Augmented Reality

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Abstract: This paper is an overview of augmented reality's basic concepts and its connection to the logistics field. The paper includes a brief history of the tech and how it differs to the virtual reality. The main goal is to understand how augmented reality is being used in logistics to innovate and enhance services. It refers to how courier and freight companies are taking advantage of this technology to upgrade the warehouses, transportation and enhance value added services. It also analyses how the retail market is modernizing its stores and is using mobile applications for online shopping. Using augmented reality has overall pros and cons and even though is a technology on its early stages it shows a great potential to revolutionize the supply chain in its totality.

Keywords: augmented reality, technology, logistics, smart glasses

Introduction

There was a time when everyone thought that is wasn't possible for real objects to interact with virtual objects or vice-versa. But there is a new technology that will change the way that humans interact with machines, called augmented reality. In a simple way, augmented reality is a technology that superimposes an image computer-generated into the real world.

It allows a bigger interaction and opens a new dimension on the way that we execute tasks with common used technology, like a mobile phone. For example, when shopping for clothes, it is now possible to check the product's extra information or visualize how two pieces of clothes would match or fit the costumer by using an application, available in any app store. Another example is the smart glasses, with those, anyone could repair its own car by actually visualizing the problem with the help of the company's professional to guide every step.

Augmented reality is many times confused with virtual reality, but they differ in a way that in virtual reality there are environments generated by computers for humans to interact; augmented reality actually adds information to the reality that we see, does not replace it. The combination of these two is meant to simplify everyday tasks and help us be more efficient.

Milgram's Reality-Virtuality continuum from 1994 [1] is defined by Paul Milgram and Fumio Kishino, as a continuum that spans between the real environment and the virtual environment, comprise Augmented Reality (AR) and Augmented Virtuality (AV) in between, where AR is closer to the real world and AV is closer to a pure virtual environment, as seen in Figure1.

The AR/VR technology is growing at a rapid pace, the investments in AR have been rising rapidly and it seems to become a trend. Studies shows that back in 2014, there were less than 1 million VR users.

This number has grown to more than 150 million users nowadays and a tremendous rise is expected. A report by Zion Market Research shows that in 2016 the virtual reality market was valued at approximately $2 billion and is expected, by 2022, to reach $26.8 billion. [2] Of course, as any big technological advancement there are not only good outcomes, but some drawbacks as well. These are mentioned bellow. But this article approaches virtual reality specifically on the logistics field. It examines and sees how and where is being integrated in managing the logistics processes of courier and retail companies, starting from the very top company's management system, following to production, warehousing, transportation and value-added activities.

1. Brief History of Augmented Reality

In 1968, Ivan Sutherland, a Harvard professor and his student, Bob Sproull, invented the "Sword of Damocles", a head-mounted display hung from the ceiling. The system showed users simple wireframe drawings generated by a computer, but this could be considered closer to the virtual reality than AR. In 1974, Myron Krueger developed a project called Videoplace that combined a projection system and video cameras that produced shadows on the screen, surrounding users with an interactive environment. In 1990 the term "Augmented Reality" was coined by a Boeing researcher called Tom Caudell. In 1992 was created the first real operation augmented reality system, Virtual Fixtures, by Louis Rosenburg from the USAF Armstrong's Research Lab. A robotic system helped with efficiency by placing information on top the of workers' work environment. Julie Martin created the first theatre production to use augmented reality in 1994, "Dancing in Cyberspace", featuring acrobats dancing within virtual objects on the stage. After 1994, as technologies advanced, AR started making its way into entertainment. In 1998 Sportvision used the 1st Ten Line computer. The system casted the first virtual yellow first down marker during a live NFL game. One year later, in 1999, NASA used a hybrid synthetic vision system that integrated an AR in their X-38 spacecraft, which helped improve the navigation during their test flights. Hirokazu Kato from the Nara Institute of Science and technology in Japan, created a software called ARToolKits in 2000. The software could capture real-word actions and interact them with virtual objects. For the 2003 NFL season, Sportvision used Skyscam, a computer graphic system, to insert the virtual first down marker. Esquire Magazine used in 2009 AR in their printed media, allowing readers to scan the cover to make Robert Downey Jr. come alive on the page. In this same year ARToolKits made AR available in web browsers. [3]

More recently, in 2013, Volkswagen started using AR as their car manuals. Using an app called MARTA through the IPad, users can get repair assistance and mechanics can receive instructions to foresee repairing processes and projects that they're working on. In 2014 Google announced that the Google glass was becoming available for consumers, starting the trend of wearable AR. Even though the Google glass wasn't as successful as the developers expected in the daily life- like in the use of social media- factory workers started using the tech to help with work efficiency. In 2016, Microsoft introduced the HoloLens (figure 2). An "improved Google glasses version" but obviously, way more expensive.

Nowadays we have AR in games like Nintendo 3DS, Pokémon Go, in social media like Snapchat and Instagram and now more than ever, has become part of our daily life.

Figure 1. Microsoft HoloLens [4]

2. Overall Advantages and Disadvantages of Augmented Reality

The AR system is very interactive, the advantages related to its use include: enhanced perceptions and interactions of the virtual world with the real world like games, motion picture, television and other media and promotional campaigns. AR application are suitable for all ages. Retrieving relevant information about anything is efficient and quick, for example for navigation and tourism. In the medical field it is revolutionary, helping with efficient diagnosis and treatments. It also helps save money when testing critical situations to see the possibility of success without making changes in real life. On the military field, it is used to create battle field simulations, without endangering people's life. AR is also very useful in training programs and in education. When talking about maintaining a virtual workforce for any kind of business, the pros include saving on the office space, more satisfied employees with flexible hours that can work from anywhere, and this already covers the problem of hiring talented personal that might not be able to work full time or in a specific geographic place. But on the other side this system might affect the organization of the company as everyone has its own timetable, and with no human interaction, the employees might lack the ability of team work.

Furthermore, as most forms of technology, AR is very expensive, not only to purchase by to maintain as well. Plus in some way it depends on the advancements of artificial intelligence (AI) such as machine learning, computer vision, natural language processing, among other forms of AI. The lack of privacy is one of the biggest concerns not only it's a prone to cyber-crimes, as anyone could try to access the confidential data in the cloud, but in case of an accident the data might be all lost. So it's always recommended to have a backup. AR also requires basic learning for users to be able to experience it fully. And most importantly, it can be very dangerous physically and emotionally as people tend to get sucked into the virtual world. [5] Taking as an example is the Pokémon Go, a very interactive game that has created controversy due to associate accidents and death. [6] Moreover, in cases where everything is facilitated at the same place, either from the smartphone or the smart glasses, it can lead to minimal physical movements, which is unhealthy.

3. The use of Augmented Reality in managing logistics processes

Logistics is the support function within various sectors. The logistics importance is growing as there has been a huge development in global communication and travel options, emerging markets and supply chain globalization. With that comes the need of improvements in the logistics services all over the world. The processes must be simplified and more accurate in identification, real time tracking and delivery. All the operations are connected in a way that one functional principle can change the actions of the rest of the system. World class logistics requires a perfect execution and satisfaction of the costumer for a reasonable price. Therefore, the use of Lean Management in companies' logistic, supply chain all the production processes has become highly popular.

Integrating the Lean Management into Logistics is a huge challenge, but it also has a huge impact. [7] There is a lot of processes involved from the production until the moment the product arrives at the long distance costumers. The main goal is to eliminate all waste [17] [18] [19], so the amount of work in process inventory and its cycle time decreases, ultimately increasing the flow and speed of the supply chain.

One of the main Lean theories is that all inventory that is not immediately necessary to support the operations and the needs of the customers must be eliminated; defending that the Supply Chain system must be a "Pull" and not a "Push" system. The "push" System is based on forecasting. The company starts production based on the forecast that a certain amount of the product is going to sell and also considering that it cannot run out too soon. The forecast tends to be excessive or just completely wrong because of countless reasons. This leads to a pile of inventory, creating waste and unnecessary expenditures. The "pull" system on the other hand, uses more modern technology and uses demand data for replenishment and production. The inventory is kept short, only the immediate costumers' requirement are drawn from the protective inventories upstream.

Related to the pull system, is the Just in Time (JIT), also known as the Toyota Production system. This is a management system that calls for production of exactly what, when, where and how much the costumer wants, without relying on inventory. So instead of building a big stock of what the costumers might want, the company produces exactly what is asked for. Just in Time is sided with Manufacturing Resource Planning (MRP2) programs that will plan every process within the facility, indicating quantity and timing. These software packages control every complex planning so the costumers don't wait months for their order nor the company has extra expenditures on inventory. [8]

This management system also includes the Shop Floor Management, which refers to the area where the production and assembly takes place in a manufacturing company. The productions is carried out either by workers and automated system or both, and inventory, storage and quality control may be included in the area. This system primes to improve the communication between the management and the workforce, in an attempt to reduce errors due to lack of teamwork. The approach is done directly on the production hall with daily meetings to solve the emerging problems. The shop floor management hierarchies and schedules the workforce, keeps the processes in sequence, stabilizes the operational control and value-adding processes.

The AR has been included in this management system through mobile devices with a software in which managers, supervisors and workers can access the work progress. It includes checking machine usage, labour hours, evaluating material status and other resources, receiving notifications and real-time information. The software runs over Wi-Fi or through wired connections for companies that prefer so. [9]

Figure 2. Using of a mobile device to track the work [9]

3.1. Changing Logistics with AR

Although is still in the early stages, the AR phenomenon has been accepted within the logistics and distribution sector with open arms. Logistics is one of the pioneer in using AR to enhance the processes. In general, AR can bring general efficiency improvements in logistics: manufacturing and employee training, increasing productivity in warehouses and transportation and delivery processes. By using AR devices, staff can easily read bar codes, identify products, and provide navigation and feedback, and many others tasks that would traditionally be done by paper checklist. These methods optimize the time and energy spend to get these tasks done and reduces costs and errors.

In retail it's more and more common the use of AR to provide customers a better shopping experience, where you can see the product's details, placement option and even try clothes on.

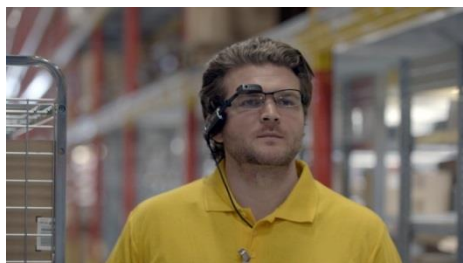Courier and freight companies are seriously investing, mainly in these key areas:

Figure 3. Employee using smart glass to "Pick up by vision"

Warehouse operations- These operations are estimated to be 20% of all logistics costs and the task of picking up accounts for 55% to 65% of the cost of warehousing operations. [10] Pick-by-vision (fig. 4)

is being used to optimize the picking process. There are cameras, wearable PC, head-mounted display and battery packs that can last for the whole work shift. The vision-picking software can read bar codes, allow object recognition, indoor navigation and sync all the information with the management system. By using this system each staff member can see the digital picking list in their field of vision or analyse the best route. With the bar code scanning it is possible to check if the worker has arrived in the right location or quickly guide the worker to the item's location while simultaneously enabling the real time stock update. In additions this helps with language barriers, and reduce the time in training employees. Another important update is on the optimization of warehouses. Warehouses are becoming more that just storage, they are now being used for the value-adding services as repair stations, packaging areas and assembly lines to products labelling. AR has been very helpful to preview new models, visualize in full scale any rearrangement that is being made and make sure everything fits in place.

Transportation optimization- With AR tech, workers are able to check freight loading, detect damage and check correct locations much faster than manually. With wearable 3D depth sensors and scanners, will be possible to check the number or the volume of pallets or parcels by scanning specific markers. Nowadays, many economic processes depend on the flow of physical goods and traffic congestion often delays that. Is estimated that, each year, traffic congestions costs Europe around 1% of the GDP. [11] In the future, drivers could get assistance using AR apps for real time information, with glasses or smart windshields that are already being tested. This way they wouldn't have to take eyes of the road, beating our present navigation system. With the economic growth, market and transport flows increasing in many regions, there is a need for a more detailed shipment operations, like regulations or trade documentation. AR can reduce port and storage delays by translating documents, scanning for key words and identifying commodity code classification. Printed cargo list and instructions can be completely replaced.

Last-mile Delivery- refers to the movement of goods from a transportation hub to their final destination. It is the last step in the supply chain but the most expensive as well. Studies say that most of the time spent by drivers is locating the correct boxes in the trucks, and not driving. They are mostly relying on their memory during the loading process to find a box. Using AR, drivers could receive information on each parcel, making it easier to locate, if it's heavy or not, fragile or not and what specific position to put it on. The AR device could also calculate the space needed for the parcel and the address to be delivered to. Delivery time would reduce considerably and be easier, while also reducing package damage.

Enhanced value-added-service- besides the logistics operations, services such as assembly and repair and customer support tools are now being provided to assist customers. An example is how DHL collect materials from providers for Audi and assemble these components into interior door panels that are delivered to the Audi production plan in Germany. AR can help train warehouse staff to assemble the products and ensure the high quality standards of the service, reduce cost for costumers and repair time for the workers. DHL is also using the "Paketassistent", a system that allows the user to print a sheet with an icon very similar to a QR code. With a Webcam, holograms available at DHL boxes

are projected for the costumers to match their item to the right-size box, and help them order the correct shipping option.

For the retail industry, augmented reality was considered a far-fetched solution. But nowadays there's been some significant changes. In fact, a study by Digital Bridge says that 75% of consumers now expect stores to provide an AR experience while shopping and 51% of consumers thinks that the retail industry is not taking full advantage of the technology. [12]. The main reason for this change of judgement was the launch of the Apple's ARKit and Google's ARCore.

The ARKit was launched by Apple, it's an AR development platform for iOS devices. With the new iOS 12 the promise is to enjoy the IPhone and IPad's hardware at the fullest. Is possible to share AR experiences simultaneously with friends, play interactive games and with the cooperation from other companies there are now applications to make routine activities easier and quicker. Like GE – that is using it to enable workers to visualize and repair industry equipment more efficiently; American Airlines' app- that overlays real-time information on airport terminals helping people to find their way around, boarding gates, restrooms, or coffee shops; and IKEA [13]
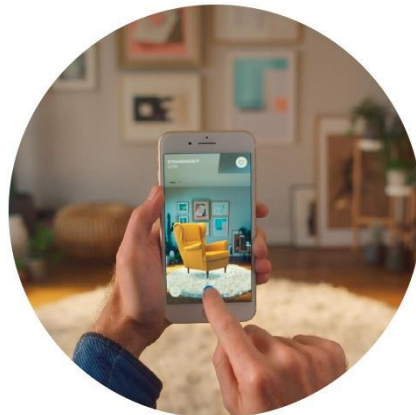

Figure 4. IKEA Place app

The IKEA Place app was launched in 2017 and has currently more than 2000 furniture items for customers to choose from. "IKEA Place lets you place true-to-scale 3D furniture in your home using the lens of your iPhone camera. You see the scene as if these objects were real and you can walk around them and interact with them, even leave the room and come back." [14] The idea of using the AR came after studies showed that costumers weren't confident when buying, they were worried that the furniture wouldn't match or fit the room. [14]

Google's ARCore has basically the same function, a software devolvement kit used to build augmented reality apps. It is usable in both iOS and Android devices. The ARCore uses this three key capabilities: Motion tracking- the phone understands and tracks its position in relation to the world, Environment understanding- the phone detects size and location of surfaces and Light estimation- the phone estimates the environment current lightening condition. [15]. It has been used for major companies like Wayfair- which is a furniture company, the application has the same purpose as the Ikea Place app, My Tamagotchi Forever- a gaming app that brings virtual pets to the real world, Just a Line - the app allows drawings to come alive and eBay application- that is using a new fitting feature.

The eBay "Which Box" feature was designed to help customers find boxes that fits perfectly the item they're shipping, as most costumers has trouble deciding which box to purchase. It is possible to place the virtual box over the item and rotate it for a complete view of the item inside. This feature can help with accurate sizing for any kind of sold merchandise. [16]
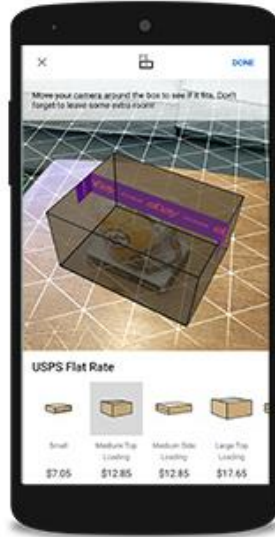

Figure 5. eBay app "Which Box" feature

Conclusion

We can see that technology, management and logistics are all connected. Smoother and faster logistics processes is possible with the use of AR tech, but is required an innovating upper management system for the company to keep the head up. There are many obstacles and the augmented reality technology is still a work in progress. But overall it is very beneficial and costs are reduced, time is saved and errors and accidents are prevented. Besides, is expected even more advances in AR in health care, games, advertisement, transportation, navigation and maps, sports, shopping and basically in every other aspect of our daily life.

Long term speaking, brands that take full advantage of Augmented Reality will be the ones that satisfy customers more. But, as any big advancement in tech, it leaves us with many doubts. Could Augmented Reality be some form of better reality? Some experts predict that humanity could be diving into a mixed reality phase where everything we see in the real word has virtual added data. The line between real and virtual could become inexistent, leading to difficulties distinguishing the real from the virtual, and creating confusion. The AR advancement can be considered as positive progress, and it is up to the innovators and designers to create AR content that isn't unhealthy and doesn't make people obnoxious or confused, but as a society, we are the ones that decide where to draw the line.

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