Front Illumination Based Multi-touch System with Blob Detection and Communication Enable

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Abstract: **Class of interaction technologies is very wide, including sensor based, motion based and touch technologies. Multi-touch technology is the second generation of touch technology. To develop a multi-touch system, there are some issues to be deal with, like, selection of technique for multi-touch development and blob processing. This research focuses on finding a solution for development of a multi-touch system by using modified front illumination with blob detection that minimizes the cost, effort and complexity and making a demo system. An application is also made to work in multi-touch environment and communication feature is added to make system full help provider.**

Key Words: **Multi-touch, front illumination, complexity, blob detection and sensors.**

1. INTRODUCTION

Multi-touch technology is continuously growing after its precedent single touch technology (late 1970s) and first multi-touch was coming in the year 1982 that was very hard to implement. The modern multi-touch prototype was given by J. Han in year 2005 [1], that was based on optical based multi-touch technology, Frustrated Total Internal Reflection (FTIR), it is a light phenomenon that occurs in some situations, that makes touch panel able to detect more than one touch. Than another optical technology based multi-touch was launched by Microsoft corporation (2007) [2], which was based on different optical technology, Diffused Illumination (DI). This device was made for commercial purpose as it was very costly (price $12500) to afford by a common man. So, finding a way to develop such system by reducing prices and complexity is the objective of this research.

Application development for multi-touch device is also not a quit easy task to do as windows were not originally come with multi touch compatibility. To make an application supported by multi-touch that will run on windows platform is another issue to deal with. A helpdesk application to run on multi-touch platform for an institution is chosen to be developed and that is made in visual studio 2010 and earlier versions of it, with using Windows Presentation Foundation (WPF) framework and with extensive surface SDK 2.0 [3].

Communication facility in this system is added to provide better care for the user of helpdesk system. Two modes of communication are added in this application; first is client-server communication and second is Global System for Mobile communication (GSM).

2. SELECTION OF METHOD AND DISCUSSION

There are numerous technologies available to develop a multi-touch system. Selection of suitable technique is a very important step to be done. Since 1982, capacitive and resistive touch technologies are being used for making electrical based multi-touch technologies, and optical based multi-touch system became famous after its first successful implementation given by J. Han in year 2005. This was based on FTIR technology. Major classification of multi-touch development technologies is given below:

Table: 1
Classification of Multi-touch Technologies

Technology	Property	Remark
Capacitive	Uses capacitive sensing	Electrical based smooth touch
Resistive	Uses resistive sensing (pen or styles)	Electrical based hard touch (pressure required)
Vision Based	Optical or camera based	Camera vision and light phenomenon

Vision based technologies are camera based technologies with requires some optical phenomenon to occur, there is a further classification of optical technologies, which is FTIR, DI and Laser Light Plan (LLP) [4].

DI is the selected choice for making the multi-touch system described in this document, because the motive is to develop a cheap and less complex device for general purpose application. FTIR and LLP based systems are more complex to develop they require lots of coating, IR/Laser light and camera modifications, however, IR light is also required in case of rear diffuse illumination, so, leaving all these the next best option is front side illumination.

Rear Diffused Illumination (Basic):

Front illumination method is the optical phenomenon in which

illumination occurs by the ambient lights provided to the touch surface [5]. This technique highly dependent on the lighting environment provided to it. If proper ambient light is provided to touch panel it can be constructed in less cost. So, as per the objective some modifications to basic setup are made in order to achieve desired results.
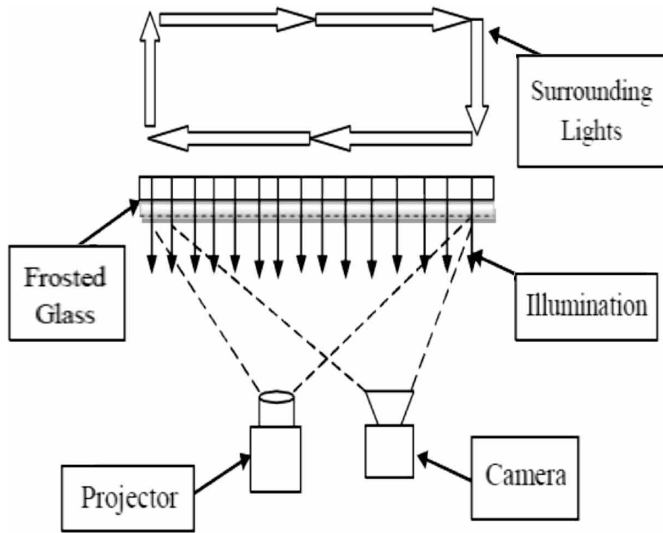

Fig: 1 modified setup of front side DI

Modifications:

1) Matte finish glass or frosted Glass sheet is used instead of glossy simple glass or Acrylic sheet.

2) Ambient light environment by AC bulbs instead of Infrared light.

3) No Diffuser Material is used (cost of diffuser and silicon coating is saved now).

3. TECHNOLOGIES RELATED TO DEVELOPMENT OF A WHOLE SYSTEM

The technology for making multi-touch surface is discussed in the above section, now other technologies are described in this section.

1. Image processing:

Image processing for detection of blobs on touch panel is applied with the tool "Touchlib". Touchlib is open source software which is used to help multi-touch detection process. There are many filters given in touchlib which can be applied as per requirement [6].

Various filters are: Capture filter, Background filter (noise and threshold), Highpass filter, Scaler filter and Rectify filter. By adjusting the values of these filter better blob detection can be achieved [7].
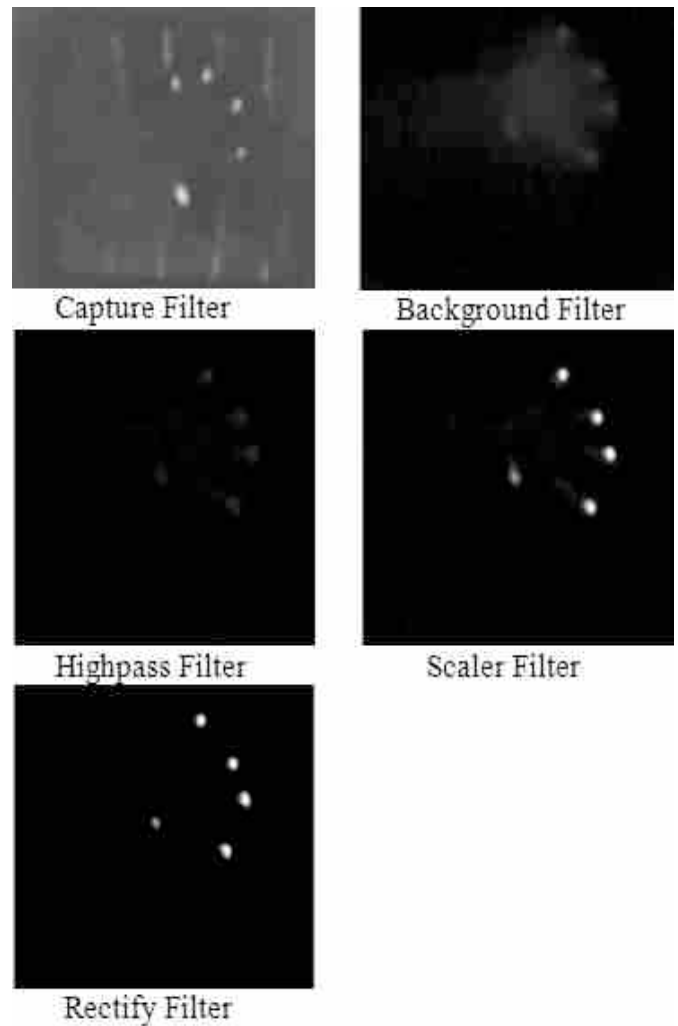

Fig : 2 Touchlib Filters

I. Communication Technologies:

There are two types of communication methods used in this system which are described below:

1) Client-Server Communication:

    This is a LAN based communication system that works on the TCP/IP protocol by using socket programming [8]. This chat application will run within the campus range of institution. There are two separate applications developed for client and server. There is a single client application which can be connected with multiple server systems. Socket programming is used to make connection with application [9].

The Client will be the helpdesk application which will send message to server application that HOD of particular departments. Client system makes a connection via IP address and port no of the server system.
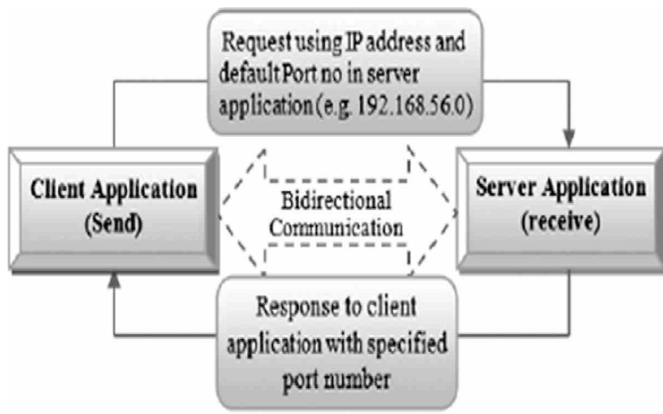
Fig: 3 client-server technology

2) GSM Communication:

GSM (Global System for Mobile Communication) is the telecommunication communication technology. To make connection with mobile devices using GSM system, it requires some extra hardware and software components [10].

Requirements: Software (Virtual Serial Port Driver, Hyper Terminal) and Hardware (USB to Serial converter Cable, GSM Modem SIM300).

USB-to-Serial converter cable is connected to the computer via RS-232 port to make serial port communication enabler.
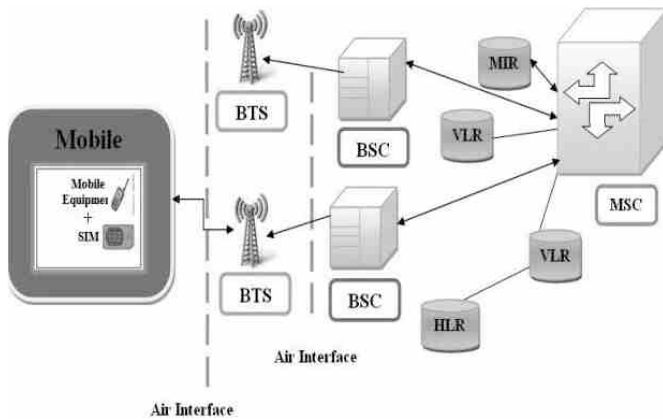

Fig: 4 GSM Communication System

II. Application Development Technologies:

Application development for multi-touch system is not as easy task as for regular applications. There are some extensions need to be added in visual studio 2010 to make it capable to develop a multi-touch application.

Surface SDK 2.0, is added to VS 2010 that adds surface WPF framework that allows making a multi-touch application for windows operating system.

The whole GUI of the help desk application is made in this extended VS 2010 includi0ng chatting application. C# is used as a development language and extended Application Markup Language (XAML) for GUI.

4. HARDWARE SETUP

Before going towards setup first all necessary requirements are listed below:

1. *Screen:* A simple glass sheet of size 12×12 inches, Selection of touch panel has gone through experiment with two different types of glass sheets:

   a). First one is a "simple glass sheet" or "Acrylic sheet" (same as used in conventional FI setup). A diffuser is placed on it to make touch panel capable of processing multiple inputs from multiple users.

   b). Second one is a different type of glass like "Frosted glass" available in the market, using the frosted glass instead of acrylic or simple glass sheet is the part of experiment done in this thesis. There is no need to place a diffuser in this case.

2. *Light Source:* (6 volt AC bulbs) the light source is placed in surrounding manner which is equally distributed on the surface which doesn't create shadow or false blob detection problem.

3. *Camera:* Camera used is a IT_LITE_VU 100 Intex webcam (night vision) with face detection for the blob detection purpose.

4. *CPU:* Intel Core i3-370M Processor running at 2.40 GHz. The computer contains 3.0 GB of memory.

5. *Projector:* Digital Light Processing (DLP) for short distance projections.

6. *Cable:* It is a USB-to-Serial converter, for connecting the modem to the computer. It is used for connecting the modem via RS232 port of the computer.

7. *Modem:* There is a GSM modem (SIM 300) is used to make calls and sending text messages via the "Helpdesk" system.

8. *Table:* Wooden Table with a glass holding frame attached.

9. *Diffuser:* Rice paper, as diffuser.

Now, first camera is placed at the bottom centre of the table facing in upward direction and then glass sheet is placed in the upper frame, all bulbs are placed in a surrounding manner so that to create an ambient light environment.

GSM modem is connected to a CPU via USB-to-Serial converter cable.

5. APPLICATION DESCRIPTION

Helpdesk departments in any company or institute are established for helping purpose, so there may be a self help
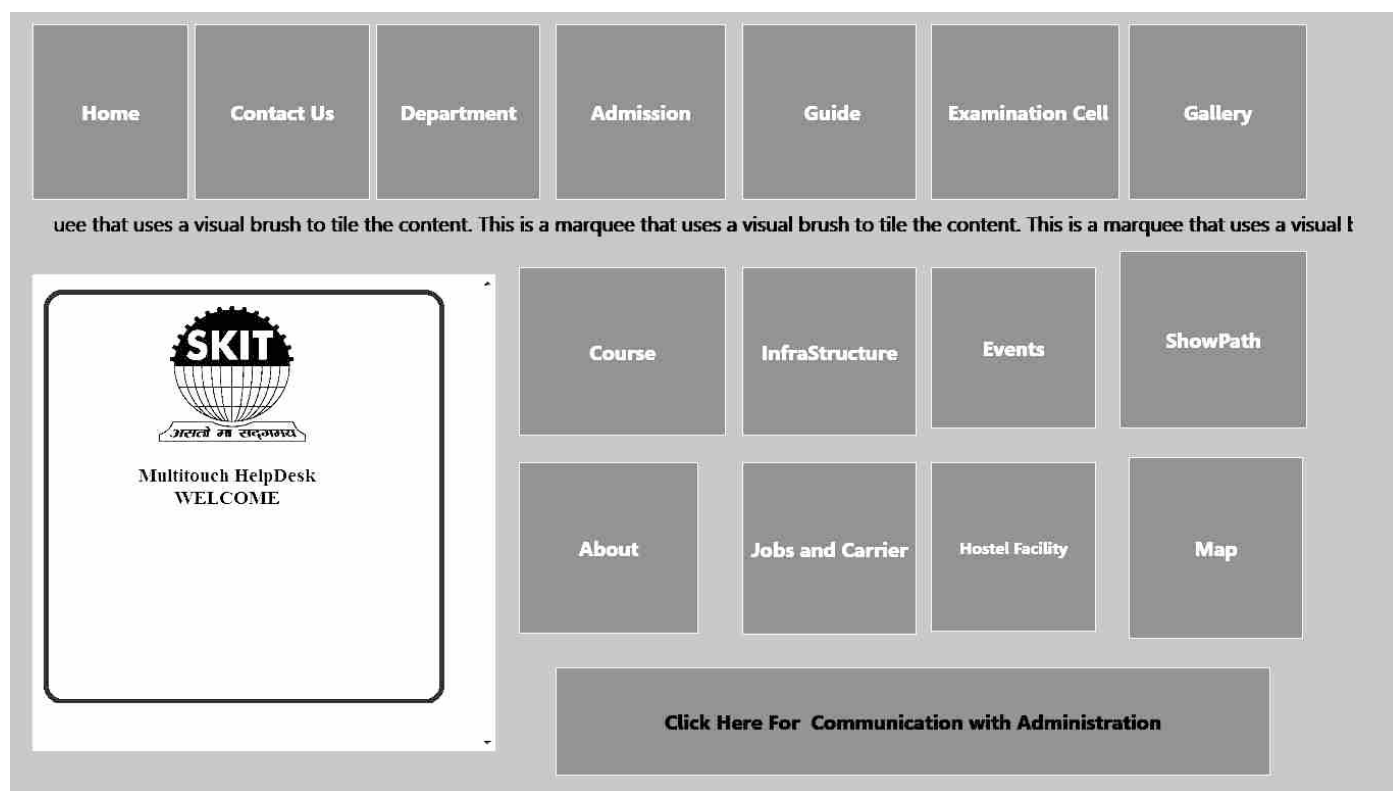
Fig:5 Application preview

provider system to replace a person dependent help desk to self service helpdesk that would be managed through an a software application. It avoids the dependency and provides a new experience for its users.

- It contains all information regarding the collage and contact details.

- It contains a user guide Helpdesk guide for new users or outsiders, so there is no need of any kind of training for its use.

- It contains a video guide to each department, in Find Way option.

- If a user wants to contact with any faculty or administrative person, he can choose between two alternative ways: By Chat server and By GSM communication system or both.

- There is a multi-touch gallery for viewing images of related departments.

6. IMPLEMENTATION AND WORKING

After setting up hardware and software with configuration, workflow of the table starts with touch detection module. Touch is assumed as white controls on the screen refers as blobs, when working with an FI system invert filter of touchlib is used[11], now detected blobs are tracked by tracker application (TUIO events, [12]) where image processing is applied for making blobs under criteria discussed in coming sections. Then response is produced by application which is a throughput of the touch table (on laptop screen in this experiment). Performance evaluation of working is done by comparing it with modified FDI setup and Normal FDI setup.
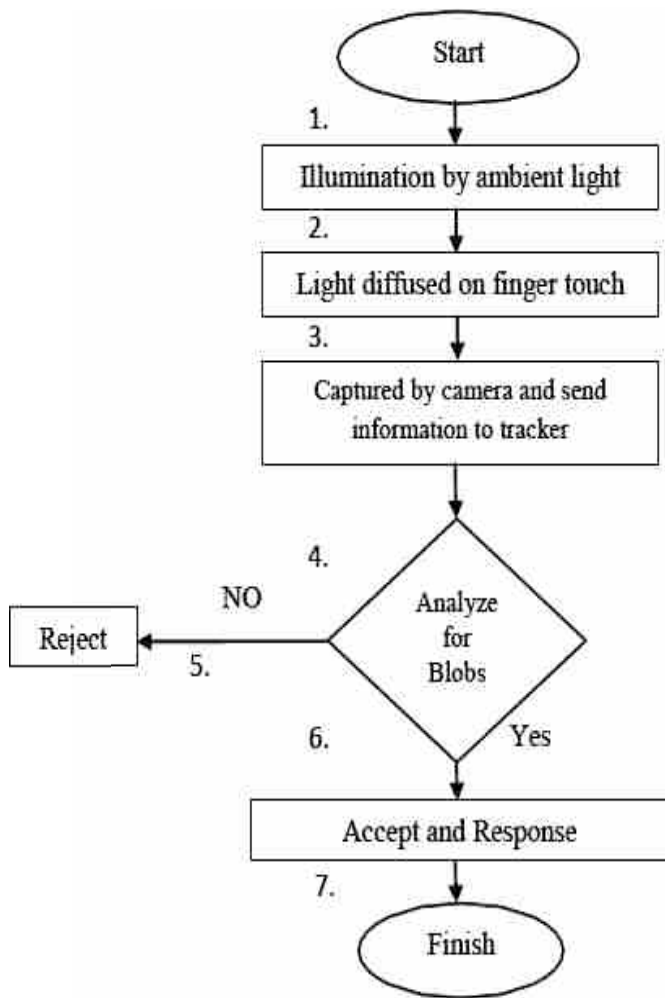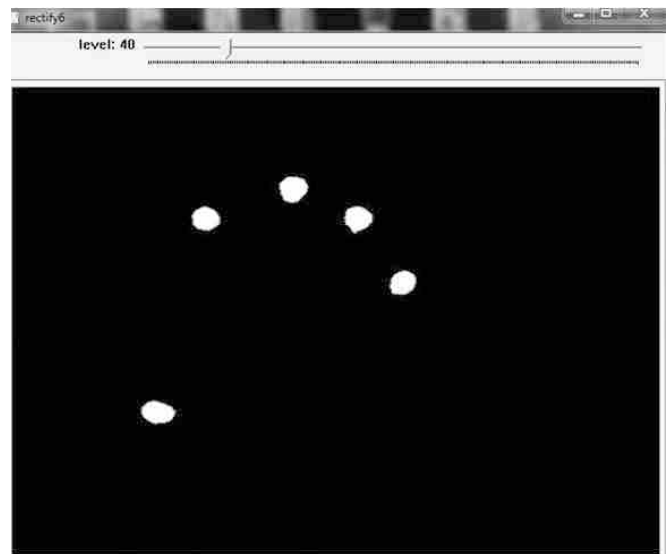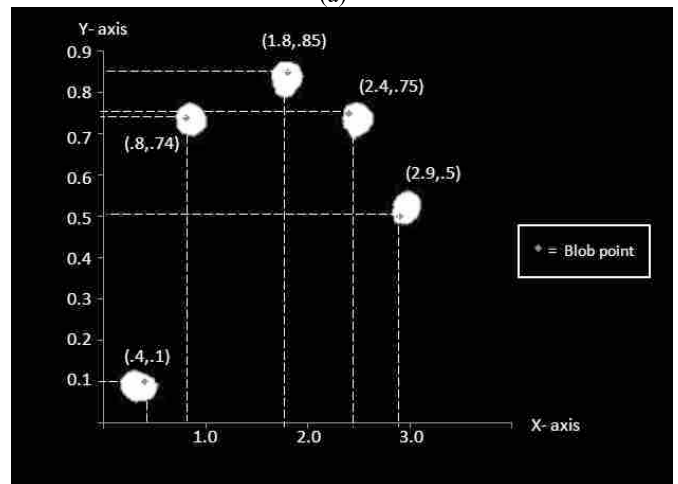
Fig: 6 flow chart of blob detection event

After execution of blob detection cycles and applying filter blobs as finger tip expression (noise free) is given in below images.

(a)

(b)

Fig: 7 Image (a) is filtered blob image and image (b) is point location detection information on screen

Communication module implementation:

1)   *GSM Implementation:*

GSM is a wireless communication protocol for working world wide. Application of GSM in helpdesk is done in WPF also so that it works well for multi-touch system. The VS 2012 provide components and connecting facility by GSM network. For the establishment of connection first application has to deal with port setting which is done with:

- *"System.IO.Port"*: This is a Namespace used to connect ports for GSM communication.

- *Serial Port*: this refers to class of ports used in GSM communication.

2)   *Client-Server Implementation:*

Client-server protocol implements with LAN connectivity. The Client application will require an IP address of Server system.

- *Namespace*: this is a library which contains various different Namespace parameters, some them are given below which are useful in this chat application.

- *System.Net*: This namespace provides a programming interface (set of classes) for network applications.

- *System.Net.Socket*: This namespace provides a supervised implementation of the Windows Sockets (Winsock) application interface.

- Used classes: "SocketPermission", "IPHostEntry", "IPAddress", "IPEndPoint"

7. RESULT AND ANALYSIS

The whole system works under the touch detection cycle by multi-touch panel. The performance of the system can be noticed by seeing the detected blobs and their clarity as per the lighting conditions. Applications works fine with multi-touch and all modules including communication and multi-touch gallery works fine with both types of touch panels, so this is clear that frosted glass can be used than simple glass or acrylic panel to reduce cost and complexity for development.

Fig: 8 Resulting System

Resulted comparison of MFDI with other technologies is given below:

TABLE 2
Mfdi Vs Other Multi-touch Technologies

ITEM	TECHNIQUES			
	FTIR	RDI	FDI	MFDI
Component Cost	High	Low	Low	Lowest
Construction Complexity	High	Medium	Low	Lowest
Closed box required	No	Yes	No	No
Suitable for experiments	Yes	Yes	Yes	Yes
Influence of ambient light	Low	High	High	High

By observing above comparision it is clear that MFDI similar to FDI. Graphical representation of above comaprion is given below with FDI and MFDI.
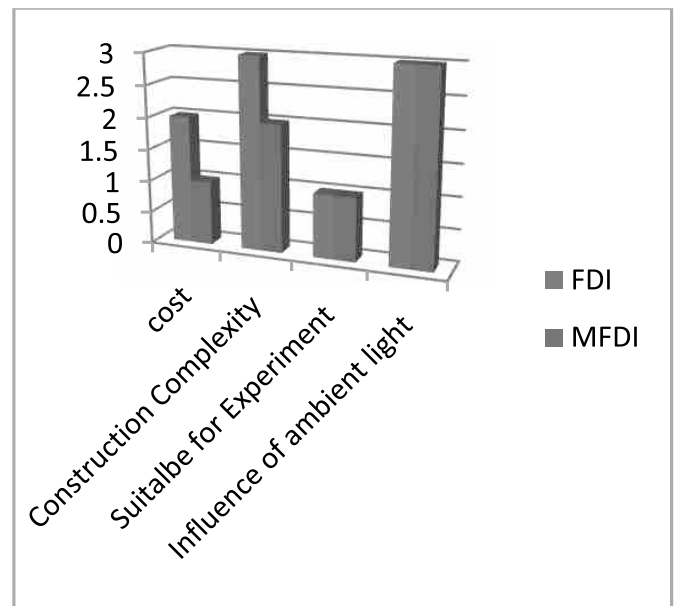

Fig: 10 graphical representation of comparison

Calibration output decides the accuracy of touch detection by a multi-touch panel, below are the values taken in different light conditions with both frosted glass and simple glass with a diffuser. And then the touchlib blob detection output. That window shows how bad calibration results and its dependency on lighting condition.
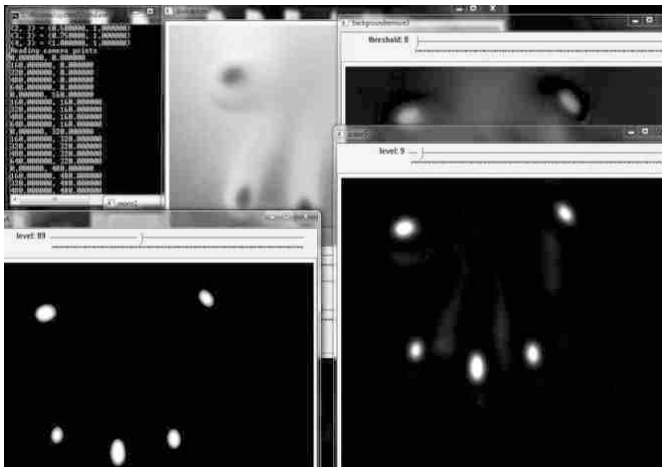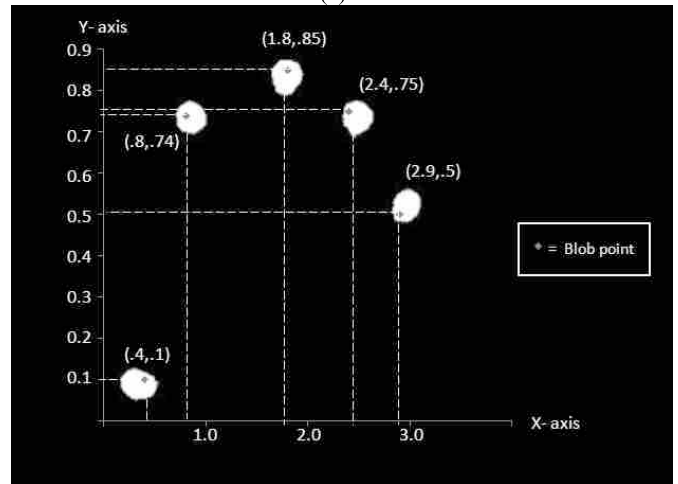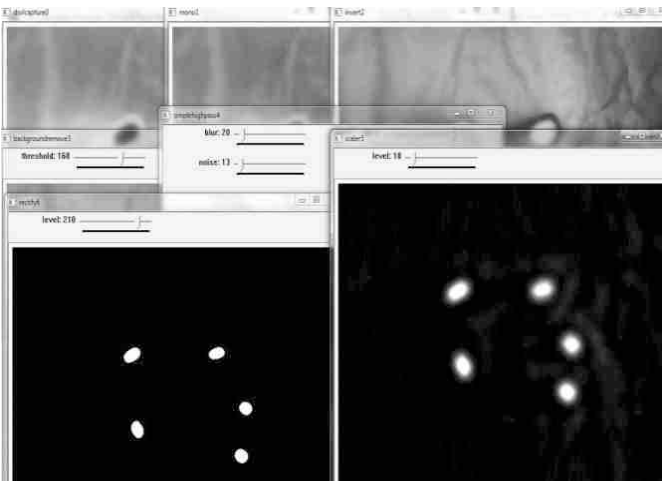
Touchlib output windows:
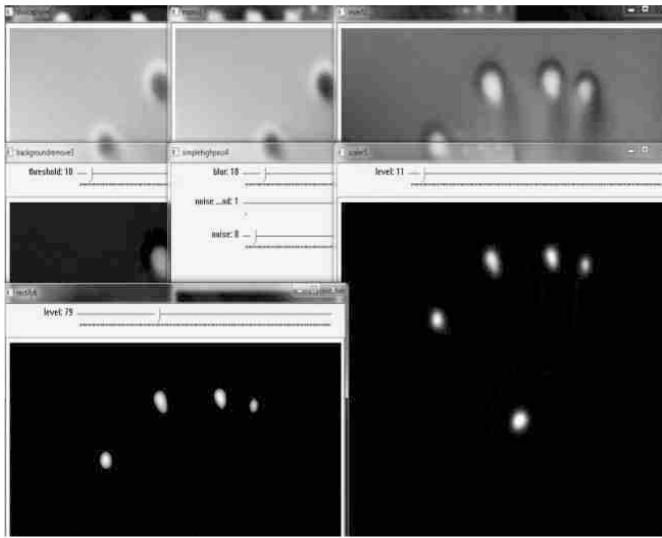
(a)
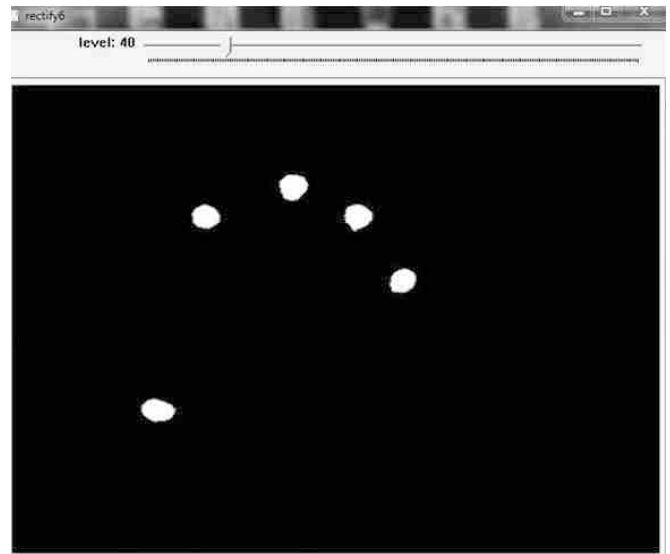
(a)

(b)

(b)

Fig: 7 Image (a) is filtered blob image and image (b) is point location detection information on screen

By observing above output windows of touchlib it is clear that the ambient light environment is necessary to work properly and avoiding false blob detection and the frosted glass provides robust touch sensing than other glasses (without coating) this is also the reason behind above calibration output.

Cost Comparison:

Cost analysis of this system is shown by comparison with existing similar systems in the following table.

(c)

Fig:13 snapshots of the touchlib calibration output window, image (a) are taken in ambient light (b) is taken in normal light and © is taken in uneven lighting condition

Name	Cost
Microsoft Surface (pixel sense), [2]	$12500-$1500 (₹ 8- ₹ 10 Lakh)
FTIR based systems, [20]	$1000-$5000 (₹ 75000- ₹ 1Lakh)
Other Optical devices	$500 approximately
Proposed System (in this paper)	$150-$225 (₹ 10000- ₹ 15000)

8. CONCLUSION AND FUTURE WORK

This paper offered a solution, an interactive self, helping helpdesk system that is implemented on a multi-touch device, which is well known in present time. Such systems are available only some high class big hotels and military and medical systems. As they are very costly. By applying changes in its basic hardware component as discussed in this paper, the cost and complexity can be reduced by maintaining the performance. If this technique is implemented by using a projector that will improve its performance.

This application mainly focuses on institutional work, but the scope leads to development in playing games. Some modification can be made like increase in screen size, more gestures and to increase the size of the table add multiple camera's.

REFERENCES

[1]   Jefferson Y. Han, *"Low-Cost Multi-Touch Sensing through Frustrated Total Internal Reflection"* in Proceedings of the 18th Annual ACM Symposium on User Interface Software and Technology, pp. 115{118. New York: ACM Press, 2005.

[2]   Microsoft Surface [Online] http://www.microsoft.com/surface/PixelSense, Last Access: November 2015.

[3]   David Chappell, "Introducing Windows Presentation Foundation" [Online] https://msdn.microsoft.com/en-us/library/aa663364.aspx, Last Access: September 2015.

[4]   Guifen Gu , Guili Peng "The survey of GSM wireless communication system", Computer and Information Application (ICCIA), IEEE, 2010 International Conference on Tianjin, DOI: 10.11 09/ICCIA.2010. 6141552.

[5]   Multitouch Technologies, Book Version 1.0, © 2009 NUI Group Authors, NUI Group.

[6]   Touchlib- A Multi-touch Development Kit [Online] http://wiki.nuigroup.com/Touchlib, Last Access: November 2015.

[7]   Laurence Y. L. Muller. "Multi-Touch Displays: Design, Applications and Performance evaluation." Master's thesis, University of Amsterdam, Amsterdam, Netherlands, 2008.

[8]   IEEE 802 LAN/MAN Standards Committee [Online] http://www.ieee802.org/, Last Access: July 2015.

[9]   Kameswari Chebrolu, "Socket Programming", Dept. of Electrical Engineering, IIT Kanpur.

[10]   Ma Yuchun, Huang Yinghong, Zhang Kun, Li Zhuang, "General Application Research on GSM Module" International Computing and Information Services (ICICS), IEEE International Conference, Hong Kong. 2011.

[11]   M. Kolsch and M. Turk, "Robust hand detection", Automatic Face and Gesture Recognition, 2004. Proceedings, Sixth IEEE International Conference, DOI:10.1109/AFGR.2004.1301601.

[12]   Qian Liu, "TUIO, Touchlib, reacTIVision and Community Core Vision", Media Arts and Technology University of California, Santa Barbara.

[13]   Thiago de Freitas Oliveira Araújo, "Recognition, Tracking and Association of Hands, Fingers, and Blobs: A Tbeta Upgrade", NUI group project paper, 2009.

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