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An Exhaustive Survey on Human Computer Interaction's Past, Present and Future Archanaa Rajendran, Assistant Professor,

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Abstract Technology has grown so much that interactions can happen even between computers and humans. The study related to this filed is called as HCI (Human Computer Interaction). It is more of an inter-disciplinary domain consisting of Computer Vision, Augmented Reality, Machine learning, Networking, Computer Graphics combined to build an effective computing system, analysing the behaviour of humans as well as the computer technologies. HCI has simplified the human interaction with computers in the past, present and will always evolve till the end of time. Although the term HCI is in use since 1980's, this field has come into limelight only after 1990's. HCI deals with the design aspects of an entity which can be software or a product. It neither focuses on humans nor on the computers, but it certainly focuses on bridging the gap between the humans and computers. The main aim should be to develop a user friendly system rather than being confound. Keywords: Virtual Reality, Augmented Reality, Ubiquitous Computing, Information Visualisation

1. Introduction

In this Internet era, almost everyone is interacting with digital gadgets such as Computers, mobiles etc. in one way or the other. These gadgets have become a necessity than just a need. With the rapid increase in the usage of computers, the way of interaction between humans and machines became an area of interest for researchers. This geared up and catalysed the research and led to the development of the massive field - Human Computer Interaction or Man-Machine Interaction. HCI aims at building interactive computing systems to facilitate the communication between humans and computer. Before we just dive into the details of HCI, lets understand what is Human Computer Interaction and why do we need it in first place?

2. What is HCI? The foundations for HCI are mainly from two areas: Ergonomics and Information science and technology. Ergonomics is primarily concerned with physical characteristics of the systems and machines and how these characteristics affect the user performance. As computer research became widespread, researchers started studying the interactions between people and machines. In the initial stages this interaction is called Man Machine Interaction which ultimately turned to Human Computer Interaction. From a small desktop window design to a major virtual reality product, everything falls into HCI. HCI constantly works on bridging the performance gap between Humans and Computers. It provides the ease in accessing the systems reducing the manual errors. Long term goal of HCI is to reduce the barrier between the humans effort for accomplishing a task and computer support of the users task. HCI has two perspectives: one, a professional practitioner of HCI and the other is a researcher perspective. Professional practitioners are interested in the practical applications of the HCI design models to solve real world problems, where as researchers are interested in designing new models, theories of interaction and prototyping new software systems. HCI draws on different disciplines but it's a central concern for computer science. From this perspective of computer science, HCI involves steps like design, implementation and evaluation of interactive systems. Figure 1: Activities in HCI design 3. Activities in HCI design Human interacts with computer in many different ways out of which the most popular are Graphical User Interfaces (GUI for Browsers, Desktop applications). There is another side for it with using Voice for interaction with the computers and they are termed as Voice User Interfaces and the emerging multi-modal interfaces (user can interact using different modes). Traditional HCI designs include a single user interacting with system either by a mouse, joystick or a keyboard whereas the current trends in HCI interactions are not always clear instructions, and often includes several users. This is because of the remarkable progress in computer technology, processor speeds, memory enhancements and availability of various peripherals making pervasive computing a reality. Some of the input/output devices include PDAs, laptops, mobiles, wall size displays etc. This wide range of devices with different computing capabilities opens up the door for developing novel ways of interactions. Some of the methods include gestures, eye blinks, speech, haptic and many others. 4. Evolution of HCI Anything and everything will have a history and it just as humans should have evolved over a period of time. HCI is no different. In the Past, the devices developed were more of process centered and the designers did not emphasise much on the GUI part, as a result it lead to systems with not much usage of graphics. The best examples could be early day PCs. And also, these systems have high learning curve. The Present generation of devices are more of User centered which targets more on the look and feel of the interface. The present generation of HCI aimed at incorporating natural feel, motion capture, touch screen, multi-touch capabilities in the device. The future generation will be much faster and precise compared to the present HCI. The challenge is to develop multi- technologies on one -gadget with high mobility and minimal learning curve, to put it in a short and sweet term, "Make life easier". The current focus of HCI is mainly on multimodal interfaces. Multimodal interfaces have been shown to have many advantages compared to traditional HCI. It brings more robustness, error reduction and add alternative communication methods to different environments i.e. a single system will provide various methods for communicating with it. 5. Building blocks of HCI HCI is undoubtedly an inter- disciplinary domain acquiring inputs from all these fields, thus giving a magnificent user experience with the devices. The different components of HCI are shown below in Figure 2. The inputs given in any forms like voice commands, text, gestures to a HCI application processes it effectively and the user gets a Virtual experience/ Sophisticated interaction as the output. Figure 2: Building blocks of a HCI system 6. Diverse forms of HCI In our day-to-day lives, HCI exists in many different forms. The most focussed areas are VR ,AR, Ubiquitous Computing and Information Visualisation. But it also has its vast branches stretched out in other fields as well. This paper discusses the above mentioned area in detail giving a comprehensible understanding of its practical aspects in building a prototype model. 7. What is Virtual Reality (VR) ? Virtual Reality means that it is not physically existing but a software/ technology that simulates a three- dimensional world where the user can feel his presence and can manipulate, explore the objects in that Virtual world. VR is experienced through sound and sight, though it is not restricted to only these two senses [2]. With VR, a complete virtual environment is simulated and make the user to get into the Virtual world by head mounted displays or goggles. With VR, it is easy to simulate all kinds of environment which is not possible in the real scenario. VR has its application in many fields like that of Health Care, Education, Military, Gaming, Architecture and Research. There are many controversies on the concept of VR because many researchers claim that VR is "Death to Realism". The user may be carried away with the Virtuality; what it is not actually existing. There have been dozens of devices and software applications developed implementing the concepts of Virtual Reality. There are several views what accurately give a true VR experience to the user, but in common: ● A 3-D display of any objects in the virtual environment ● Track the user's motion in the virtual world and alter the position of the images accordingly on the display to get a real feel of the environment 7.1 Types of Virtual Reality Virtual Reality can be classified into different types based on the proximity of the application to the real world. i.e how close it corresponds to the physical environment. Based on the degree of immersion of the user into the Virtual world, it can be classified as -

3**Non Immersive (Desktop) Systems, Semi immersive Projection Systems, Fully Immersive Head Mounted Display(** HMD) **systems** [8]. The majority **of the**

VR applications falls into one of the categories. 7.1.1 Desktop VR Desktop VR uses a computer to simulate a 3D environment using specialized software's and the user experiences it through the computer monitor and can interact with the environment using input devices like keys, mouse. This kind of VR system does not provide a complete immersion inside the environment, but the user can take a walkthrough of the virtual environment and get a feel of it. Desktop VR also known as Non-Immersive system. An example of desktop VR is VirtusWalkThrough. It is a tool for creating 3-D architectural designs and enable the user to explore the virtual environment. This has its application in numerous field like that of Commercial Advertisements, structural design, tutoring, Arts, etc. [4] [5].The figure below clearly depicts how VirtusWalkThrough works. It has two windows – a design window and walk window. The design window helps to create a 3D design and the walk window allows the user to take a virtual tour inside the design to give a better idea of what it looks like. Many computer games can also be quoted as examples to Desktop VR. Figure 3: VirtusWalkThrough to design a 3D design and move interactively in the Virtual space 7.1.2 Semi -Immersive Projection System: The classification of the Immersive System into Semi-Immersive and Fully Immersive is based on depth and breadth of the information it provides about the objects in the 3-D virtual world to the user. The depth information can be anything like that of resolution of display unit, efficiency of audio and video, quality of graphics etc. The breadth information is how effectively it could simulate the number of human senses. A semi-immersive system

> 2**consists of a large** curved in **screen, projection system and** a screen **to** display **the**

objects. The experience perceived by the user will be similar to the IMAX screens. This also involves high performance graphics computing system. This kind of VR technology is first used in Flight simulators to train the pilots and astronauts [8]. The cockpit is simulated and is presented in a 3-D view to the user for training as training in a real environment involves risks. This simulation setup gives the user the intellect of existing in real scenario to visualize and make decision. At the same time, the user is also aware of his surroundings. When talking about Semi-Immersive systems, one of the essential topic to be discussed is about

> 2**Liquid Crystal Shutter (LCS) glasses.** This LCS consists **of a headset**

which is light weight and a pair of liquid crystal lens for view [10]. The semi-immersive systems give a superior sense of experience than the Non-Immersive systems but it is expensive. It also has some disadvantages when compared to the fully Immersive systems . The limit of interaction of the user in the virtual environment is limited and also multi-user interaction is a problem. 7.1.3 Fully Immersive System: A Fully Immersive VR constitutes a display which is head-mounted called HMD linked with a processing device, position tracking devices,(based on the user's head movement he get different views in the Virtual environment) data gloves and audio systems providing 3-D (binaural) sound. The HMD gives a 3-D imagery and the position tracking devices like that of goggles can be used to track the users head and body movement in the Virtual environment itself or data gloves can for tracking hand movements and manipulate the objects in the Virtual space. The audio systems enhances the feel of the user in the virtual world thereby giving a complete immersion into the 3-D Virtual World. Since in HMD VR requires the user to wear head display setup to experience Virtual Reality which is not comfortable to many. For that some complementary concepts like BOOM, CAVE have been developed for providing the same fascinating experience of the Virtual world to the user. BOOM: The BOOM (Binocular Omni-Orientation Monitor) consists of a stereoscopic display device which is head- coupled from Fakespace. It is also referred as "head coupled" display [11]. This is similar to that of using binoculars which provides a mobile, wide range window in a Virtual environment. BOOM has Screens and optical system incorporated as a single unit which resembles a box and is fixed to a arm with multi-link . The box has two holes through which the user can look into the virtual space, and can shift the box to any desirable point inside the operational scope of the device. Tracking of Head postures is supervised using sensors which are attached in the links of the arm that supports the box. The BOOM device have been wiped out of market mostly with the development of enhanced and extensively improved HMD gadget and projection-based arrangements like the CAVE. Figure 4: A BOOM System to view a VR setup CAVE Automatic Virtual Environment A virtual environment with closed walls and ceiling where the user can walk in and have a reel experience is given by a technology called CAVE expanded as CAVE Automatic Virtual Environment [9]. It is a cubical room with many Projectors displaying the visuals. Setting up of a CAVE environment requires ● Walls with Projection surfaces at the rear side and basement of the cube ● Sensory nodes fixed on wall to track movements ● Audio and Video System The person entering the CAVE wears a lightweight stereoscopic VR glasses and can freely walk inside the CAVE. The person's movement is tracked by the sensors in the wall and the images are projected based on their movement. Figure 5: CAVE Automatic Virtual Environment [11] Virtual Reality have been used in many fields like Education, Military, Animation etc. A brief view of its application is discussed below: 7.2 Virtual Reality in Medical Field In the past, the doctors rely on MRI scans and X-rays for doing surgery which is very difficult for brain, heart surgeries. With VR, these kind of surgeries have become easy these days as they can simulate an exact replica of any organs and practise

with it before they can operate on patients. Virtual Reality game that helps to train the vision of people with Amblyopia(Lazy Eye) and Strabismus(crossed eye). 7.3 VR in Education VR in education can be used to simulate many theoretical concepts which helps them to understand better and motivates in learning.Some of the softwares useful for educators are [1] 1. AC3D – to develop 3D model for simulation setup, gaming, medicine, information visualization, 3 D designing. 2. Alice- is a tool used in WWW, for creating 3D graphics. This is done at the University of Virginia. 3. Anim8or – A3 Free 3D animation software 4. Blender 3D - It is a open source software for modelling 3D objects, cartoon, portrait, post-fabrication. 5. Blink 3D Pelican Crossing- It is a tool for creating 3D environments. It can be used to create environments on the World Wide Web or on a computer. 7.4 VR in Military Virtual reality has got its practical application in manifold areas. The most key area being military training and operations ;VR applied for various missions like Flight simulation, Battlefield simulation, Virtual boot camp and vehicle simulation etc. The armed persons are trained in a reel environment wearing Head Mounted Displays (HMDs) which has tracking system incorporated into it and they interact using data gloves in the reel setup. 7.5 VR in Gaming (Oculus Rift) VR games have become popular these years. An attempt has been made earlier where the gaming companies developed the Virtual Environment for the games giving its users to experience the Virtual world using the head gears. But it failed due to its high end hardware [6]. Now VG games again had its gloom with the launching of Oculus Rift .It is a virtual reality head-mounted display developed by the manufacturer Oculus VR. Figure 6: Oculus Rift ; mage Courtesy: oculus.com 8. Augmented Reality (AR) Augmented reality is a view of environment that can be direct or indirect where the environment is real and the objects in the environment are supplemented by the sensory inputs such as sound, video, graphics or other data. In simple words, it could be said as virtual objects embedded in the real world. Augmented Reality can be considered as advancement to Virtual Reality, although both have their own significant differences. This is more close to reality as the environment in AR is real and objects are augmented which is in contrast to VR where real world is replaced by a virtual environment. AR will give more realistic experience as the user can see the real world around him while operating on augmented objects. One best example for AR is the sixth sense technology that has started at MIT media lab [3]. A small example of sixth sense technology is given in the following picture: Figure 7:Sixth sense technology by Pranav Mistry [3] Unlike virtual reality, AR tends to co-exist more with the real environment. Augmented reality appends graphics with the main senses –sound, sight, touch, smell which a user in general experience in the natural world so as to give a finer perception. Two major factors that drive AR are Gaming and Mobile technology. Figure 7 will define a new way of accessing mobile phone for making calls even without holding a mobile phone in hand. The concept of Google Glass is one more application of Augmented Reality. Augmented reality when added with fields like image processing and entity detection; the information the user gets from the surroundings involves more reciprocal actions or influence between the two. Most of the modern day smartphones or tablets are suitable AR platforms as they contain the necessary hardware components like camera, touch screens, MEMS sensors such as GPS, accelerometer, gyro sensors and solid state compass. 8.1 Difference between AR and VR Augmented Reality is a blend of virtual reality and real world. With AR, users collaborate with near practical objects in a practical world and can clearly demarcate between the real and reel. AR has the upper hand against VR as AR seems more realistic. Whereas VR is all about creating a virtual environment with which users can interact. But the challenge is in developing these virtual environments close to real environment so that users will find it difficult to identify which is real and which is virtual. VR might better work with Video Games and some virtual social networking applications like Second Life [7] or even Play stations. Both VR and AR are usually achieved by wearing a goggles or VR helmet like Oculus Rift. 8.2 Augmented Reality in Education AR and VR both are revolutionary technologies that can change the things the way they are. These two technologies can change the education curriculum by making it more interactive. The amount of knowledge that we can memorise from the books is far little than the knowledge that we memorise from the visuals. AR and VR will give the users a provision to interact and learn, which will give students a real time feel of what they are learning. For instance, AR can change the way we learn Engineering drawings, geometry or any other mechanical subject. User can rotate the diagrams or images, scale them, tilt them etc. and can learn effectively. AR can also be used in subjects like Chemistry in understanding the structure of molecules etc. Another application of AR can be in 3D modelling of objects. Applications of AR in education need not confine to higher education, AR can be applied in Primary level of education to teach kids more effectively. For instance, teaching kids about human body, bones etc as shown in the below figure 8.This kind of interaction with objects helps them to understand things easier. Figure 8: AR :Pop up images when reading text 8.3 Augmented Reality in Medical A head mounted display of AR can actually help doctors and surgeons for operating on patients. There can be wide range of applications built on AR for medical field. We can have notifications popping out on the glass telling the patients to take medicines. A head mounted display with a virtual X-Ray capability can actually help doctors in identifying bone fractures as shown in the figure-9. A doctor can actually look into a patient's body by combining one source of images (X-ray) with a video. This can help in operating the tumours. AR can also help doctors in enhancing the viewing experience of foetus inside mother's womb. A pre-programmed AR goggles can help old people in identifying their medicines. The applications of AR are unimaginable. There can be N number of applications which can help mankind for making their day to day life easier and better. Figure 9: AR: To analyse and find the fractured bones 8.4 Augmented Reality in Automotive The automotive companies like that of Jaguar and Land Rover is trying to integrate Augmented Reality in the windshield of the car [12]. Technological advancement is at its peak that driver need not even look at his smart phones to find the route of the unknown Place. Everything is

displayed on the windshield which makes it easier to drive. Augmented reality has outdated the text and voice inputs given to the mobiles and gets the map. Also, AR can also be used to detect obstacles and gives a warning to the driver as a display. The advantage of this using this technology is that visualizations are more effective than voice and it gains more attention of the driver. The future years can see many cars with this technology being launched. The only question is that whether are we ready to have the display in the line of sight of our eyes. 9. Ubiquitous Computing Ubiquitous computing also sometimes referred as Pervasive computing is an emerging field or paradigm that has grown rapidly in the last few years. It's a paradigm for interacting between humans and computers and has some of its branches from Human Computer Interaction. This paradigm is an advancement of the traditional desktop model of Human Computer Interaction in a way that processing of information is made by small computers that are embedded in many varieties of device that can communicate to each other and provide the user information wherever and whenever required. This concept of computing is inclined towards the Internet of Things. In today's world each and every human has many kinds of devices like PDA, Smart phones, notebooks etc. Ubiquitous computing focuses on the communication between these devices and also with the environment, A perfect example for this is Smart Home technologies, where each and every device in the home can communicate with other devices and also understands the environment surrounding these devices. One can visualize the future world to be device-device communication. A small example could be a device reading the room temperature and give this as input to the another device ,say fan or AC. Based on the input received, the AC/fan can be turned ON/OFF or can be regulated. 10. Information Visualization Information visualization has emerged as part of research in Human Computer Interaction. Information Visualization is the study of data representation. This data is typically abstract data that includes both numerical and non-numerical data. The name by itself explains us that this domain deals with the visualization of the abstract data. Insights of Information visualization are applied in many different areas including scientific research, data mining, financial data analysis, information graphics and digital libraries etc. Human perceptual skills are quite remarkable. Human has the capability to understand and analyse even large data. Information visualization can work hand in hand with human so that, large data can be visualized in a better way improving the perceptual capabilities of human. As it is a known fact that there is no system that can outperform a human in terms of large data analysis and decision making, information visualization can actually help human by putting the data in a visual environment making the analysis easier for the human. If it is still difficult to picture what Information visualisation is; the below figure [10] helps with it. This kind of latest technologies is shown in movies like that of Iron Man and the image is from a still in the movie when the iron man suit is being designed. Figure 10: Information Visualisation using AR[13] Another practical example could be a warehouse, where the tedious task is to keep track of the list of items available and its quantity. It involves manpower and the most important factor is the time. Instead of doing it manual, visualizing the data would be more helpful. The person can wear Google glasses or an AR headset which helps to visualize the items and project the quantity of the items in the display. Thus HCI helps in utilizing the technology for humans in an extremely useful and innovative way. The students of Amrita University formed a team naming GetVu (get view) and they have built the world's first augmented reality headset. It is one of the most advanced machines which support gesture interactions. Android is the base platform they used and the product is being now taken to next level in terms of applications in the medicine, education and warehouse maintenance. One can get an idea on the products by visiting YouTube with keyword getvu. 11. Conclusion This paper provides a clear insight on different perspectives of Human Computer Interaction.. HCI is a combination of many technologies like VR, AR and Information Visualization etc. Understanding these technologies from the HCI perspective is our goal. Also, this paper will give good information about the current technologies that are available in order to develop applications in the domain of HCI. 12. 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