 4

Step2: Starting Condition

The starting condition is when user (entity) moves right hand towards camera. It is assumed that an arm length is less than 60 cm so it is taken as a threshold value. Next step is to calculate the difference of depth of head (Head.Z) and depth of right-hand (Right-hand.Z) and it should be greater than threshold value (60 cm). The starting condition is given as below in equation 1

$$\text{Start} = \begin{cases} \text{True}, \text{if } |\text{Head.Z} - \text{RightHand.Z}| > 60\ cm \\ \text{False}, \ otherwise \end{cases} \quad (1)$$

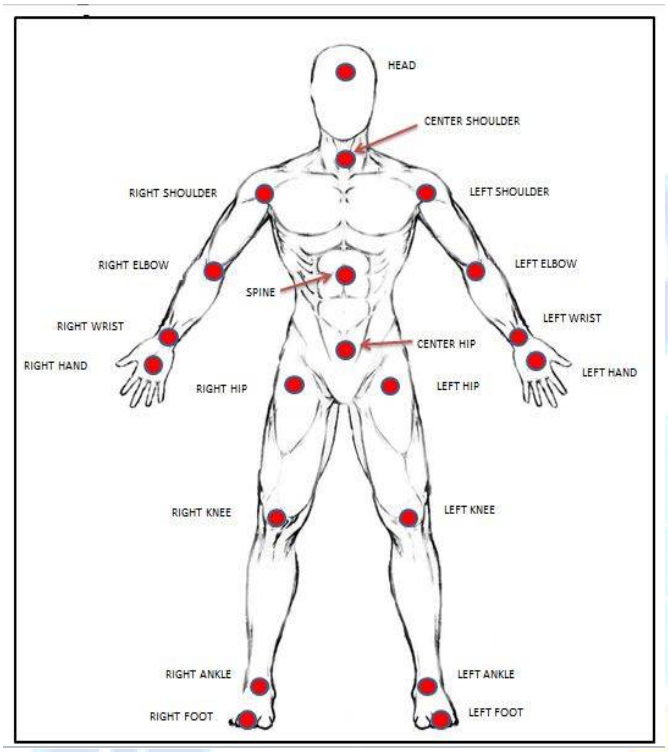


Figure 4. Representation of 20 coordinates of joint in human

The information about 20 points is extracted by skeleton tracking algorithm and further hand segmentation is applied so that the point of hand is extracted from 20 coordinates of human skeleton.

Step 3: Recognition

After fulfillment of requirement of starting condition we consider a coordinate system with respect toright hand. In this origin is considered as range between 5 cm in negative x direction and 5 cm in positive x directionbecause it is a virtual coordinate system and approximate precision can only be assumed. We conducted an experiment on 200 people to find the boundary value range value which are 20 cm on positive x axis (extreme right), 10 cm on negative x axis (extreme left), 30 cm on positive y axis (extreme up) and 20 cm on negative y axis (extreme down). After this boundary value limit is set. A virtual frame is taken for movement of right hand A flag is set that enables when hand is moved from origin towards extreme right and becomes disables when hand is moved from extreme right to center. In one complete cycle a SENDKEY (UP) is pressed which can be used for moving next slide of PPT. In the similar manner the extreme left movement of right hand is recognized and SENDKEY(DOWN) is pressed which moves the previous slide. If user moves left hand from origin to positive y direction 9cm above origin towards 30 cm or greater than for activating SENDKEY('^O'). The same is done for selecting a PPT by moving hand in negative y direction form origin towards -20 cm or greater then a SENDKEY stroke for Enter is generated.

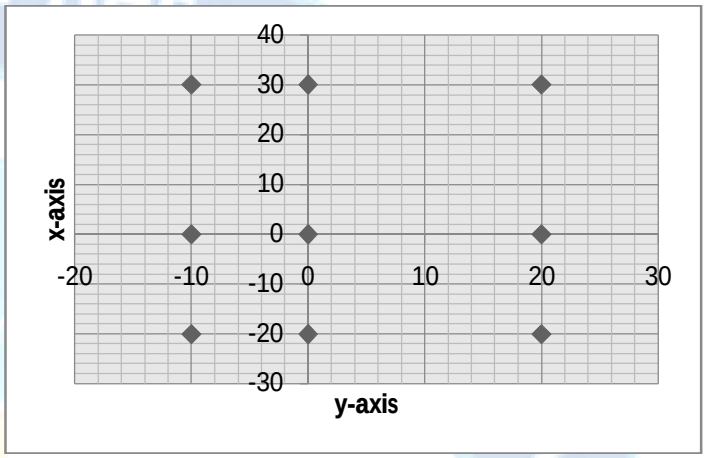


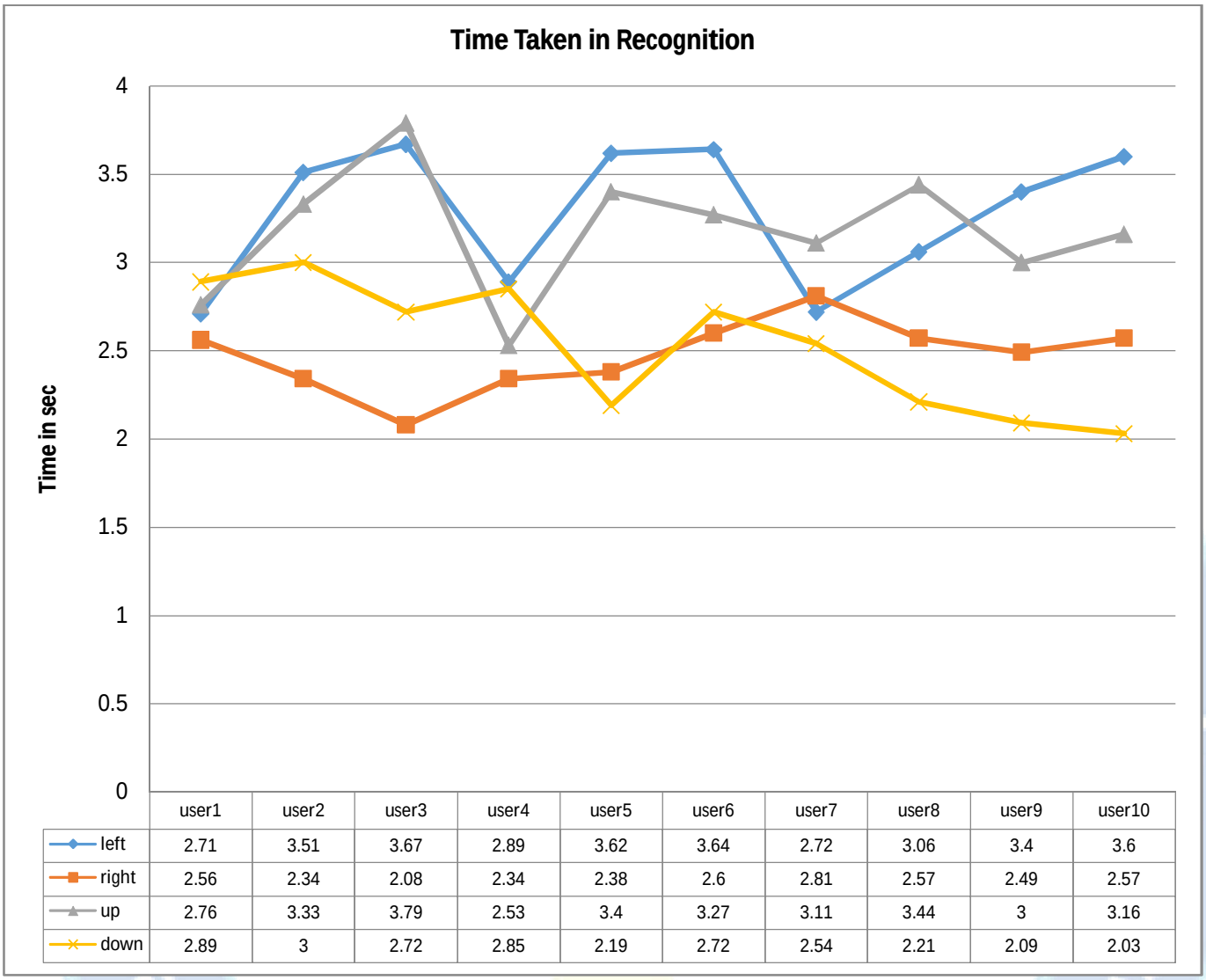
Figure 5. Boundary Value for virtual frame

IV. EXPERIMENTS AND RESULTS

The BVM technique is implemented on Windows PC with Intel Pentium (R) Dual Core CPU 2.30 GHz and 2.0 GB RAM.The platform is Microsoft Visual Studio 2010 and the programming language is C#. The hardware required is kinect and kinect tripod stand. Kinect consists of an infrared

projector for depth sensing and camera which works on RGB data and a special microchip to track 3D objects movement. Kinect also consists of multi-array microphone for speech recognition and for telling the direction of source. The experiment is conducted in standard lightning environment.

In this experiment 10 users are considered. The recognition time is set as seconds. The recognition time is estimated to find the mean, minimum, maximum time, for Direction Recognition of hand movement.



	user1	user2	user3	user4	user5	user6	user7	user8	user9	user10
left	2.71	3.51	3.67	2.89	3.62	3.64	2.72	3.06	3.4	3.6
right	2.56	2.34	2.08	2.34	2.38	2.6	2.81	2.57	2.49	2.57
up	2.76	3.33	3.79	2.53	3.4	3.27	3.11	3.44	3	3.16
down	2.89	3	2.72	2.85	2.19	2.72	2.54	2.21	2.09	2.03

Figure6.Time Taken in Recognition

Outcome:

1. In case of left direction recognition, its minimum measurement observed is 2.71 sec for user 1, the maximum recognition time(sec) is 3.67 for user 3 and mean is 3.82 sec.
2. In case of right direction recognition, its minimum measurement observed is 2.08 sec for user 3, the maximum recognition time(sec) is 2.81 for user 7 and mean is 2.47 sec.
3. In case of up direction recognition, its minimum measurement observed is 2.53 sec for user 4, the maximum recognition time(sec) is 3.79 for user 3 and mean is 3.18 sec.
4. In case of down direction recognition, its minimum measurement observed is 2.03 sec for user 10, the maximum recognition time(sec) is 3 for user 2 and mean is 2.52 sec
5. The overall average time in recognition is 2.997 seconds.

Table2 Recognition Rate

Movement& user	No of rounds	Up(%)	Down(%)	Left (%)	Right (%)
User1(first time)	8	100	100	100	100
	11	90.9	90.9	90.9	90.9
	16	93.8	100	100	100
User2 (trained)	5	100	100	100	100
	10	100	100	90	100

	15	93.3	100	100	93.3
User3	10	100	90	100	90
	17	94.1	100	100	94.1
User4	6	100	83.3	100	100
(moderate)	12	91.7	100	91.7	100
Recognition Rate		96.3	96.4	97.1	97.4

Outcome: The outcome of this experiment is as follows
1: First Time User – more number of time user input are trained the output of the recognition can be achieved 100%
2: Trained user – as the user becomes more trained every outcome is achieved 100%.
3: Moderately used user can also achieve 100% recognition rate if practice time can be increased.
4: The average recognition rate in up direction from centre is 96. 3%, for down is 96.42%, for left is 97.1% and for right is 97.3%. It can be seen that recognition rate of right direction is more as normal human is comfortable with right hand
5: The overallaverage recognition rate is 96.8%.

V. CONCLUSION

On the whole a system is developed which is based on dynamic hand gesture recognition and it can be used for Direction Judgment and for SENDKEY Stroke Generation. The RGB data and depth data is provided to kinect as an input. Skeleton Tracking is performed which provides joint information. Hand segmentation is followed by Skeleton Tracking. After that a few primitive condition is stating of Detection of events. For the Direction Recognition a Boundary Value Method is proposed. After Detection of Direction a SENDKEY stroke is generated this is further used to give the Up, Down, Tab, Enter Command. The boundary value is found by experimentation and if hand crosses a certain range then action takes place.To confirm that action happens only once a flag is also used. We use both the shape and the path of a digit as features. The proposed system average time in recognition is 2.997 sec and it achieved about 96.8%accuracy in the hand Movement and Direction recognition. It has a great potential on future human-machine development.

VI. FUTURE WORK

Various Dynamic Gestures are to be explored so as to provide the full functionality of keyboard and mouse cursor. There will be further development in Speech Recognition System that by speaking the command the SENDKEY can be generated. A New Feature can be introduced that as we draw any shape by hand so it can recognize it and generates the exact image and further a Print “SENDKEY” should be used for taking the print out and the last but not least feature is integrating it with virtual environment and 3D models.

VII. REFERENCES

[1] Han, J., Shao, L., Xu, D., & Shotton, J. (2013). Enhanced computer vision with microsoft kinect

[2] Maisto, M., Panella, M., Liparulo, L., & Proietti, A. (2013). An Accurate Algorithm for the Identification of Fingertips Using an RGB-D Camera. Emerging and Selected Topics in Circuits and Systems, IEEE Journal on, 3(2), 272-283.

[3] Ren, Z., Yuan, J., Meng, J., & Zhang, Z. (2013). Robust part-based hand gesture recognition usingkinect sensor. Multimedia, IEEE Transactions on, 15(5), 1110-1120

[4]Chen, Q., Georganas, N. D., & Petriu, E. M. (2007, May). Realtime vision-based hand gesture recognition using haar-like features. In Instrumentation and Measurement Technology Conference Proceedings, 2007. IMTC 2007. IEEE (pp. 1-6). IEEE

[5] Bellili, A., Gilloux, M., & Gallinari, P. (2003). An MLP-SVM combination architecture for offline handwritten digit recognition. Document Analysis and Recognition, 5(4), 244-252

[6] Biswas, K. K., & Basu, S. K. (2011, December). Gesture Recognition using Microsoft Kinect®. In Automation, Robotics and Applications (ICARA), 2011 5th International Conference on (pp. 100-103).

[7]Neves, R. F., Mello, C. A. B., & Zanchettin, C. (2011, October). A SVM based off-line handwritten digit recognizer. In Systems, Man, and Cybernetics (SMC), 2011 IEEE International Conference on (pp. 510-515). IEEE.

[8] Chu, T. T., & Su, C. Y. (2012, November). A Kinect-based handwritten digit recognition for TV remote controller. In Intelligent Signal Processing and Communications Systems (ISPACS), 2012 International Symposium on (pp. 414-419).

[9] Lai, K., Konrad, J., & Ishwar, P. (2012, April). A gesture-driven computer interface using Kinect. In Image Analysis and Interpretation (SSIAI), 2012 IEEE Southwest Symposium on (pp. 185-188). IEEE.