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A Review on: Augmented Reality Technologies, Systems and Applications

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Abstract: We are on the verge of universally adopting Augmented Reality (AR) technologies to augment our perception and help us see, feel and hear our environments in enriched and new ways. It defines work done by several diverse research crowds, the determination behind every new AR system and difficulties met while building some AR applications. This study recapitulates the existing applications of AR, wonders on forthcoming applications and where present exploration will lead AR's growth. Challenges AR is facing to go from the workrooms towards manufacturing, likewise the upcoming experiments. Researcher's predictions are also considered in this report. Segment 1 provides a motivation for developing this technology and introduction to augmented reality. Segment 2 discourse AR engineering science with visualization tools, stimulus devices, tracking and computers. Existing applications that have been discovered are defined in Segment 3. The challenges AR will be facing and the future of AR are discussed in Segment 4.

Key words: H mounted D, tagging, 3-D MINI, google glasses

HISTORY OF AUGMENTED REALITY

The first arrival of augmented reality dates back to 1901, a concept of electronic displays/spectacles that overlaps virtual information onto reality. It was named as 'character marker'. Next, a model called Sensorama that could encompass all the senses (sounds, vibrations, smell and visuals) in an effective way, thus drawing the viewer into the onscreen motion in Fig. 1. Sutherland designed the head bestrode display (H mounted D) in 1966. In the year 1968, he was the only person to introduce an optical catch by head-bestrode display using AR system. In late video place, that permits consumers to correlate with simulated articles. Subsequently, David Mizell and Tom Caudell from Boeing coined the term AR while assisting doers to accumulate cables and wires for aviation industry. Many contested the merits of AR versus Virtual Reality (VR). Simultaneously, L.B Rosenberg designed the initial working model of AR and revealed its value on mankind operations although Steven Feiner, Doree Seligmann and Blair MacIntyre laid out the presented on an AR system model so-called KARMA.

The reality virtuality range was vague till 1994 by Milgram and Kishino (1994) as a continuum that ranges from the actual to practical surroundings (Fig. 2). Reality and virtuality are sited in mid-point with AV found closer to virtual surrounding and AR intimate to natural world. Azuma (1997) initiated AR enabling a widely recognized resolution of AR by naming it as collating

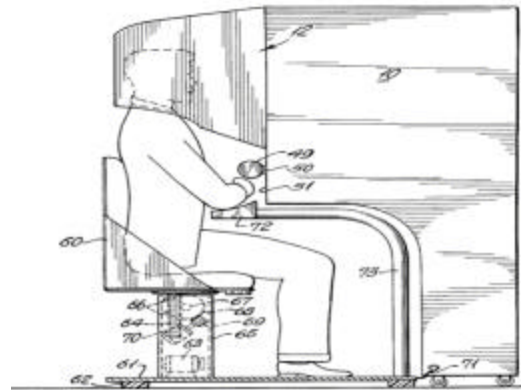


Fig. 1: Sensorama, from U.S patent #3050870

virtual and natural world as both recorded in 3-D and synergistic in real time. The foremost open-air mober AR game was AR Quake is designed by Bruce Thomas in the 21st century and revealed in International Symposium on Wearable Computers. As the study of Horizon (Johnson *et al.*, 2006) forecasts that AR engineering science will rise completely within the adjacent years and to authorize that forecasting, see through systems that can inspect forcible surroundings in physical time and share points among surroundings and objects are designed in 2005. This system of tools has become the foundation to mix reality with virtuality in AR model. In

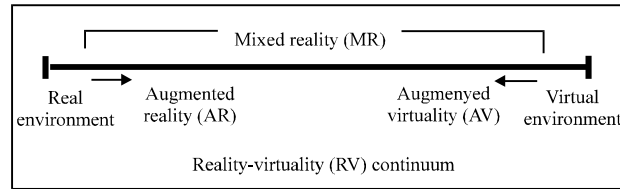


Fig. 2: Milgram’s reality-virtuality continuum

future years, increasingly AR usage are designed mainly with smart-phone apps for example Wikitude AR Travel Guide established in 2008. Currently with the new improvements in AR engineering science had enable and advancement in amount of applications are produced guiding light with sixth sense model in MIT, current and upcoming launch of the iPad and its descendants and rivals notably the Eee Pad and iPhone4 which give assurances to modernize mobile AR.

INTRODUCTION TO AUGMENTED REALITY

AR is a real-time view of an existing world background which are enriched by including virtual PC engendered data to it. AR combines real and virtual objects which get disclosed in 3d. Paul Milgram and Fumio Kishino explained the Milgram’s Reality-Virtuality Continuum as a band that duos between the existing world and the virtual world exclude AR and Virtuality (AV) mediate within where AR is nearer to the existing macrocosm and AV is nearer to an utter computer-generated world, as shown in Fig. 2 (Milgram and Kishino, 1994). AR objectives is to streamlining the user’s life by bringing by adding virtual info his adjacent ambience, merely to any collateral vision of the existing earth, for instance streaming of live videos. AR augments the user’s consumption in collaboration with the existing cosmos. While Virtual Reality (VR) technology called by Milgram, fully submerges people in an artificial environment avoiding the existing world, AR technology enhances the feeling by overlaying the computer generated things over real world.

Note that as Azuma *et al.* (2001), researchers assume AR as imperfect to the sense of sight nor we are not considering AR, as it is limited to a specific case of exhibit like head-bestrode display (H MOUNTED D). AR can be applied to all feelings, augmenting aroma, hearing and touch. For enhancing or substituting feelings of users AR can be used, for example for blind person we can enhance the vision or use of sound signals if the users have reduced sight or for hearing impaired people we can enhance the video signals. In addition to adding virtual things Azuma *et al.* (2001) believed that Augmented

Reality apps needs to eradicate the existing target from the natural world which are usually called liaised or small authenticity. So, slaying articles of the existing earth agree to cover the article with computer-generated virtual info that turns the object present in the background unavailable. Computer generated virtual target sum up with the natural world to show information to user that cannot be spotted with his senses. Virtual data generates the information, this information can be utilized by the user to perform daily-task such as heading proletarians via conductive cables in a planes by revealing binary information over a receiver. The information delivered by the virtual things can be used for amusement purpose like Wikitude travel guide or mobile AR apps. Bio images, way finder, maintenance, Ad, annotation, amusement etc are the classifications of the AR.

AUGMENTED REALITY DEVICES

Presentation, stimulus devices, tagging and estimators these are the major devices used for Augmented Reality.

Displays: Handheld displays, head bestrode displays (H MOUNTED D) and spatial displays are the three major types of display devices used in AR. H MOUNTED D is worn on the head which is a display device (Huang *et al.*, 2009) or as part of a spectacles and that combines both images of the virtual and real environment as shown in Fig. 3. H MOUNTED D can either be optical catch by or video-catch by and binocular display optic or monocular display optic. Optical-catch by systems are less commanding than the video-catch by systems as the user has to hold cameras (Diverdi and Hollerer, 2007) on his head which needs the processing of the two images coming from the cameras to deliver the enhanced part of scene by adding the computer generated virtual information. As the optical-catch by works on magic mirror technology to authorize the vision of real world to go over the lens (Parviz, 2009) and diagrammatically superimpose info to be replicated in the users senses (eyes). Then again, Video catch by systems enhanced vision is previously compiled by the PC and allow a check



Fig. 3: Head bestrode display (H MOUNTED)

over the solution. Hence checking all around the timing of the actual sight will be attained through coordinating the computer generated figure with the scene.

In optical catch by apps, the picturing of actual data should not be late (delayed), so the delay of processing of images is apparent from user to user. Such properties in figure may not be attached to the actual object but they are made to be equate, due to this there will be unbalanced, floating when the user look on to it. Hand-held display device consist of small processing devices that user can clamp in their reach (Table 1, Fig. 4). Hand-held device usage moving picture-catch by methods to superimpose visuals on the physical world and uses sensing elements for example GPS and compasses for their 6th DOF tagging sensing elements, indicator systems, for instance machine vision methods (SLAM) or AR Toolkit. Hand-held display device consist of small processing devices that user can clamp in their reach (Fig. 4). Hand-held device usage moving picture-catch by methods to superimpose visuals on the physical world and uses sensing elements for example GPS and compasses for their 6th DOF tagging sensing elements, indicator systems, for instance machine vision methods (SLAM) or AR Toolkit. There are presently trio different modules of commercially obtainable portable devices: PDAs, Tablet PCs and smart-phones. Mobile-phones are particularly handy and on the latest development present is a mixture of sinewy PC, GPS, measuring device etc. compass, creating them an identical promising stand for AR. PDAs exist plentiful of the same pros and cons of the smart-phones but because of recent advances in smart-phone technology for example AOS (AOS Operating System) established device, iPhone, Tab PCs remain commanding when compared to interactive mob device but then again they are expensive, heavy even too

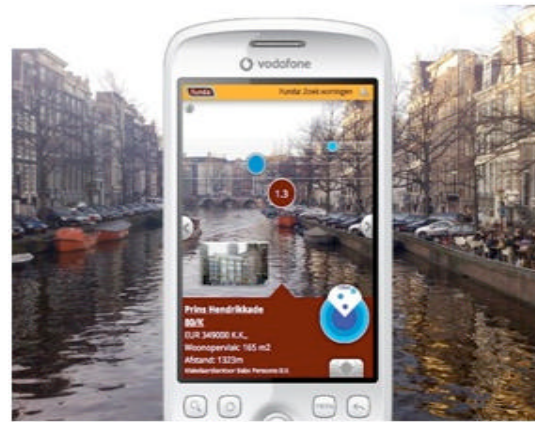


Fig. 4: Handheld display device

lengthy dual-handed usage. Withal, iPad recently released, researcher's trust that Tab PCs might turn out to be a hopeful stage for hand-held displays. Spatial Augmented Reality (SAR) is a kind of optical components, RF tags, video projectors, holograms, dogging technology to show computer generated graphics data straight on physical stuffs and there is no need to carry the display (Fig. 5) (Bimber *et al.*, 2007). Spatial displays differentiate the technology from the user then combine this with the real time. This allows spatial domain reality to logically rescale to clusters and then permitting Quislingism in-between consumers. By doing this we can increase the curiosity of AR models in institutions, laboratory, art and museums. There occur trio diverse methods to SAR which mostly vary in the method they enhance the surroundings: In SAR, apparatuses and normal PC is compulsory. Spatial optical catch by shows figure that are overlay on the real world. Spatial optic mixtures such as planar, optical holograms, curved mirror beam splitters or transparent screens are crucial elements of this displays (Mistry *et al.*, 2009). Still, cover established video catch by, spacial optic-catch by, none of these support smart-phone apps because of spacial adjusted oculi and video exhibit technology. Lastly, optical device-based spatial presenter's project figures straight on the real time surfaces (Bimber *et al.*, 2007).

Stimulus (input) gadgets are numerous used for AR systems. For example (Reitmayr and Schmalstieg, 2003) mobe AR system (Reitmayr and Schmalstieg, 2003) uses mitts, ReachMedia (Feldman *et al.*, 2005) utilizes a wireless wrist band. In the case of mobile-phones it can be used as a luffing device, such as Google Sky Map on AOS based phones which needs to focus to the sky bids to know the name. Stimulus devices selected rest on significantly on lotion the system that is actuality established.

Table 1: Comparison of display

		Handheld					
		Vodeo-see-through		Spatial			
Type of display techniques	HMD	Optical-see-through	Type of display	HMD	Handheld	Optical-see-through	Direct Augmentation
Advantages	Complete visualization control, possible synchronization of the virtual and real environment	Employs a half-silver mirror technology, more natural perception of the real environment	Portable, widespread, powerful CPU, camera accelerometer, GSP and solid state compass	Portable, Powerful CPU camera accelerometer, GSP and solid state compass	More powerful	More natural perception of the real environment	Displays directly physical objects surfaces
Disadvantages	Requires user to wear camera on his/her head requires processing of camera video stream, unnatural perception of the real environment	Time lag, jittering of the virtual image	Small display	Becoming less widespread, small display	More expensive and heavy	Donot support mobile system	Not user dependent everybody sees the same thing (in some cases this disadvantage can also be considered to be an advantage)



Fig. 5: Spatial augmented reality

Such as, when an apps needs the consumer to exist handy, Stimulus device is one which can be used by the users to use hands for certain application and there is no need of using strange gestures, for example stimulus device comprise of gaze fundamental interaction as in (Lee *et al.*, 2010) neither RF wrist-band. Similarly, if a system uses hand-held device, the designers can make use of resistive stimulus.

TAGGING

Tagging systems comprises of GPS, accelerometers, digital cameras, wireless sensors, compasses etc. All of these engineering science has diverse degree of precision and hinge on system actuality established. In Li *et al.* (2008), researcher recognized the over-all tagging technology for AR to be: Magneto sensors, mechanical, GPS, inertia, optics and ultrasonic. In Papagiannakis *et al.* (2008), researcher uses connection based DiVerdi (Diverdi and Hollerer, 2007) established on orbit, fix surroundings and resolution. Researchers additionally accepted the comparing technique for such a report in Table 2.

PROCESSING UNIT

AR systems need dominant CPU and momentous increase of RAM to process cam pictures. Up to now mobe processing devices utilize a movable system within

a knapsack shape, as there is increase in mobile-phones technology and iPhone, users can have a confidence assure that laptop substituted by a smart-phone and more stylish viewing system. Static systems can use old-fashioned workstation with an authoritative video card.

APPLICATIONS

Augmented Reality has many applications and many possibilities of using it in a pioneering way. In this we have restricted to three types of applications that are mostly used in the field of AR for research: medical, advertising and commercial, education and entertainment. At the commencement, AR had industrial, medical and military attention but later commercial and entertainment usage got into it gained more focus.

COMMERCIAL AND ADVERTISING

At present AR frequently used by the traffickers for the promotion of their new products online. The technique, the marketers are using is users should show the marker given by the marketers to webcam present in front, they use a special software to analyse these markers (software will be running from Ad troupe website). For instance, in the year 2008, MINI (Milgram and Kishino, 1994) the well-known automobile industry promoted there product using the augmented reality in automotive

Table 2: Comparing tagging technologies, range, setup, precision, time, environment

Technology	Range (m)	Setup time (m)	Precision (mm)	Time (sec)	Environment
Optical:marker-based	10	0	10	∞	In/out
Optical:markerless	50	0.1	10	∞	In/out
Optical:outside-in	10	10	10	∞	in
Optical:inside-out	50	0.1	10	∞	In/out
GPS	∞	0	2000	∞	out
WiFi	100	10	1000	∞	In/out
Accclerometer	1000	0	1000	1000	In/out
Magnetic	1	1	1	∞	In/out
Ultrasound	10	1	10	∞	In
Inertial	1	0	1	10	In/out
Hybrid	30	10	1	∞	In/out
UWB	10-300	10	500	∞	In
RFID:active	20-100	When needed	500	∞	In/out
RFID:passive	0.05-5	When needed	500	∞	In/out



Fig. 6: MINI advertisement

magazines (Geekology, 2008). The user who is reading the magazine has to go the company website and has to present the advertisement ahead of a camera to get 3-D MINI which will appear in the screen as shown in Fig. 6. Beyond reality has issued an advert which doesn't use any markers, the software could recognize and animated (Papagiannakis *et al.*, 2008), that user has to download from the publisher website.

They understand that on a system like this, they can contribute a gain full selection, that would permit them to get admission into extra content such as seeing a clip and then on a click to download the full flick, converting the clip into a flip voucher (Marco Sacco). AR bids solutions to costly problem of constructing a model. Certainly, big industries are confronted by the cost essential to manufacturing a goods ahead of commercialization to discover when there is any alteration must be complete

and also to check the ware has met the expectations. A group of the Institute of ITIA of the National Council of Research of Italy (Marco Sacco) developed a tool for associate virtual prototyping using Milan works on Augmented and Virtual reality. They convoluted their investigation for application using VR and industrial contexts. Augmented reality, real time 3D etc., is used for product analysis, evaluation and development. For instance virtual layout of a factory (Fig. 7). Augmented reality for advertisement and commercial applications lays in completely substituting the trail of clothes or something that's on shops, hence minimizing the quantum of period for customers that can help the customers to try on more wearing (pants, shirts, dresses, watches etc.) and therefore raising the probabilities of selling. AR has not amply gained industrial market in ad apps largely as an elite advances want to be finished to systems similar to Cisco's retail fitting room (Fig. 8). Definitely, manufactured article to be feasible in market it requires to provide the users with an unflawed design of the model.

EDUCATION AND ENTERTAINMENT

Educations and Entertainment apps comprise of gaming apps, museum guidance and light seeing with AR usage on mobile applications for education and entertaining role. In some applications which uses AR for virtually constructing the ancient shells (Huang *et al.*, 2009) or by telling about the site history through virtual teaching (Malaka *et al.*, 2004). Old-style game by augmented reality and AR usage on mobile applications for education and entertainment role. In some applications which uses AR for virtually constructing the ancient shells (Huang *et al.*, 2009) or by telling about the site history through vitalteaching (Malaka *et al.*, 2004).

There exits limited systems which uses AR for museum guidance as in Bruns *et al.* (2007) and Miyashita *et al.* (2008). In Bruns *et al.* (2007) and Miyashita *et al.* (2008) systems uses mobe device,



Fig 7: Virtual factory prototype

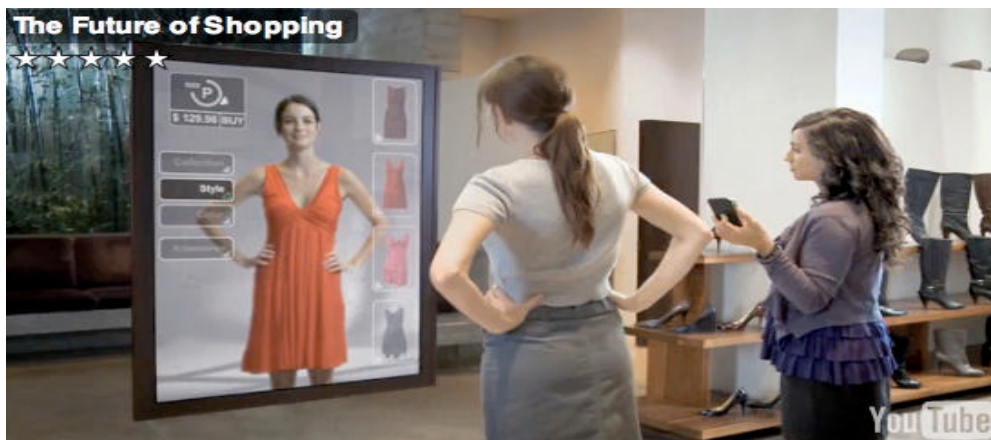


Fig 8: Cisco's AR commercial where a user is trying on garments in front of a magic screen

however in Bruns *et al.* (2007) uses smart-phone as an interface while in Miyashita *et al.* (2008) it uses a fairy-tale (magic) lens pattern. In Brunset *al.* (2007), the writers recognized the welfares by means of AR as an interface for social applications as: Intuitive and natural technique, well-organized communication through multimedia demonstrations to the user, acquisition costs and low maintenance for the museum in the case of mobile phone being used. Augmented Reality gaming apps gives numerous advantages with the physical board for instance, the capability to present multimedia presentations and animations. The capability to present animations to add enthusiasm to a game. For instance, signs to assist players study the game or indications to the user after they made an illegal change.

In Cooper *et al.* (2004), they created a game called Chinese checkers using AR (ARCC) that uses tierce markers and cam attached to the roof to trace the markers as soon in Fig. 9. One markers is used for manipulating the game pieces and remaining two indicators are used for positioning the checkerboard. Taking single instrument for controlling the parts permits the writers to adjust their format to dissimilar kinds of game only thing they have to alter is the Graphic User Interface of the games logic and the board games. Once more, this is typically due to technological improvements for instance tagging model. For instance, we have seen that the little museum guidance models designed were only appropriate to that museum or exhibition they were established for and might not be employed for other museums, due to the fact that

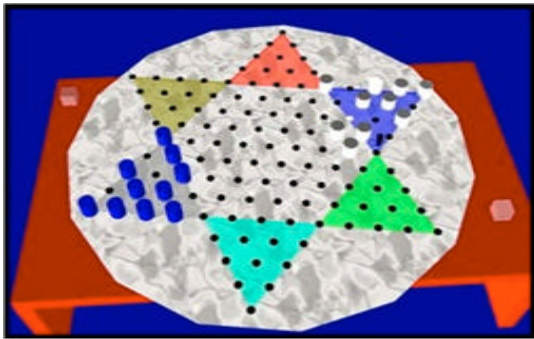


Fig. 9: ARCC

together these systems trusted on the exhibition to distinguish the artifacts. Paintings do not existing such a vast trouble for model for instance Google Goggles (Google) due to their even form objects, for example objects of recent art have very uneven shape that makes it tough to track a sharp article.

MEDICAL APPLICATION

Major medical applications deals on robot-assisted surgery and image guided surgery. Because of this, substantial research is going on to implement AR in instruments which incorporate the surgeon's intuitive capabilities. Substantial discovery is made in medical imaging for example endoscopic camera which records video images inside the patient and present it on the monitor. Yet these discoveries will have limitation on physician's direct 3-D vision, natural view of the human anatomy as the physician has to deal with virtual data that is additionally added which will be shown in monitor (Bichlmeier *et al.*, 2007). AR can be used to like procedural task while surgery is progressing. Bichlmeier *et al.* (2007) designed an AR system that can view real skin through virtual anatomy by polygonal surface model which can be used for real time visualization as soon in Fig. 10. Even Bichlmeier designed a system which can use the directed medical tools to enhance the surgeon vision with in the human body. Remote controlled robot assisted surgery will give physician an extra pros with dexterity, visualization and precision. Still enforcing feedback is limited by feelings and it is subjected to physician skills .if there is a lack of feedback then the performance of operations will be affected (Bethea *et al.*, 2004). In Akinbiyi *et al.* (2006) the writer insisted a solution for sensory substitution which provides a feedback to the user .The strength applied by the physician is graphically



Fig. 10: Bichlmeier *et al.* (2007) system

characterized and superimposed on a streaming live video by means of a system of circles that separately change colors through three programmed ranges (green, yellow, red) permitting to the quantity of winding forces noticed by strain devices. It necessary to decrease surgical processes is not the only one to hinge on seeing medical imaging data on the patient in real time, the need to develop medical analysis also depend on it. In this research field, the ICAR-CNR group of Naples (Giuseppe De Pietro) is functioning on an AR cooperative system for examining patient's hand for swelling by superimposing in real time 3-D. Magnetic Resonance visualization data straight on upper part of the patient's hand. Since swelling disabilities are powerfully related with pain, so need a straight operation of the hand region to be identified, the system may back physicians by permitting them to do morphological analyses at the similar time (Gallo *et al.*, 2010). AR could also be used to manage client's bio chronicle. Guess if all Physicians crisscross a patient's health record by engaging an H MOUNTED D and urge the patients to see a computer-generated label disclosing the patient's previous history of illnesses and injuries.

FORTHCOMING APPLICATIONS OF AUGMENTED REALITY

Augmented Reality is at initial phase and forthcoming likely apps are endless. Innovative study in Augmented Reality for visualization purposes include virtual retinal displays and H MOUNTED D for creation of organized surroundings comprising many amount of actuators and

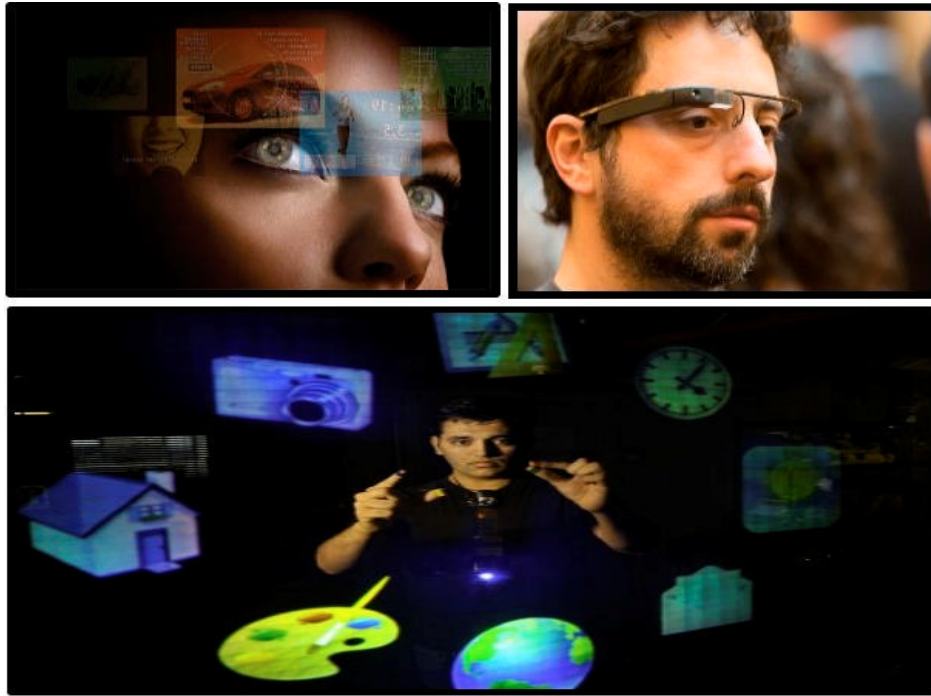


Fig. 11: From left to right, top to bottom: Contact lens, Google glasses, MIT media labs 6th Sense

sensors. The best example of AR research is “Sixth Sense” project by MIT Media Lab (2010) (Fig. 11) (Mistry *et al.*, 2009). Sixth Sense is a wearable gestural interface where users can relate information without having any in-between device. It augments the physical world with digital information around us. Current research also include project glass program by Google to develop an AR head bestrode display. The anticipated purpose of project glass would be to provide hands free displaying of info presently available on smart phone. The operating system used in this will be Google is AOS which allows interacting with internet over via natural language voice commands in a same manner when compared to the iPhone feature Siri. By using AR contact lens Parviz’s contact lens (Babak *et al.*, 2006), by using this information can be observed only by the user. Obviously, eyeglasses can also be used but the benefit in together circumstances above using a mobe phone, for illustration, is that not at all one can see the projected information. Cisco has fictionally developed a creation wherever AR is used for virtual clothes, by doing this we can save time and also we can try extra clothes by substituting the old-style fitting ways by a digital clothes, by doing this we can save time and also we can try extra clothes. By this we can increase the chance of stocks to sell more. AR also brings the likelihood of augmented lost intellects for approx.

users. Because, AR might be employed as a feeling replacement device. Hearing-disability people might obtain graphical signals enlightening their lost sightless be given an audio signals.

Altering them of mysterious visual events. What we want now to embrace is reality will allows you to do amazing things, this will remove barriers that currently exist. AR will allow 3D elements of virtual universe that can take advantage of any were we are, any time What we want now to embrace is computer vision, the ability to see the world as scene and the elements within it like tables, walls and objects once you know that you can relate information very smartly. Augmented reality will allows you to do amazing things, this will remove barriers that currently exist. AR will allow 3D elements of virtual universe that can take advantage of any were we are, any time we want. For instance holding the device up to the sky we can see the iteration of the weather like cloudy morning, afternoon, behind that we can see something like wind, rain or some other relevant information. We need office, we have provided some square feet’s area and 12 employees. Put this into AR you can virtually see how the desk would be setup, change the colour, change the economic posture and even we can see the cost related things when we change the configuration. What AR will do break the barrier we have with conventional desktops,

laptops and we want the convenience of having the information were ever you are. Current technologies will provide 20-30% of digital experience but AR will provide 100% experience by embracing this new virtual world, we open a new door to virtual universe were mind the only boundary. We trust that new portable devices like AOSbased devices, iPad and iPhone are not used properly in Augmented Reality. Without doubt, almost all the present applications comprise of gaming, education and entertainment. These are considering being the “amazing applications”. Even though the upcoming is not extremely challenging for AR. We assure privacy concerns and social concerns issues rising on the forthcoming of AR apps within industry. Social tolerance frequently ascend from mobe devices, these devices should be discrete, elusive, unnoticeable and stylishness. For this system to be utilizable the retraining of staff should be done privacy concerns get out of bed merely with bio applications even with engineering science that has a power to recognize and detect use. Wearable Ur World done by MIT has a lotion capable of spotting people and exhibiting evidence of the person to the user.

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