CHAPTER 8

IMPLEMENTATION AND RESULT DISCUSSION

8.1 Implementation of Hand Mouse using Kinect sensor Camera:

8.1.1 Flowchart of the mouse controlling

Fig 8.1: Flowchart of the mouse controlling

Modelling Algorithm one: For the mouse controlling

Step One: Start → Configure Webcam with the computer;

Step Two → Construction of object for RGB and Depth camera;

Step Three → Activate the configuration Kinect Cam;
Step Four  → Obtain the Detail specification of the image;

Step Five  → Trigger Both Objects;

Step Six  → Detect Skeleton Joint Coordinates;

Step Seven  → Calculate the Z distance between right hand and the shoulder centres;

Step Eight  → If (Distance > Threshold)

{  
    Enable User Function and calculate X and Y displacement of Right Arms  
}

Else

Repeat  → Step Five;

If Max ((dx, dy) <Threshold Value)

{  
    User is moving mouse pointer;
    Calculate coordinates of the mouse pointer;
}

Else

Repeat  →  Step Five;

Step Nine:  →  If (Hand is Open)

{  
    Operates on Left Click Down;
}

Else

Left Click UP.
8.1.2 Flowchart of the Hand Movement Detection

Modelling Algorithm Two: For the hand movement detection

Step One: Detection of Skeleton Coordinates According to the image.

Step Two Detection of right hand co ordinates

Step Three: Measurement of the depth map of the right hand.

Step Four: Extraction of all the depth values from the range of right hand.

Step Five: Calculation of Compactness.

Step Six: If (Compact < Threshold)

Fig 8.2: Flowchart of the Hand Movement Detection
{ 
Palm will be closed;
}

Else
{

Palm is open;
}

This algorithm is designed for the Palm gesture detection, where as in the first step of the algorithm the skeleton coordinates of Palm are detected from images following the measurement of Depth-map has been conducted regarding all the coordinates, and transferred into the RDM. Subsequently, the hand section is acquired from depth map utilizing the provided formula.

\[ \text{Palm} = (\text{Depth-map} < \text{Rdm}+5) \& (\text{Depth-map} > \text{Rdm} -5) \] ........1

Equation 1 provides binary images. Following such, analysis of the depth map creates an array of compact values with considerable compact capacity, which is subsequently contrasted with the established threshold values and in accordance to the value assessment, the palm is give its directions. Compactness can be gained by the following formula

\[ \text{Compactness} = \frac{\text{Perimeter}^2}{4 \ \Pi \times \text{Area}} \] ........2

Fig 8.3: Hand Open Operation.
In Figure 8.3, subplot 2 demonstrates assessed right hand over the depth map, and under the subplot 3, the right hand’s segmented mask sourced over the hand’s depth values. The compact capacity is assessed over the right side binary mask and based over its value, it is considered open.

![Image of Color and Depth images with labeled hand]

**Fig 8.4: Hand Close Operation.**

Figure 8.4 demonstrates the closed operation. This operation allows left-clicking through the mouse. The closed hand’s mask is also constituted with a section of the wrist given the possibility that values of the compact increments over the threshold and it could be assessed as open, and therefore, the threshold values should be selected with substantial care.

An assortment of fifty experiments has been conducted for the closed and open gestures. Table 8.1 demonstrates the confusion matrix of the Hand open as well as the threshold value of 1.5. It becomes rather obvious that open operations are far superior in efficacy as compared to closed operations.

Table 8.1: Confusion matrix for Hand open close operation.

<table>
<thead>
<tr>
<th></th>
<th>Open</th>
<th>Close</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>48</td>
<td>2</td>
</tr>
<tr>
<td>Close</td>
<td>7</td>
<td>43</td>
</tr>
</tbody>
</table>
An open hand is based on no operation, e.g. if individual has their hands open and move in a steady motion, the cursor should move. Figure 8.5 demonstrates the conclusion of moving cursor. In (a) individual is shifting cursor towards the right without clicking, whilst in (b) the individual is steering in the left direction.

Fig. 8.5. (a) Moving cursor right (b) Moving cursor left

If an individual steers their hands while they are closed, the dragging feature is activated. Figure 8.6(a) demonstrates dragging operations over the down direction whereas (b) demonstrates dragging in the right.

Fig. 8.6. (a) Dragging cursor down (b) Dragging cursor right.
An assortment of twenty experiments has been conducted utilizing all 4 gestures. The confusion matrix has been illustrated under Table 8.2. The efficacy of the algorithm generally is based on thresholds. Therefore, it becomes a necessity to elaborate thresholds with major care.

Table 8.2: Confusion matrix for Hand movement operation

<table>
<thead>
<tr>
<th></th>
<th>Up</th>
<th>Down</th>
<th>Right</th>
<th>Left</th>
</tr>
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<tbody>
<tr>
<td>Up</td>
<td>16</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Down</td>
<td>0</td>
<td>18</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Right</td>
<td>2</td>
<td>3</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Left</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>19</td>
</tr>
</tbody>
</table>
8.2. Implementation of Smart Ward System in a hi-tech hospital using kinect sensor camera.

The Kinect sensor finds application in clinics for the treatment of patients suffering from paralysis stroke. In the existing systems, patient is given remote control to adjust the bed as well as to call nurse for any assistance. Most of the hospitals have not installed appliance automation system due its high cost. Along with those appliances automation system comes with remote control which results in inconvenience to the patient. Conventional gesture recognition system requires some sensor to be worn or requires simple background i.e. it will not work in outdoors. 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.

Here we are assuming that 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. Figure 18 shows the block diagram of proposed system. The proposed methods can be divided into three modules 1) System enable and disable 2) Mode selection 3) selected mode operation.

![Proposed System Block Diagram](image)

**Fig 8.7: Proposed System Block Diagram**
8.2.1 System Enable and 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. If user wants to enable the system he has to point his hand towards camera for 3 seconds. To check that gesture, we take 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 we check another condition i.e. z distance of right hand with shoulder centre. If the distance is more than threshold then we start 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.

![Color Image](Image)

**Fig 8.8:** Enable/ Disable Gesture

The most important feature of our system is to enable or disable the system at any point of time. Figure 8.8 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 8.3 shows the confusion matrix for all classifiers. From table it is clear that SVM performs better than ANN and KNN.

Table 8.3: Confusion matrix for all classifiers

<table>
<thead>
<tr>
<th></th>
<th>Mode 1</th>
<th>Mode 2</th>
<th>Mode 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SVM</td>
<td>ANN</td>
<td>KNN</td>
</tr>
<tr>
<td>Mode 1</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Mode 2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mode 3</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

8.2.2. Mode Selection:
Once the system is enabled by patient, patient has to select the mode to get particular service or control particular device. We have defined three modes in SWS. 1) Head section adjustment of patient bed 2) electrical appliances control 3) patient assistance system. First we take 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 figure 9.

![Model 1](image1)
![Model 2](image2)
![Model 3](image3)

Fig 8. 9: Gestures for Mode selection

In figure 8.9, 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.
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 figure 8.10. As you can see in above flow chart we have used 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 SVM, ANN and KNN for analysis. Out of three classifiers SVM gave best output. The system will then enter into respective mode of operation.

![Mode Selection Gestures](image)

Fig 8.11: Mode Selection Gestures.

Figure 8.11 shows the gestures for different modes. The tracking of the hands are accurate and the performance of the gestures are comfortable. In figure (a), gesture for mode 1 is shown where user has to rotate the right hand in circular manner. Figure (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 figure (c).

8.2.3 Mode Operation:

As mentioned earlier there are three modes

8.2.3.1 Mode 1: Head section adjustment of patient

The flow chart of mode 1 operation is shown in figure 8.12. 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.
Initialize Depth Camera
Trigger Camera
Obtain Skeleton Coordinates
Calculate Y Different Between Hip centre & right-hand
Calculate the Y displacement of right hand
Increment Gesture Counter
Is Gesture Count = Th4?
Is Ydisp <0?
Yes
Yes
Yes
Bed Up
Bed Down
No
No
No
Start
Is Ydiff1>Th1?
Is Ydiff1>Th2?
Is Th1>Ydiff1>Th2?
Fig 8.12: Flow Chart for Mode 1 Operation.

Fig 8.13: Mode 1 Operations.
Once the user has selected mode 1, the window as shown in figure 8.13 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 figure (a) or move the hand downward to reduce the height of the head section as shown in figure (b).

8.2.3.2 Mode 2 & 3: Graphical interface mode.

The flowchart of mode 2 & 3 is shown in figure 14. 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.

Fig.8.14: 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.

Figure 8.15: Mode 2 Interactive Window.

Figure 8.15 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.

Fig 8.16: 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 figure 16. 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.

![Image](image1.png)

Fig 8.17: Mode 3 interactive window.

If user selects mode 3 then the interactive window shown in figure 8.17 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.

![Image](image2.png)

Fig 8.18: Mode 3 operations.

Figure 8.18 show operations for mode 3. In this mode the size of icon increases, when selected, to confirm the selection of the action. Figure (a) and (b) shows actions of calling nurse and asking for water respectively.
8.1. Conclusions

Skin segmentation techniques classify the skin pixels from the non skin pixels. The major limitation of the skin colour segmentation is that it is hard to extort the specific colour from a given coloured image as the colour of the object differs with alteration in illumination colour, illumination shape, sensor parameters, movement of the object, etc. Another drawback of skin colour detection is the skin tone which varies with the race of the human.

In motion detection the three major steps in analysing the human movements are human motion analysis, tracking of human motion and identifying the human actions. The motion analysis involves 2D or 3D interpretation of the human parts using low level segmentation, movements of the human parts, joint detection. Tracking of the human movements is executed using high level processing where the human parts are not recognized clearly. When tracking an object in an image sequence from multiple cameras, all the features are to be projected on to a common spatial domain. The feature tracking has to be expertise for recognizing human actions in an image frames. Human action recognition mainly depends on the feature extraction from consecutive frames, which is still a restriction in many methods. To reduce the uncertainty in matching process, many restrictions are forced on the human motions. These limitations may not be conventional to general imaging condition or may lead to passive problems like complexity in approximating of model features from dynamic image data. The main limitation of motion detection is the restriction on the movement of the object, i.e. the range of the movement is limited by the camera.

Hence to overcome the limitation of both skin colour detection and motion detection, an algorithm “Human Hand Recognition System Based on Moving Object Detection, Colour of the Skin and Face Recognition System” was developed which combined both the skin colour detection method and motion detection method. The results obtained were satisfactory compared to the skin detection or motion detection method only.

A limitation of this approach was that the face was also detected. The face was deleted after the execution of face detection algorithm.

To avoid the face of the user and to overcome the limitations of both skin colour detection and motion detection, kinect sensor camera was used in which the
segmentation (based on skin colour, motion and depth information) and tracking (Based on the coordinates of the joints of human) is simpler.

The patterns drawn by both bare hand and with colour caped fingers were recognized and classified by using three classifiers K-Nearest Neighbour, Artificial Neural Networks and Support Vector Machines. Their performances are compared and the best classifier SVM is used in the prototype application.

The proposed model for hand gesture recognition system is implemented in a prototype application with an objective to serve as an interface for controlling the movement of the mouse in right, left, up and down direction and to click and drag the mouse.

Smart ward system is implemented using this model. The system is enabled to work in three different modes such as Controlling of the Patient’s bed, Electrical appliance automation and Smart assistant system is demonstrated by enabling the objects on the interactive window.

8.2. Future Scope

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.