Galway Mayo Institute of Technology, Dublin Rd Campus

BSc Honours in Software Development

Gesture Based User Interface Experience – Accessibility, Evolution and Challenges

Author : Tomás O'Malley (G00361128)

Module Lecturer : Damien Costello

Department of Computer Science

February 14, 2021

Contents

Chapter 1

Introduction

1.0.1 Abstract

Since the beginning of digital computing, there has been a massive jump from the traditionally used console (bash terminal) to interface with our programs to the now-standard graphical user face we see on our personal computers, smart devices, and even home appliances. Gesture systems have been a concept in sci-fi films like Iron-man II (2010) and television series like 'black mirror' (2011). Voice, Gesture, and facial recognition are now standard delivered by Microsoft's and Apple's assistant 'Siri' and 'Cortana' which allows users to interact in a new way. We almost forget how fast and convenient our devices and are ranging from our flagship smartphones to our Desktop Personal Computers. Due to the rapid growth of the wide use of computers for consumers businesses are developing and incorporating new ways to interact with their devices. Gestures for communication can help people suffering from speech impediments or short hearing can interact via these new technologies I will diagnose. Gestures can be found in day-to-day devices such as your smartphone, tablet, personal computer and even used in McDonald's Interactive order takeaways. Throughout this paper, I will explore the current state of the User interface based gestures used in modern society, how these technologies formed and defer from traditional methods used such as the keyboard and mouse combination, their accessibility, and the challenges to overcome. Finally, I review these technologies and access their prevalence and use in modern society and diagnose if gesture systems will increase or decrease in popularity in years to come.

Chapter 2

User Experience Evolution

2.0.1 What is a user Interface?

Wikipedia describes a UI as ' a user interface (UI) is the space where interactions between humans and machines occur'.Common examples of user interfaces in day-to-day life range from the ATM system to The rotary dial developed in 1892(as shown in figure 2.1). The interface creates the link between the user and the devices, A simple user interface is vital and we can notably see this in how we use our devices. Never has there been more variety of interfaces for businesses, consumers, teachers, etc. For example in the early 90s music players were dominated as portable disc players until the early 2000s there were hundreds of different players tailored to your taste and you can decide instead of examples 70s turntables consisting of the needle, arm, and record we are spoilt for variety.

Research-Latex/images/classicRotary.jpeg

Figure 2.1: Classic Rotary Dial Telephone .

2.0.2 Mobile Technologies

Over the last decade, we have seen a colossal improvement in the connectivity, size, and power of mobile devices. The current trillion-dollar company Apple boosts 'the iPhone in your pocket has more than 100,000 times the processing power of the computer that landed a man on the moon 50 years ago' which is nearly unbelievable. There are estimated to be a total of 22 billion smart devices on the planet as of the year 2020. As displayed in Fig 2.1 there has been a consistent jump in the popularity of mobile devices or the traditional desktop. There are currently estimated to be 5 million smartphones with android have a share of 75 percent with apple contributing 25 with about 1.2 billion devices.
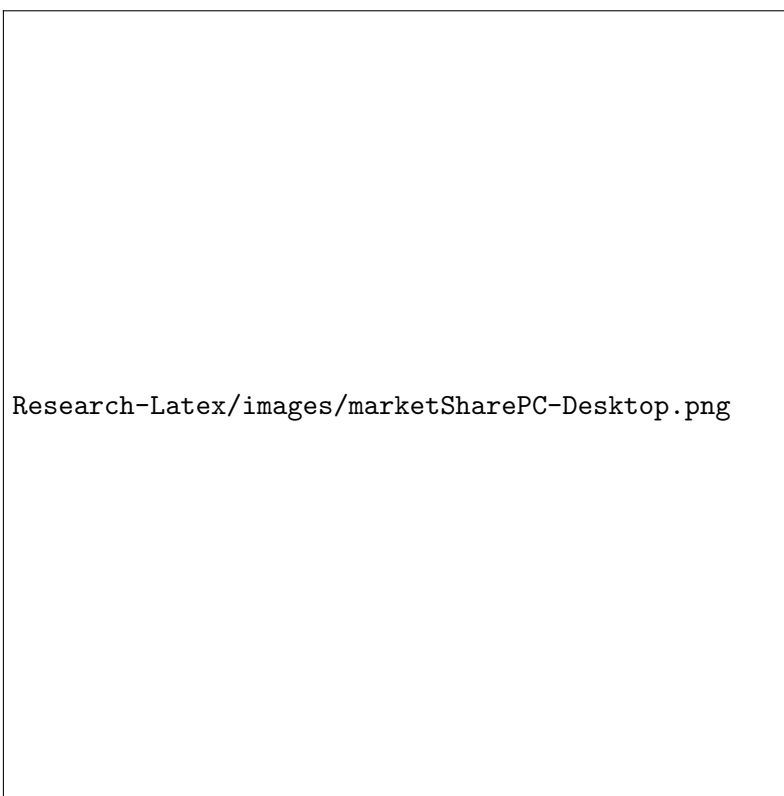
Research-Latex/images/marketSharePC-Desktop.png

Figure 2.2: Desktop vs Mobile vs Tablet Global Share .

2.0.3 Consumer driven market

Computing since the early 1960s was only a reality for large companies.The very first consumer orientated computer named 'Altair' developed by Intel in 1974. Today this entry-level Personal Computer would cost an estimated €15879.44 while today consumers can purchase an entry-level pc such as the Raspberry Pi for €35 which is no larger than the size of a mouse! The editorial team reports 'The Raspberry Pi's processing speed is approximately 150,000 times faster than ENIAC's' an unbelievable figure for a machine 30 tons in weight, that is the weight of 15 standard cars! Consumers to a degree dictate what projects large companies deliver yearly

2.0.4 The video game Industry

The video game industry has been rapidly expanding due to the mainstream use and the expansion of fast and cheaper computer hardware. According to -Statista as of 2019, The video game industry is now the more profitable entertainment industry generating

145.7 billion a year. Due to this explosion in popularity companies have developed new technologies such as Microsoft's project named 'Kinect' in the year 2010. Xbox console users were the first to experience true gesture-based interaction instead of using the console shown in fig 2.1

Research-Latex/images/kinect.jpeg

Figure 2.3: Kinect Camera Sensor.
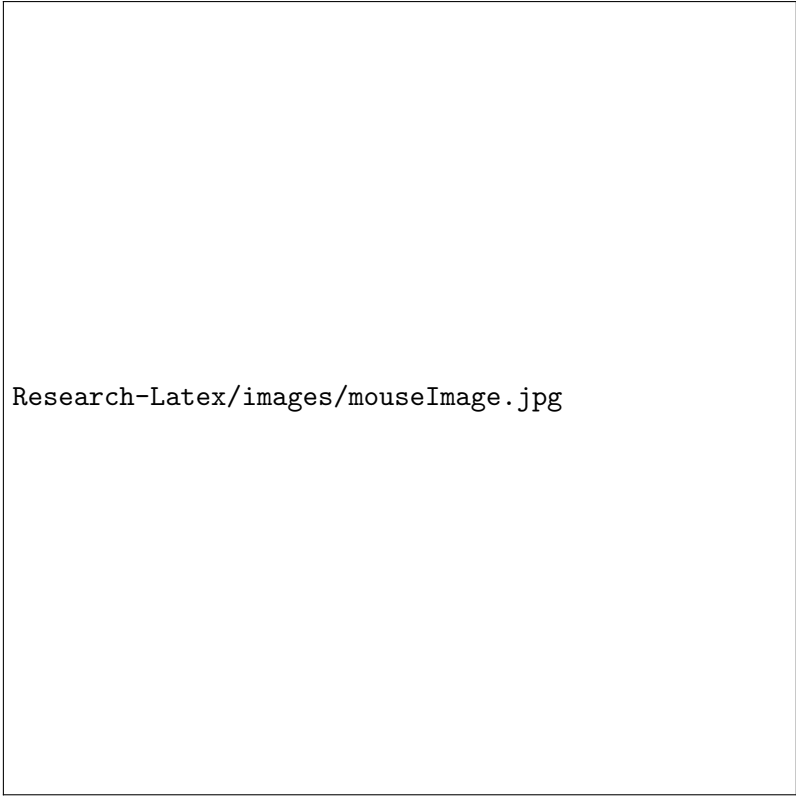
2.0.5 UI hardware

Mouse
Webster's dictionary defines the mouse as follows 'a small mobile manual device that controls the movement of the cursor and selection of functions on a computer display'.The mouse was invented by the 'xerox' company and changed forever how individuals interact with their company when the founder of Apple - Steve Jobs borrowed the device and launched Apple's first Graphical user Interface incorporating the mouse on their newest machine named 'Lisa' on January 19, 1983. The mouse evolved from a simple wired navigation device with a single button now in the year 2020 users have programmable buttons with a light-speed laser tracker like the popular MX-Master developed by Logitech.

Keyboard
Websters dictionary defines the keyboard as ' to enter (information) into a computer by using a keyboard'.The keyboard and mouse are the bread and butter of computing.The first keyboard was designed ' In November, 1868 Christopher Latham Sholes [0] and his colleagues, Carlos Glidden, Samuel Willard Soulé, and James Densmore, in Milwaukee shipped out their first 28 key piano style keyboard-like typewriter'.Keyboards are found on all devices such as desktop's to smart which provide a pop digital keyboard using touchscreen capabilities
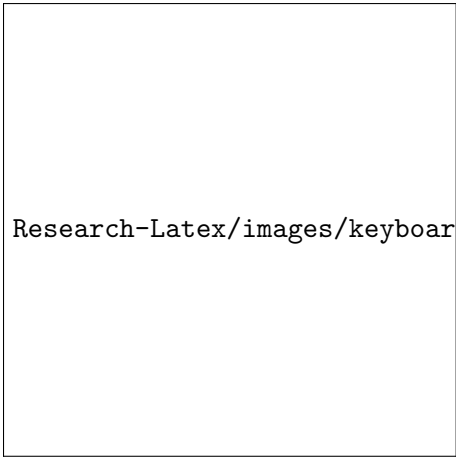
Command Line Interface vs Graphical User Interface

According to Wikibooks 'A command-line interface or CLI is a method of interacting with a computer by giving it lines of textual commands'.Since the early 1970's computers were devices orientated towards companies and were out of mainstream consumer use. As shown in figure 2.2 there is CLI (command line interface). This method did not implement the mouse and was not operated without a steep learning curve. The CLI dates back to as early as 1950 used on teletype machines. The CLI is still popular today in the tech field but remains for developers and for educational purposes.

Research-Latex/images/mouseImage.jpg

Figure 2.4: Apples Lisa Mouse.

Research-Latex/images/keyboard.jpeg

Figure 2.5: Happy Hacking QWERTY Mechanical Keyboard.

GUI (Graphical User Interface) is described by Steven Levy as 'Graphical user interface (GUI), a computer program that enables a person to communicate with a computer through the use of symbols, visual metaphors, and pointing devices'. The 'Xerox Alto' was the first computer to use the graphical user interface over the common text-based command-line interface. In the year 1983 Apple releases the Lisa, the first commercial computer with a graphical user interface (GUI), and changes the norm forever. All commercial computers now use a GUI for some sort such as Windows 10, Mac OSX, and Linux Operating Systems.

Touch Screen

Webster's dictionary defines a touch-screen as ' a display screen on which the user

Research-Latex/images/TheBashterminal.jpg

Figure 2.6: Bash Terminal on Macintosh Computer

Research-Latex/images/WINDOWS10-DESKTOP.jpg

Figure 2.7: Graphical user Interface Windows 10 Desktop.

selects options (as from a menu) by touching the screen '.E.A. Johnson developed the

touch screen in 1965. It is estimated ' Global Multi-Touch Screen Market Will Reach USD 22.33 Billion By 2025' reported by' Zion Market Research. All smartphones use a touchscreen interface as seen in figure 2.7 the latest generation of the Apple iPad with a full touch screen. Apple launched the Newton—a handheld, portable, touchscreen device—in 1993 but was pulled due to its poor sales and research and development issues. The latest leaps in touch screens jump from the durability named Gorilla Glass to the new 3dimensional touch which allows a new level of features to smart devices using special touch sensors.

Research-Latex/images/ipadProTouchScreen.jpg

Figure 2.8: Apple iPad Pro Touch Screen Tablet

Chapter 3

Gestures as a communication tool

3.0.1 Commercial Use

Over the last decade, we have seen huge advancements in commercial devices such as cellular devices, computers, and gaming consoles. Providing users an alternative form of interaction can allow all groups. Google is currently developing an experimental project named 'Soli' that uses radar-detected gestures for touch-free gesture controls. public-ally available devices such as the Google Pixel have implemented this technology at the top of the smartphone. Soli is supported in applications such as Google Music for skipping tracks and Pokemon wave rendering wave gestures and responding with a wave back from the Pokemon on screen.
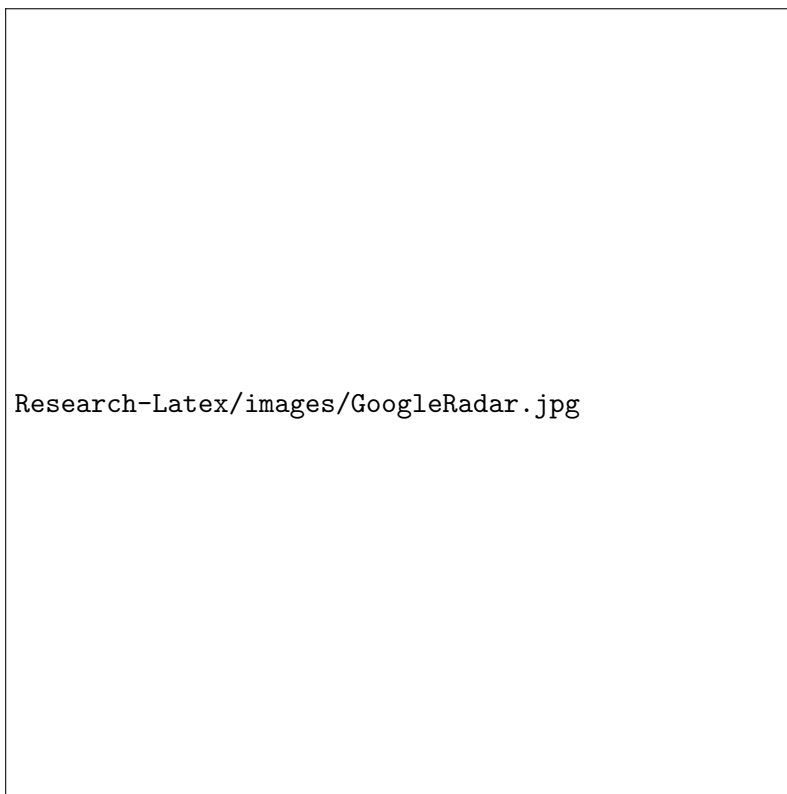
Research-Latex/images/GoogleRadar.jpg

Figure 3.1: Googles Project Soli

3.0.2 Requirements for use

Gestures are developed around the basis of the human who is trying to interact with the computer holding the gesture recognition system. Humans have been researching gesture systems as early as the 1980s.The human must know the language the machine is operating by for example 'hand pal' the computer must have the gesture mapped and displayed by the machine. It is required for the computer two have three entry points

1. (Software:)There must be a software project with the appropriate software using machine learning or any subset of artificial intelligence. A prime example of gesture recognition is Microsoft's Cortana.

2. (Hardware:)There must be a piece of hardware in place for the camera sensor to capture users' movement.

3. (User:) The end user being behind the computer with a knowledge of the basic gestures for the programs features.

3.0.3 Disabilities

A huge benefit of the implementation of gesture-based user interfaces is allowing individuals with mental and or physical disabilities to interact with devices which usually inoperable. People with physical conditions such as Parkinson's cannot interact with traditional hardware such as keyboards and computer mouses. Currently, three students from the Royal College of Art have developed a recognition system for amputees by way of two white, silicone discs containing inertial measurement unit sensors. A startup company named Limix are currently developing gesture recognition to record Deaf peoples hand movement and translate into words and read via an assistant voice reader.

Research-Latex/images/PeopleWithDisabilities.png

Figure 3.2: Two dots motion sensors allowing drawing gesture

Italian start-up Limix uses gesture recognition named ' Talking Hands' to record the sign language hand movements of deaf people while wearing glove-like hardware. They are then translated into words, which are played by a voice synthesizer on a smartphone. The product is still in the development phase will be a breakthrough for gesture systems and for communication tools for people with disabilities.

Research-Latex/images/talkingHandsPrototype.jpg

Figure 3.3: Talking Hands Wearable tech Prototype to track deaf peoples hand movement

Chapter 4

Challenges for design of applications

4.0.1 Social Implications

A very popular topic in current technologies 'Big-data' has made users more conscious of how companies store and manipulate data. Users are less comfortable using cameras and microphones to monitor their actions. An extremely popular device used by consumers is the 'Amazon Echo' a range of voice assistant controlled devices. Amazon has reportedly sold over 100 million Amazon Alexa devices. By the end of 2018 it was reported there are 22 billion internet of things (IoT) devices. Computer consoles such as the Nintendo Wii and the Xbox Kinect incorporated gestures since 2006 both selling over 35 million units overall. Over the last decade, traditional consoles use consoles by mainstream leaving a large majority of games unsupported due to the social refusal of using gestured based controls. China has been implementing facial recognition used to publicly shame jaywalkers and toilet paper thieves in China which is a prime example of how smart cities are changing how people interact and act as a society. As written by Chris Horn for the Irish times ' Hands off: Covid-19 is fuelling a boom in touchless technology' due to the explosion of the covid-19 virus companies are investing in touch-less gestures to prevent staff or users from sharing the same surface.

4.0.2 Modeling gestures

Creating a standard model for gestures using the human body can be extremely tricky due to language barriers and modeling the suitability. For example, the gesture 'thumbs up' has a different rude meaning in the middle east. The system for modeling the gesture must use a robust scaling system to integrate body Gesture Modelling.

1. Modeling Techniques

   - **Machine Learning :** As defined by SAS Institute - 'Machine learning is a method of data analysis that automates analytical model building. It is a branch of artificial intelligence based on the idea that systems can learn from data, identify patterns and make decisions with minimal human intervention.'
   - **Artificial intelligence :** As defined by Oxford - 'the theory and development of computer systems able to perform tasks normally requiring human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.'

Chapter 5

Challenges for implementation

5.0.1 What is a gesture?

Webster's dictionary defines a gesture as ' a movement usually of the body or limbs that expresses or emphasizes an idea, sentiment, or attitude '.

Ways Gestures can be implemented into devices

- **Touch Gestures:**Touch gestures are most commonly found on touch-screen devices. The user interacts with the device using their hands and has controls such as pinch to zoom, scroll left-to-right, and tap to zoom. All modern smartphones utilize touch gestures to provide users with a new level of interaction.

Research-Latex/images/touchscreenGestures.png

t

Figure 5.1: iPhone Touch Screen Gesture Recognition

- **Camera Gestures:**Camera gestures refer to the use of users interacting with their device by the device's camera implementing methods for accessing functionality via mathematical algorithms. Use cases range from pause, start and sleep functions,

etc instead of using traditional hardware. Hand detection plays a huge road in recognizing gestures inside of the camera sensors. The automobile giant BMW has included a gesture recognition system for the dashboard by using a 3D Camera and deep learning algorithms to model the user's movement into gestures. Sample gestures included are as follows:

– Accepting a Call / Confirming pop-up: Point one finger towards the iDrive screen and pull it back

– Rejecting a Call / Closing pop-up: Swipe your hand to the right Turning up the volume: Circle your finger clockwise

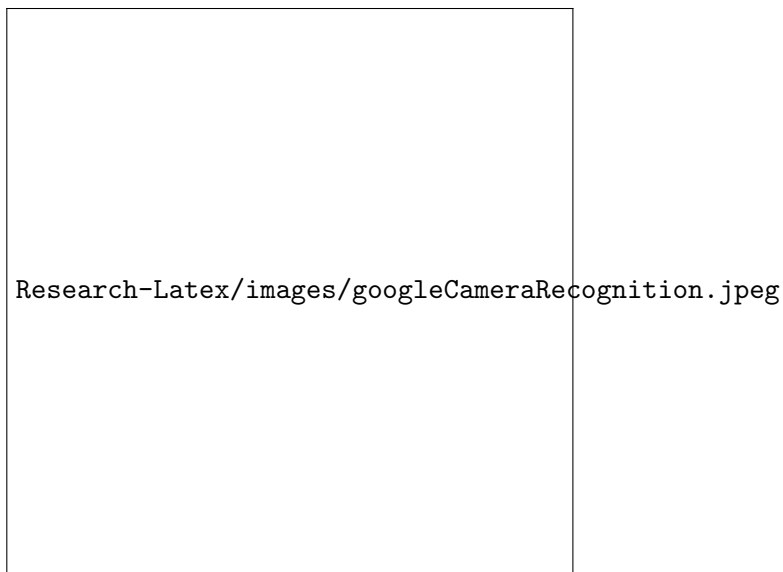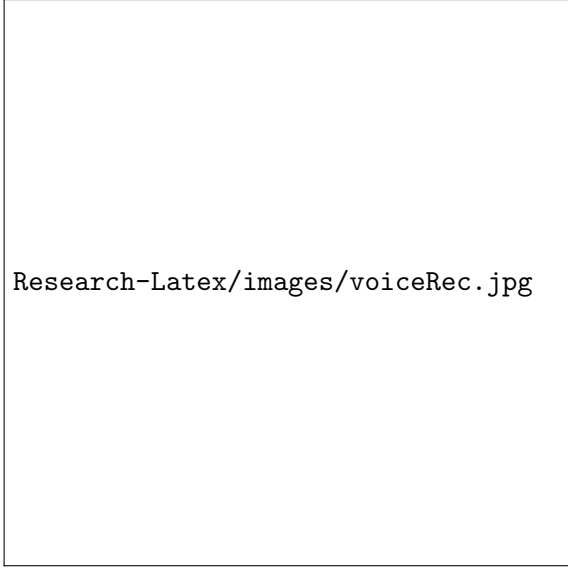Research-Latex/images/googleCameraRecognition.jpeg

Figure 5.2: Camera Gesture Recognition

- **Voice Gestures:** Voice gestures refer to the use of users interacting with their device by the device's microphone implementing methods for accessing functionality as pause, start and sleep functions, etc. Prime examples of devices that implement voice recognition are Microsoft's ' Cortana ' assistant and Apple's voice assistant 'Siri' released in October 2011 now turns a decade old but still offers a near-identical interface.

Interacting with voice Assistants Siri and Cortana

– **Example Siri Commands**

– Siri is exclusive to the Apple ecosystem

– "Hey Siri" - Activates voice assistant

– "What's the weather today? - Reads weather forecast based on location

– "How many cups are in a quart?" - mathematical question

– **Cortana Commands**

– Cortana is exclusive to the Microsoft ecosystem

– click the Cortana button to the right - Activates voice assistant

Figure 5.3: Voice Gesture Recognition between user and smart device

5.0.2 Gesture Systems

Gesture recognition is made possible through the use of artificial intelligence. Wikipedia defines AI as' Artificial intelligence (AI) is intelligence demonstrated by machines'.

5.0.3 Gesture Suitability

A large issue is how companies can overcome incorporating their gestures into current systems. Users are used to interacting with their devices in a hardware orientated manner such as turning the volume up with a volume controller. The motor industry is a prime example of a sector that is highly monitored and companies must meet standard regulations on e.g side mirrors, windscreens, etc. One area companies fell in implementation is the suitability of the gestures. Consumers want a simple user and will only use gestures if it is easier or faster. I too have felt defeated to use a new gesture on console or tablet due to simply the hardware is easier to use and have already know the Ins and Outs of the device.

5.0.4 Current market

As discussed in section 2.0.4 ' the video game Industry ' The Xbox Kinect at launch in 2010 was a wide success but was short-lived by the current market. The device was great for activity-orientated games such as boxing, bowling, etc but it failed in the juggernaut areas such as First Person shooters like Call of Duty and Medal of Honour. Currently an expanding market. The vast amount of funding needed to create gesture systems is not worth time and finance if the market share is not big enough. The current generation of consoles (PlayStation 5, Xbox One) all provide gesture-based equipment such as via camera and handheld equipment with unique software. There has been an absence of gestures in multimedia players and e-reader devices due to its poor market share. Over the last decade, there has been a leap in gesture technology in medicine, University ' Ben Gurion has developed a ' hand-gesture recognition system that enables doctors to manipulate digital images during medical procedures using hand gestures instead of touch screens or computer keyboards.' This is a massive achievement and due to the Covid-19 pandemic, this could become a new way to interact with reports in offices and the workplace.

Chapter 6

Conclusions

6.0.1 The future directions of gesture-based UI

In summary, Gesture-based user interfaces will stay relevant and push us today on how we interact with our own devices. From the explosion of the Internet of things and the drop of unit price on camera sensors areas such as the Cars Industry, Public transport, Medical Research, and the Games Industry will see large exciting advancements in the field. From my analysis gesture recognition systems are dependent on how technology advanced the region's society is. As reported by Grand View Research ' China and India are among the fastest-growing economies in the world, Increasing disposable income and growing industrial digitization are poised to supplement the growth of the region.' This proves true by the Gantt chart created as shown in Fig 6.1.

It is for certain the complexity and speed of devices are allowing for the addition of gestures but the market is preventing mainstream use of gestures of classical hardware. Gesture recognition is a reasonably new technology and needs further testing in areas such as Medicine, Teaching automobiles only trial and error can tell its stability. Due to the COVID-19 pandemic as of early 2019, we have been faced with new ways of interacting. In my opinion gesture technologies will prevail as we try to reduce the physical contact with our devices to prevent bacteria on our devices.

Research-Latex/images/futureOfGestures.png

Figure 6.1: China's explosion in gesture popularity

Chapter 7

References

7.0.1 Researched Areas

Referenced sources from my Research

1. Graphical User Interface Definition

2. SAS Institute Definition

3. Mouse Hardware Definition

4. Touch-screen Definition

5. Gesture Definition

6. Command-line interface

7. Machine Learning Definition

8. Hand Gesture

9. Hands off: Covid-19 is fuelling a boom in touchless technology

10. Artificial Intelligence definition

11. Gesture Recognition China

12. Rasberry Pi Speed

13. Limix Talking Hands

14. iPhone Speed vs Apollo

15. Entertainement Industry Revenue

16. Keyboard