A Systematic Overview and Study of Touchless Touch Screen Technology

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Abstract: Touch screens were responsible for creating a great future to the technology at an emerging rate. The Touch screen enables the user to interact directly with what is displayed on the gadget, rather than using any other intermediate device. Also, by frequent touching a Touch screen display with a pointing device such as a finger or touching device can result in gradual dullness or de-sensitization of Touch screen to input & the result can ultimately lead to failure of the Touch screen. To avoid these problems, a simple user interface for Touchless control of electrically operated equipment and devices is being developed for Touchless technology. Elliptic Labs innovative technology lets you control your apparatuses, device or gadgets like Computers, Mobile tab, Mobile phones or any interaction device without touching them. Unlike the other system which most probably depends on the distance from the sensor or sensor selection, this system depends on the hand, finger motion or movement, a hand wave in a certain direction, or a flick of the hand in one area, and holding the hand in one area towards which we are pointing with one finger i.e. according to user's gesture. The device is based on optical pattern recognition using a solid state optical sensor with a lens to detect hand motion with the help of lens. This sensor is then connected to a digital image processor (DIP), then DIP interprets the patterns of motion and outputs the results as signals to control fixtures, appliances, machinery, or any devices which are controllable through electrical signals.

Keywords: Touch Screen, Touchless, UI, GBUI, SDK, Display, Screen, Technology, Touch.

1. INTRODUCTION

Touch Screen is an important source of input or output device integrated with an electronic visual device or a gadget. A user gives the input or control the information processing through single or multi-touch gestures by touching the screen. It enables the user to interact directly with the gadget or with the display of device, rather than using any intermediate equipment. The Touchless Touch screen sounds like it would be nice, easy, unique and interesting, however after closer examination it looks like it could be quite a workout. The unique screen is made by TouchKo, White electronics Designs, and Groupe 3D. With the Touchless Touch screen our hand doesn't have to come in contact with the screen at all, it works by detecting our hand movements in front of it. This is a pretty unique and interesting invention, until we break out in a sweat with our interest and knowledge.

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2. LITERATURE REVIEW

The Age Of Touchscreen Is Soon To Be Over.

About a decade ago, the new revolution was started as "Touch Screen". Almost it was in a starting phase, but the Touch screen emerged within ample of time and covered most part of devices. As the started developing day by day the Touch screen was almost in every aspect of device and gadgets. Let us see a small review of our life in which we use devices like Computer, Mobile, Television, Washing machine and more. User Interface play an important role in the gadget i.e. User interface exists everywhere e.g. washing machine which we use on the top surface of it there are various buttons that is nothing but a UI. You can use them to stop the machine or turn ON just by the selecting proper button on the UI. User interface comes in very handy where user can't actually visit in that environment e.g. chemical industry. User interface should be easy to understand, speedy in operation and must be User friendly. Just for understanding a User Interface no special training or session should be required. If we considered our smart phone UI, they are easy to understand even a small baby play with it and under- stand. In this paper different types of UI are explained and compared. Different touch screen technologies are compared and why capacitive touch screen is preferred is explained. Also, UI is designed and developed few parameters like threshold, response time and crosstalk are explained in the paper. The user interface or UI is nothing but helps the user to control the machine. The UI are classified as follows:- Button type, GUI type, Touch type. The touch screen based UI are preferred because they are compact in size, speedy in operation and just by the symbol or the label you can understand the operation and use the UI. From this touch screen technology infrared and capacitive is famous [2]. In recent years, a mobile device is more friendly and powerful. The trends of new developed mobile device are focusing on big screen and thinness. The intuitive operation input is gradually becoming an important topic. With the advance of PC and mobile device technology, more and more new human machine interfaces are invented. Electronic mouse enables the user to control the position of the mouse cursor on the screen and give commands such as menu selection or editing the document on the screen. Touchscreen sensor technologies, including capacitive, resistive, magnetic or surface acoustic wave types, let the user be able directly to point out a position on the screen and move the objects across the screen. Some other devices, such as air mouse, 3D mouse or IR LED and proximity sensor are applied to control the cursor of the screen by detecting the movement in the air. The most intuitive way to interact with devices is to operate right in the center of the screen. In our system, we use the proximity sensor to detect the inferred from IR LED. The operation area in our system is limited between the sensors. The maximum operation distance from devices is affected by the emitting power of IR LED. The proposed system allows a bare hand or finger to trace a screen position touchless in a certain distance from a device. In some situation, the touchless control ability is useful. For example, when the hand is dirty after performing mechanic works, or greasy after handling the food, users will have the requirement of interacting with the PC or mobile devices touchlessly [4]. Computer information technology is increasingly able to make a way into the hospital domain. One such hospital domain where in the information technology has been unavoidable is Interventional Radiology. Interventional Radiology (IR) is one of the rapidly growing areas of medicine that provides solutions to common problems affecting men and women of all ages. This is a minimally invasive treatment for vascular and non-vascular disease, using small catheters and catheter based instruments guided by radiological imaging techniques such as x-rays, fluoroscopy, ultrasound, MRI and CT. These non-surgical techniques are advancing medicine and improving outcomes for a range of patients with life threatening conditions. Interventional radiologists are physicians who specialize in minimally invasive, targeted treatments that are performed using imaging guidance. The interventional radiologist or surgeon performing this procedure needs to interact frequently with an increasing number of computerized medical systems

before and during surgeries in order to review medical images and records. However, the computers and their peripherals are difficult to sterilize, so usually during a surgery, an assistant or nurse operates the mouse and keyboard for such interactions. This mouse and keyboard interaction suffers from communication problems and misunderstandings. This is one of the main reasons why, in recent years, touch-less interactions have been considered for use in operation theatres [3]. Nowadays, the interest has been increased in creating wearable device interaction approach Technology like Novel emerging user interface have the capacity to significantly affect market share in PC, smartphones, tablets and latest wearable devices such as head wearable device (HWD), i.e. Google Glass, since the miniaturization of mobile computing devices permits anywhere access to the information. Therefore, displacing these technologies in smart devices is becoming a hot topic. Google Glass has many impressive characteristics, and will not meet the occlusion problem and the fat finger problem, which frequently occurs in direct touch controlling mode [5]. Like these the are many fields in which Touchless technology will be used in future.

3. ANALYSIS

As seen, it obviously requires a sensor. The sensor is not attached on the screen nor it is hand mounted. The sensor cam is to be placed either near the screen or on the table. And the hardware must be setup such that, it is must be compact thus it can be fitted into a tiny gadget like a MP3 player or mobile phones, Screen, tab, etc. of an object from as 3 to 5 feet. This technology is based on optical pattern recognition using a solid state **Optical Matrix Sensor.**
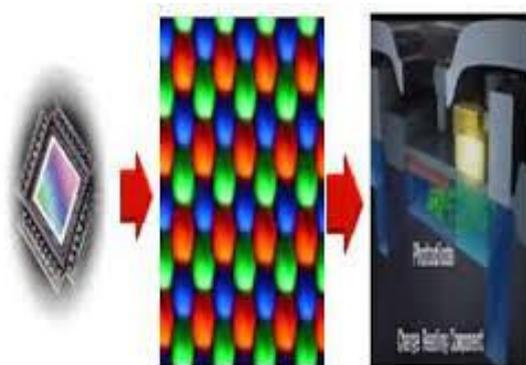

Fig 1. Optical Matrix Sensor

4. WORKING

Sensors are placed around the screen that is being used, by interacting with the line-of-sight or in the range of these sensors the motion is detected and interpreted into on-screen movements or on the display. There is a kind of stop sign or stop unintentional gestures being used as input that are not completely clear, but it looks promising nevertheless. The system is capable of detecting movements in 3-dimensions without ever having to come in contact with the display or screen or put your fingers on the screen. Touchless interface does not require any kind of gadget to come in contact or to wear any special sensors on our hand for navigation control. We have to point fingers at the screen within a range and manipulate object in 3-dimensions. The best part of Touch less touch screen is that the technology will be compact and easily small enough to be implemented into mobile, device, gadget and everywhere.

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The touchless device is based on optical pattern recognition using a solid state optical matrix sensor to detect hand motions with the help of lens. This optical matrix sensor is then connected to a digital image processor (DIP), this DIP plays an important role to interpret the gestures. Then this DIP interprets the patterns of motion and outputs the results as signals. These Signals are signs to control fixtures, appliances, machinery, or any other devices which are controllable through electrical signals. You just point at the screen with your hand gestures or in the area of range (from as far as 5 feet away), and you can manipulate objects in 3-dimensions.
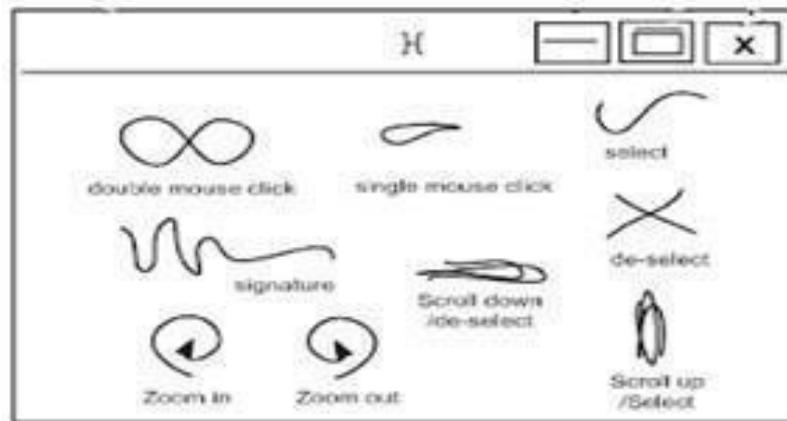

Fig 2. 3D Navigation of Hand Movements in Touchless Screen

5. BLOCK DIAGRAM

The Touchless Touchscreen consists of an IR sensor which are mounted near the screen or it can be paced near the screen with certain range. When the light strikes to the 3-dimension object, the light gets reflected back to screen. These consists of a solid state optical matrix sensor used as a 3-dimension Image sensor with a lens which recognizes the optical pattern of the hand motions with the help of that reflected IR light. In each of these sensors there are matrix pixels. Each pixel is coupled to photodiodes incorporating and generating charge storage regions.
The reflected IR light enters to the 3D Image sensor and hits the pixel matrix.
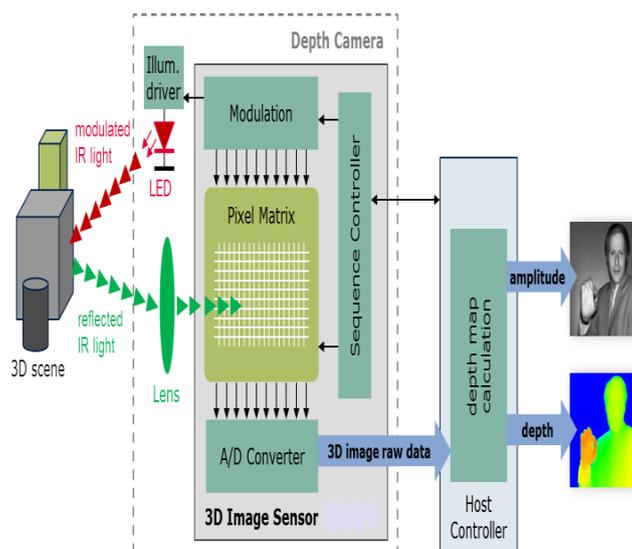

Fig 3. Block diagram for Touchless Touch Screen

When the photon of sufficient energy present in the light strikes the photo diode, it creates electron-hole pair. If the absorption occurs in depletion region, these carriers are swept from the junction by the built-in electric field of depletion region. Thus, electron-holes move towards the anode and electrons towards the cathode, and current is produced which results in the electric charge. Which is given by,

$$I = Q/t$$

Where,
I = Current
Q = Charge
t = time

Thus, the sensor generates electric signals. These signals are in the form of analog. Thus, these signals are converted into digital signals with the help of analog to digital converter for further processing.

The digital output of ADC (Analog to Digital Converter) is given to the host controller (HC). The host controller controls the transmission of packets on the bus. Frames of 1msec are used. At the start of each frame the host controller generates a Start of Frame (SOF) packet. To synchronize the start of the frame and to keep track of the frame number SOF packet is used. It also controls depth map i.e. an image that contains information relating to the distance of the surfaces of scene objects from a view point

Host controller gives its output to the sequence controller. Sequence controller controls the user actions and computer logic that initiate, interrupt, or terminate transaction. Sequence controller allow users to take initiative and control their interaction with the computer; try to anticipate user requirements and provide appropriate user control options and computer responses in all cases. The output of sequence controller is given to the both pixel matrix and modulator for controlling the action.

The digital modulator maps the input binary sequence of 1's and 0's to analog signal waveform. It modulates the digital output of sequence controller. Thus the 3D movement are detected and interpreted into the electric signals which are processed by the digital image processor to provide output to the devices, thus controlling the navigation according to the user's hand gestures. In this way the touchless screen technology works.
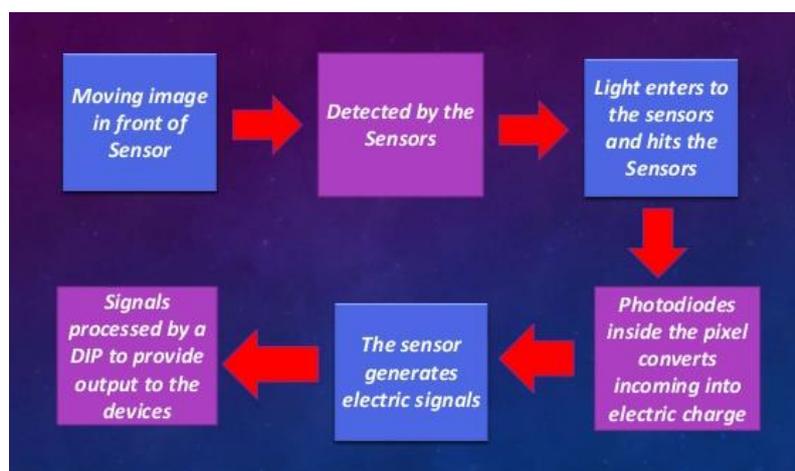
6. WORK FLOW

Fig 4. Work Flow for Touchless Touch Screen

7. APPLICATIONS

The applications of Touchless Touchscreen Technology are :
- Touchless Monitor
- GBUI (Gesture Based User Interface)
- Touch Wall
- Touchless UI
- Touchless SDK

7.1. Touchless monitor

It is specially designed for the applications where touch may be difficult, such as for doctors who might be wearing surgical gloves. The display features capacitive sensors that can read movements from up to 15-20cm away from the screen and software translates these gestures into the screen commands. The monitor, based on technology from TouchKo was recently demonstrated by White Electronic Designs and Tactyl Services at the CeBIT show. Touch Screen interface is boundless, but it needs actual touching to the screen which can be little bit of an effort. The input method is well in the thin air.

Fig 5. Touchless Monitor

The technology detects motion in 3D. It does not require special worn sensor for operation. By simply pointing a finger towards the screen user can manipulate the object being displayed in 3D.

7.2. GBUI (Gesture Based User Interface)

We have seen the futuristic user interfaces movies like Minority Report and the Matrix Revolutions where people wave their hands in 3 dimensions and the computer understands what the user wants and shifts and sorts data with precision. The GBUI as seen in the Matrix. The GBUI as seen in minority report Microsoft's vision on the UI in their Redmond Headquarters, it involves lots of gestures which allow us to take applications and forward them on to others with simple hand movements. A movement of part of body, especially a hand or the head, to express an idea or meaning Based Graphical User Interface.
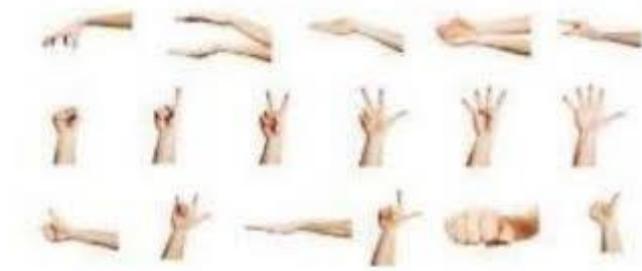
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Fig 6. GBUI (Gesture Based User Interface)

7.3. Touch Wall

It consists of a touch screen hardware setup itself. The corresponding software require to run the Touch wall is built on a standard version of vista, called Plex. Touch wall and Plex are superficially similar to Microsoft Surface, a multi-touch table computer that was introduce in 2007 and which recently became commercial.

It is a fundamentally available in select AT&T stores. Simple mechanical system, and is also significantly cheaper to produce. Touch wall consists of three infrared lasers which scan a surface. A camera notes when something breaks through the laser line and feed that information back to the Plex software. Earlier prototypes were made which is simple on a cardboard screen. A projector is used to show the Plex interface on the cardboard, and a system works fine with that. Touch wall certainly isn't the first multi-touch product we have seen in iPhone. In addition to surface and of course there are a number of early prototypes emerging in this space Microsoft has done with a few hundred dollars' worth of reality available hardware is spectacular.

It is also clear that the only real limit on the screen size in the projector which is the entire wall, can easily be turned into a multi touch user interface. Scrap those white board in the office and makes every flat surface into a touch display.
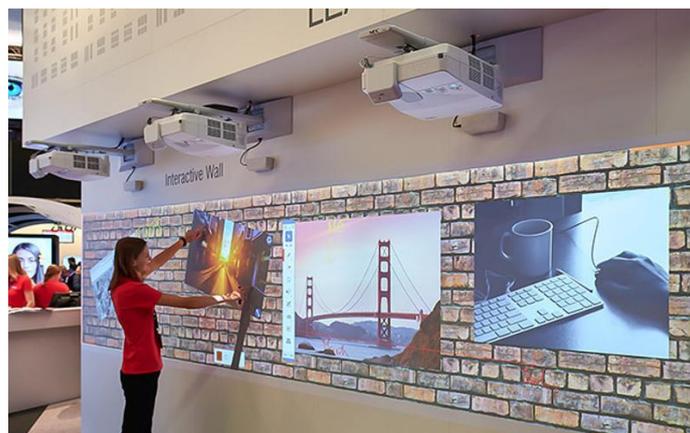

Fig 7. Touch Wall

7.4. Touchless User Interface (UI)

The basic idea described is quite clear , that there would be sensors arrayed around the perimeter of the device capable of sensing finger movements in 3-D space The user could use his/her fingers

similarly to a touch phone ,but actually without having to touch the screen, that's why it is so interesting.

Future technologies and research in human-computer interaction indicates that touch interaction and mouse input will not be the only broadly accepted ways clients will engage with interfaces in the future. The future will also be touch less. These emerging technologies will enable varieties & brands to create new forms of media and interfaces to capture the attention (and imagination) of their audiences.

They will facilitate increased interaction with their products and media in new ways, helping drive brand awareness, adoption and commerce.
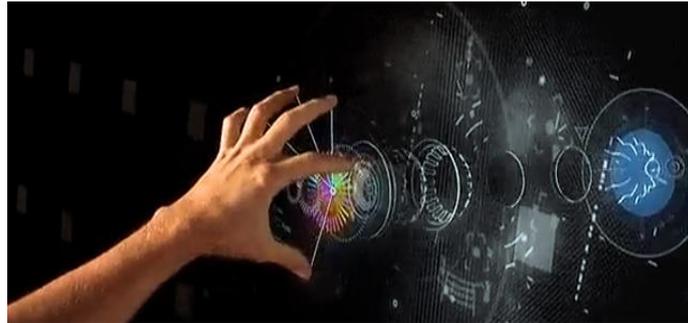

Fig 8. Touchless User Interface

7.5. Touchless Software Development Kit (SDK)

SDK stands for software development kit. It is typically a set of software development tool. It allows the user in creation of any application for a certain software package, software framework, hardware platform, computer system, video game or similar development platform to enhance application with advanced functionality, advertisements, push notification and many more.

The Touch-less SDK is an open source SDK for .NET application. It enables developers to create multi-touch based application using a webcam i.e camera for input. As color based markers defined by the user are tracked and their information is published through events to clients of the SDK. That enables "Touch without touching".

Fig 9. Touchless Software Development Kit (SDK)

8. ENHANCEMENTS

In an attempt to overcome the device's limitations particularly in regards to hand rotation and digits touching, it may be possible to infer the location of fingers, fingertips and movements in periods where we are able to assume the fingers are still present but the controller is failing to detect them.

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For example, if we're making the sign for 'A' by touching the right index finger to the left thumb, at the point of contact the device would lose sight of both the index and thumb, however the other digits being detected would remain relatively stationary. At the point when contact is broken detection of the index and thumb would resume fairly close to where it was lost at the point of contact.

Downside of this strategy is that sign recognition would need to be delayed until after the fact when we have assessed inferences like digits touching and digits dropping in and out of signal, potentially delaying real time feedback.

9. CONCLUSIONS

Today's thoughts are again around user interface. Efforts are being taken to better the technology day-in and day-out. The Touchless screen technology can be used effectively in computers, cell phones, webcams, laptops and any other electronic devices. May be after the few years, our body can be transformed into a virtual mouse, virtual keyboard or may be turned in to an input device. It appears that while the device has potential, the API supporting the device is not yet ready to interpret the full range of sign language. At present, the controller can be used with significant work for recognition of basic signs, However it is not appropriate for complex signs, especially those that require significant face or body contact. As a result of the significant rotation and line-of sight obstruction of digits during conversational signs become inaccurate and indistinguishable making the controller (at present) unusable for conversational However, when addressing signs as single entities there is potential for them to be trained into Artificial Neural Networks.

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M28-7-3