

# **Gesture-controlled user interfaces, what have we done and what's next?**

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## **Abstract**

This paper presents a review of the history of Gesture controlled user interface (GCUI), and identifies trends in technology, application and usability. Our findings conclude that GCUI now affords realistic opportunities for specific application areas, and especially for users who are uncomfortable with more commonly used input devices. We have tried collated chronographic research information which covers the past 30 years. We investigated different types of gestures, its users, applications, technology, issues addressed, results and interfaces from existing research. We consider the next direction of gesture controlled user interfaces as rich user interface using gestures seems appropriate for current and future ubiquitous and ambient devices. This paper also provides a research background for gesture controlled research for elderly or disabled people.

## **Keywords**

Gesture-control, user interfaces, elderly, survey, ubiquitous and ambient devices.

## **1. INTRODUCTION**

Keyboard and mouse now provide the means of virtually all input. Use of other options than mouse or keyboard i.e. grasping virtual objects, hand, head or body gesture, eye fixation tracking are becoming popular with popularity of ubiquitous and ambient devices like digital TV, play stations. We will see more elderly people and fewer younger people as a process of huge demographic change. The older population will continue to grow significantly in the future. It is widely accepted that we need to address this issue through more research work.

This paper investigates the research works of gesture controlled technology for user interactions. About 30 years of research studies have been listed here. Gesture type, use of different parts of the body, gesture commands, chronological evolution, gesture application, interface, technology, user type, issues addressed, tasks and final result have been listed and described to give the background of gesture based technology development. After analysing what we have done, this paper describes next options of GCUI.

## **2. GESTURE CONTROLLED SYSTEM**

Humans naturally use gesture to communicate. It has been demonstrated that young children can readily learn to communicate with gesture before they learn to talk. A gesture is non-verbal communication made with a part of the body. We use gesture

instead of or in combination with verbal communication. Using this process, human can interface with the machine without any mechanical devices. Human movements are typically analyzed by segmenting them into shorter and understandable format. The movements vary person to person. It can be used as a command to control different devices of daily activities, mobility etc. So our natural or intuitive body movements or gestures can be used as command or interface to operate machines, communicate with intelligent environments to control home appliances, smart home, telecare systems etc. In this paper we also review the different types of technologies of gesture controlled system.

### **3. SURVEY ON GESTURE CONTROLLED SYSTEM**

We have analyzed the studies and commercial products in table1 and table-2. Each entry is summarized in different columns of the table and ordered by year of research and launch. How the system is applicable in daily life is briefly mentioned in the application field of the tables. We have classified the users of any (when disable or elderly is mentioned in general, no age range), disable, elderly, general (when disable or elderly is not mentioned) and gesture type of hand, head, finger, body or any parts. Gesture controlled system is a combination of different tools of technologies like camera, graphics, vision etc. Technology field briefly mentioned about the tools or technology used in the system. Interfacing field provides the information where gesture commands take place. It also sometimes describes the feedback of the gesture. We also included the task (s) required to find the result in the experimental method column which is kind of brief functionality of commercial products. Researchers addressed different issues in their researcher which provided a good background for further research. These are mentioned in the issues addressed.

We have also studied the commercial technology products currently available in the market using the gesture commands. The number of products is indicating that we have enough resource available to develop gesture based interface. There is an opens source application available to develop DIY gesture controlled system of any computer application.

### **4. ANALYSIS**

The number of research has shown clear signs that gesture controlled technologies are now in the interest of the people. Though there are different aspects and many points to mention from the research, but this survey study has more interest in the following categories, as these are important areas of gesture based user interface. It has been about 30 years of research and researchers have been working continuously on gesture based system.

#### **4.1. Types of gestures**

Most of the researches are based on hand gestures. Direct control via hand posture is immediate, but limited in the number of Choices [14]. There are researches about body gesture, finger point movement. In the early stage, researchers used gloves with microcontroller and connected with the device through a wire. Head gesture and gesture with voice were also in the research, but hand gesture was the most dominant part of gesture control system.

## **4.2. Users**

Most of the research of the survey use or target the general users of any age. Initially it was mostly for computer users to work on the objects or presentation. Wheelchair users are also highly considered for accelerometer based gesture controlled system. Most of the last 5 years investigations are focused on elderly and disable people.

## **4.3. Application**

Researches show that gesture based applications can be used for many different things, entertainment, controlling home appliance, tele-care, tele-health, elderly or disable care. The scope of the application shows us the importance of more researches in a gesture controlled system. Most applications are to replace traditional input devices like keyboard and mouse, accessible application for elderly-disable like accelerometer. Initial applications were on pc applications for text edit [1, 13], presentation [24]. Gesture visualization has been included for feedback and training [2]. Using digital camera rather than sensor has provided new dimension to develop gesture based user interface development. Now people can interact with any media using gesture to control wide range of applications. we have got gesture based commercial products in 2003. People get gesture based hardware and software with choice.

## **4.4. Technology**

The ways of recognizing the gesture can be considered as a significant progress of the technology. Progress of image processing technology has played an important role here. Gestures have been captured by using infrared beams, data glove, still camera, wired and many inter-connected technologies like gloves, pendant, infrared signal network server etc in the past. Recent vision technique, video and web cam based gesture recognition has made it possible to capture any intuitive gesture for any ubiquitous devices from the natural environment with 3D visualization. Lenman has developed a prototype for remote control of home electronics, such as TV and CD-player [14]. It describes a project that explores computer vision based analysis of hand gestures for developing new forms of HCI. Gesture based research are now moving towards everyday application for even older adults with simple and inexpensive implementation.

## **4.5. Commercial products**

First commercial products of gesture technology for general user launched in 2003, 23 years after the research works started. Still games industry is the main target of the products. But health, care homes industries are also getting focus gesture recognition becomes intuitive and natural.

There are important issues addressed by the researchers based on traditional system, usability. Natural intuition of the gesture control was addressed by most of the research. Natural connection with the group work like meeting, gesture recognitions , providing feedback of the gestures through visualization, sound etc, gesture training, common or unusual gesture are some issues which give a direction towards further research for elderly.

Research Study- year	Applications	Users-Gesture	Technology	Interface	Issues addressed	Result /Conclusion
"Put-That-There": Voice and Gesture[15]-1980	Pointing to items on the large screen with voice.	General- Hand	Llarge screen, a space- sensing cube on wrist, & microphone	Large screen display	How voice and gesture can be made to inter-orchestrate, actions	Conjoint use of voice- & gesture-recognition to command events on a large raster-scan display.
Hand drawn gesture for editing task [1]-1986	Text-editing	General- Hand	Stylus	Write on the surface of a display with a stylus	Consistency in using & gesture variability. Most common gestures Easy to use and remember	People behave in a way which makes gesture-driven interfaces feasible.
A hand gesture interface device[13]-1987	Manipulating pc objects using hand glove	General- Hand	Glove & the device incorporate a collection of technologies.	Computer screen with a 3D hand model, like mouse cursor	Manipulating 3D virtual objects with 2D controllers such as touch pads and mice are awkward.	Input devices, the Z-Glove and the DataGlove,
Charade[24]-1993	Presentation application using hand gloves	General- Hand	DataGlove with serial port of the pc.	Cursor movement in the computer screen using hand gesture.	Gestural command is represented by three icons. - distinguishes between gestural commands & other free-hand gestures.	Capture of gestures by using a DataGlove,
Camera based web interface by IBM[20]-1999	Web browsing with touch FREE switch	Disabled People-Body	Camera as input of web browser	Web interface	Real time behaviour of image processing for video. Mapping the gesture as command	Development of the TouchFREE applications.
Gesture Pendant [22] -2000	Controlling home appliances using wearable pendant	Disabled People-Hand	A small camera, part of a necklace, is ringed by IR LEDs & has a IR pass filter over lens, computer, controller device (slink-E, x10)	Control using wireless video	Used in a variety of lighting conditions. Enabling technology for elderly	Gesture controlled input device pendant can recognize 95% control gestures & 97% user defined gestures
GestureWrist and GesturePad.[19]- 2001	Control any device using sensor and wired device in the wrist or Pad,	General -Hand	Input of wearable computer	In wrist and cloths. To control any device	Input devices should be natural and unnoticeable to use in various social settings.	2 Input devices for wearable computer.
Ubi-Finger[21] - 2001	Control of appliance, presentation, window scrolling of Mobile PDA	General- Finger	Fingertip device with infrared sensor works via network.	Mobile PDA interface	Control various appliances by using existing metaphors and corporeality	Prototype systems, and evaluate how effective
XWand: UI for Intelligent Spaces[23] -2003	Interacting with intelligent environment using wireless sensor package	General- Hand	Handheld device , wand with variety of sensors & use Bayes networks	Natural interface with audio and LED feedback	Unifying the results of pointing detection and speech recognition,	Interface for intelligent environments

Research Study-year	Applications	Users-Gesture	Technology	Interface	Issues addressed	Result /Conclusion
Visual Touchpad [6]-2004	Interaction with PCs using touchpad.	General-Hand	Quadrangle panel with a rigid backing with PCs & two cameras.	on PCs, large wall displays	Visualization of gesture in the screen. Single and 2 handed gesture commands.	Vision-based input device that allows for fluid two-handed gestural interactions
Accelerometer based gesture control [4]-2004	Recognizing, training customised accelerometer based gestures	Elderly-Hand	Accelerometer, ubiquitous device	Accelerometer for recognition, training	Importance of the training in gesture control interface.	To reduce the error customization and training of gesture play important role
Gesture control for a design environment [3]-2005	Not specified.	Any-any	Study only	Study only	Usefulness of the gesture modality compared to other. Difference of gestures for the same task.	Gestures are a natural modality for certain tasks & can be augmented
Visualization method [2]-2006	Gesture visualization method, animation of hand movement performed during the gesture control	Elderly-Hand	Visualization method architecture using the accelerometer data	Gesture projection of the 3D path onto a plane, video, VRML	Concepts of the gesture visualization and it could be utilized in providing essential feedback and guidance.	Visualization provides information about the gesture performed.
<a href="http://atlasgloves.org">http://atlasgloves.org</a> -2006	Interaction with PCs using DIY hand gloves	General	Pair of illuminating gloves to track hand gestures. The Open Source Atlas Gloves application, webcam	Application in the PC	Controlling 3D mapping applications like <a href="http://www.google.com/earth/">Google Earth</a> .	Open source API and DIY gloves
Intelligent Smart Home Control Using Body Gestures[11] -2006	control of smart home environments such as lights and curtains	General	Smart home with 3 CCD cameras. Marker attached in the human body	Gesture extracted as 3D and 2D view.	Continuously changing gesture can be used.	Recognition rate is 95.42% for continuously changing gestures
Head gesture recognition [7] -2007	Hands free control system of an intelligent wheelchair	Elderly & disabled	Wheelchair with laptop & webcam.	Laptop Interface with wheelchair user.	Gestures are used to generate motion control commands	Head gesture control system.
Select-and-Point[17] -2008	Enables controls to applications such as MS Office, web browser & multi-media programs in multiple devices.	General	Composed of three parts-a presence server, controlling peer & controlled peer using camera, software tools	Table top, large screen PC or mobile	Eliminating different cumbersome processes in the group meeting & provides a intuitive interaction style through a pointing gesture	Implementing intelligent meeting room

**Table 1. (this page and previous): Research projects involving GCUI technology**

## Commercial products:

Name	Applications	Technology	Interface	Functionalities	Uses	Products
EYE TOY (Sony) -2003	Interacting as personalized gamer with Sony play station games.	Color USB digital camera device using gesture recognition and sound of microphone.	Game on TV, PC etc.	Uses computer vision & Gesture recognition to process images taken by the camera	Gaming application	Camera with console
Wii Nintendo[8] - 2006	Wireless and motion-sensitive remote with game console	Game with any TV, computer etc.	Interface in the screen	Remote offers an intuitive, natural way to play games.	Gaming application control	Game console and remote control
XBOX live vision -2006	Interacting as personalized gamer with Microsoft's XBOX-360 games.	Color USB digital camera device using gesture recognition and sound of microphone.	Game on tv, pc etc.	Uses computer vision & Gesture recognition to process images taken by the camera	Gaming application	Camera with console
<a href="http://www.gesturetek.com/">http://www.gesturetek.com/</a> [25] -2008	Controlling pc, mobile or console application using camera or phone.	3D Camera for computer vision. camera in mobile device. pointing over frame	Mobile , pc, large screen table top interface.	Capturing gestures for normal PC operation. body gesture based gaming in the mobile device	More intuitive vision activities Without keyboard & mouse	Natural input for different media, PC, mobile, screen etc.
<a href="http://www.mgestyk.com">/www.mgestyk.com</a> -2009	Interaction with computer to operate games and application	Software for hand-gesture processing & 3D camera	PC based interface	Capture hand movements and translate them into commands for controlling Windows application	Control games and other windows applications	Camera and software

**Table 2. Commercial projects involving GCUI technology**

## **5. CURRENT OPPORTUNITIES FOR GESTURE TECHNOLOGY**

It's to find the place where gesture commands are captured as a command or users can get the feedback. There is a special interest for the place, or interface of gesture commands as we HCI is progressing rapidly in recent years. Gestural interfaces are electronic analogues to pencil and paper. Gestural interfaces have a number of potential advantages and couple of potential disadvantages [16]. There are varieties of interfaces in the researches in the table like natural (using IR beam with black box), large screen, PC/Laptop based, LED light, audio-visual, mobile handheld etc. From the study we can see the opportunities of implementing the technology in different areas. The list, but not last, can be following-

### **5.1. Entertainment**

Gesture technology can provide more entertainment opportunity for any type of users. GestureTek [25] many different ways of entertainment using gesture such as interactive advertisement, signage, movies, screens. Wii [8], Sony Eyetoy, Microsoft's X-box have demonstrated different entertainment opportunities such as playing music, personalized gaming etc.

### **5.2. Artificial Intelligence**

People, devices and computation are going to integrate more with each other and will soon become part of our daily life [5]. Using gesture based technology will play important part in this intelligent life. Gesture from any part of the body can provide the commands of communication or even to control the curtain of the window [11]. Robotic industry is also using gesture technology to manage and control the activities of the robot as part of the Human Robot interaction. Like Select-and-Point, many researches are easily accepted by users and it can significantly improve users' interaction with various devices in a ubiquitous computing environment. Based on networking technologies and hand gestures, users can connect multiple devices.

### **5.3. Simulation**

Body gesture creates the simulation of human body activities in the screen [8]. Physical simulation can improve the realism of the resulting gestural animation in several ways. GestureTek [25] develops a stimulating computer-generated virtual reality therapy world that guides patients through clinician-prescribed interactive rehabilitation exercises, games and activities that can target specific body parts. Patient performance is measured and recorded.

### **5.4. Training & Education**

The technology solution can be developed for training and education purpose. In the rehabilitation or fitness centres, it can train people automatically based on the user's profile, body structure. Taking natural input from the body movements is the most important advantage here over mouse or keyboard. Wii[8] demonstrated many videos of training people on their own speed, based on gesture, the outcome of the training is also immediate.

## **5.5. Assistive living**

Technologies such as multi-agent systems, safe communications, hypermedia interfaces, rich environments, increased intelligence of home appliances, and collaborative virtual environment are now converging and represents an important enabling factor for the design and development of virtual elderly support community environments. TeleCARE [10] aims to design and develop a configurable framework for virtual communities focused on supporting assistance to elderly people.

During the study we tried to see the gesture controlled systems for elderly and disable with more attention. Still we need to work more for them as the numbers are growing over time. For the autonomous and assistive living of elderly and disabled people, new technology can play an important role. They can achieve by regaining some control and some very psychologically valuable independence [9]. Tele-health, tele-care, telemedicine and personal safety systems are all examples of this trend. A multimodal approach suits them best, due to external circumstances or personal preferences. Multiple considerations influence interface design decisions when designing for older users. Removing isolation of age restricted users doesn't reflect that much during interface design [18].

## **6. ELDERLY USERS AND WII**

Some research provides us with a new interface and intuitive interaction style in our daily computer use. With simple selection and pointing hand gestures, users can eliminate cumbersome processes in managing connections and controls between multiple devices as well as in sharing information/data [17]. Elderly and disable people can easily maintain communication aids with multiple device or appliance using gesture. Elderly people who are more mature than most gamers, with physical limitations are actively using Wii [8] for fun, rehabilitations in TV or computer screen. Without keyboard or mouse, it gets them moving and keeps their mind active as personalized gesture based interface. Pensioners aged 80 and above at the Sunrise Senior Living Centre in Edgbaston are now hooked to the Nintendo Wii, the latest hi-tech video games console [the Telegraph, 17 Sep 2007].

## **7. FUTURE WORK**

Technologies developed based on gesture are now really affordable and converged with familiar and popular technologies like TV, large screen. It's ubiquitous and non-intrusive as we can install a camera or remote with the TV. From this paper we can see the trends of gesture controlled communication systems. Easing of the technology use, affordability and familiarity indicate that gesture based user interface can open new opportunity for elderly and disable people. The older population (65+) numbered 36.3 million in 2004, an increase of 3.1 million or 9.3% since 1994 and it's growing over time [12]. There will be more elderly people and fewer younger ones to care for them. So we need to invest much more heavily in Assistive Living solutions. The research 'A gesture controlled communication aid for elderly and disabled people' can be a significant task for future. The two important aims of the research are to identify the different gestures of elderly and disabled people for communication and to design a rich augmented-reality interface for communication via ubiquitous device such as a television set.



## 8. CONCLUSION

We have got the first research in 1980. The journey has started then and we can see the evolution of the gesture based system from the researches of last 2-3 years. Initially it was with difficult technology like sensor, glove etc. now it becomes easier with webcam, image processing software and gaming tools. Poor usability was an issue in the early stage, but now it's intuitive and natural. In the early research gesture control or recognition process was complex, but now it's simple vision technique using hand, head or even whole body gesture. Computer application operating was the main target in the early stage. But now it is widely accepted for ambient device and ubiquitous computing. In recent researches, the more focus have been given to control home appliances, to use mobile device, large screen, table top screen and to manage group work, or even home residents activities. Another most important aspect is now it's really affordable, while it was expensive before.

This survey is the accomplishment of the task where gesture controlled user interface for elderly and disable people has been reviewed along with the other gesture technologies. From this survey it has been identified that elderly and disable needs more technology support using their nature behaviour, considering their limitations. We can use affordable technology for daily activities. In our final research 'A gesture controlled communication aid for elderly and disabled people', we are working to develop a rich augmented interface in the regular & familiar appliances like TV sets to control everyday communication using gesture.

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