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A Take on Augmented and Virtual Reality Applications in the Utility Industry

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SUMMARY

Electric Utilities are in the midst of one of the greatest workforce transitions that is seen in any industry in recent memory. Many are now scrambling to deploy tools to stem the outgoing tide of information, and most are seeking to leverage advanced technology to help. Augmented reality (AR) and virtual reality (VR) may play a key role in bridging the knowledge gap to the next generation of utility workers. This paper discusses the current opportunities and challenges of augmented and virtual reality applications in the electric utility industry. AR/VR technologies offer great benefits to other industries (15 to 20 percent increase in efficiency) and understanding the opportunities and challenges of these technologies can help electric utilities to dramatically increase their efficiency when implemented properly [1]. This paper will focus on choosing the appropriate device for the business case, a multifaceted challenge that is well worth the effort given the potential benefit and implementation strategy.

KEYWORDS

Augmented Reality, Virtual Reality, Innovation, Technology, Head-Mounted Display, Wearables

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Introduction

The augmented and virtual reality (ARVR throughout this paper) industry is exploding with growth similar to the birth of the World Wide Web. Numerous companies are popping up to develop applications and push the limits of hardware to support a wide variety of business cases. Other industries have found a 15 to 20 percent increase in efficiency with augmented reality [1]. American Electric Power (AEP) has begun exploring this technology to discover its value in the electric utility space. The opportunities for more effective communication and increased efficiency are nearly endless. What is the commonality between people drawing on cave walls, hand sketches, computer aided drawings, and models? The answer derives from the well-known phrase, "A picture is worth a thousand words." ARVR represents the next stage of evolution to this phrase. Why look at a flat or even 3-D image on a computer screen when it is possible to walk around inside the picture? Effective ARVR technology in utilities preserves enough similarity to existing practices to feel familiar while simultaneously increasing efficiency through new approaches to old tasks.

Opportunities

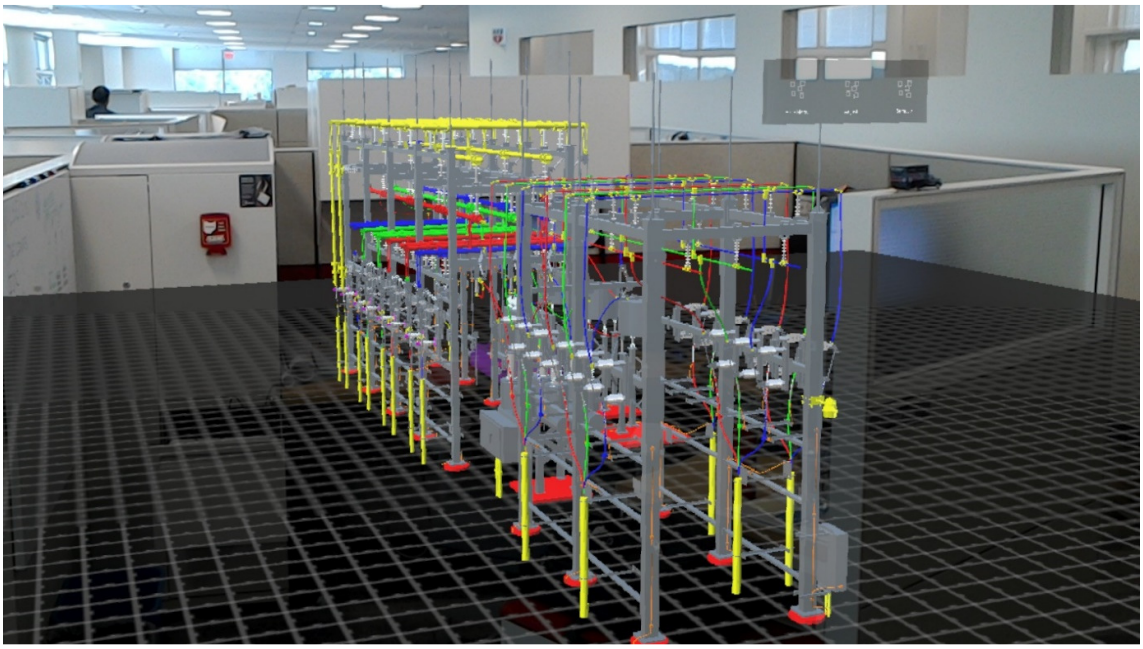
Many existing electric utility procedures are in place for employees to experience something first hand and collaborate. As an example, it is common practice to perform a substation site-visit with multiple stakeholders when scoping a project in that station. One of the first questions customers ask when talking to a utility about a project is "what will it look like." Training inevitably involves visuals and doing something to understand concepts. However, existing practices are not perfect. Each one involves an undesirable expense, such as travel expenses and business time. Information availability is not consistent for all physical locations (substations and office locations in this case). As an example, it is far easier to measure between live parts in a CAD model in the office than it is to take a physical measurement at the Substation site. ARVR provides a unique opportunity to take the best things about the office environment and merge them with the benefits gained from experiencing something first hand in the field.

CAD models are an extremely useful tool for communicating projects among stakeholders and customers. However, there is something intangibly different about seeing something first hand at the substation site and looking at a 3-D model of the substation. Part of the difference comes from scale, but the more important part of the difference comes from the type of visual. A 3-D model on a computer screen is still flat in reality. Users cannot get a true sense of depth and scale in that scenario. Substation site visits help immensely on this front, but they are also limited in their own way when it comes to information availability. Employees must carry around whatever information they need about a substation site beyond what they can see with their eyes.

ARVR enables employees to experience the feeling of walking around substation sites while also having the availability of information from office environments. Just like a substation site visit, employees can physically walk around "sites" or station models in true or reduced scale. They can access information or specifications about an entire station design or specific elements within the model. Manipulations of the model space are practical today. In others, users can scale, move, and rotate models while immersed. Local and remote collaboration abilities build on the concept of video conference calls and site visits to create collaborative engineering and design sessions. These abilities also enable utilities to pursue safe training exercises. As an example, a new employee can practice switching substation equipment procedures in this environment. It is better for this employee to open a fully loaded switch without interrupting capability in an augmented or virtual reality environment than it is to have them make this mistake in an energized substation environment. Exploded views of equipment in motion can demonstrate things like what happens to the arc as a circuit breaker trips or provide systematic instructions for maintenance activities.

Additionally, it is possible to use metadata to inform employees about the status of equipment. Temperature, current, or pressure information unavailability in real time could lead to an unsafe condition. Overlays in head-mounted displays (HMDs) can make this information readily available. It

may even be possible to have a device guide employees to a piece of equipment of interest in large facilities, similar to GPS for the road. This is an example where mixed reality (MR) can be helpful.



3-D station model immersion also creates opportunities on the marketing and outreach side of the utility business. Regardless of whether the application is augmented or virtual reality, the visuals help to inform customers about what something will look like. Supplemental information in the model can also help to educate and answer questions in an interesting way. The visual perspective provide by ARVR helps to ensure that the customer remembers the information and/or experience. As an example, AEP is using mixed reality as a visual aid to enhance marketing of BOLD.

Challenges

With innovation, there are three areas of concern: technology, process, and people. This section is a brief discussion on the technological and change management challenges as they apply to ARVR in the electric utility space.

Cyber Security
As with any new technology, security is of utmost concern, particularly for electric utilities. ARVR devices straddle the worlds of mobile devices and laptop computers which makes them a unique challenge. Antivirus and mobile device managers (MDMs) are not necessarily available for all devices. Additionally, many off-the-shelf software products are heavily reliant on cloud to support easy model access, which may be a challenge for some utilities. Assuming the hardware and software is fully secured, network availability and its impact on business cases must be considered. A business case that is bandwidth intensive should not be pursued in situations where the end user will not have access to a strong network.

Field Safety
Per OSHA guidelines, protective eyewear must be disinfected after each use if it is shared with other employees. In many cases, it is likely that HMDs will be shared between employees due to their cost. While not all HMDs can also be classified as protective eyewear, disinfecting when there is a handoff between users is still a good housekeeping measure. There are similar requirements and device restrictions when considering head protection. Some devices require special adaptations to work with hard hats while others prohibit the use of hard hats entirely. Minimal available devices can take the place of a hard hat entirely.

Organization Change Management
Organizational change management is a particular challenge when it comes to ARVR. Successes typically come from applications of the technology built around relatively simple and known tasks. Think about typical changes to organizations. Employees are most comfortable when the new thing is perceived as an enhancement to something existing. The same is true for ARVR. Introduction of something small is a good place to start. Incremental changes to the starter product can then be applied. Each enhancement should further improve efficiency and/or information availability. Keep in mind that safety is paramount and end users will have a reasonable expectation that they can utilize the technology safely.

A positive user experience is also paramount to a successful change management strategy and technology implementation. Device ergonomics must be considered. Some HMDs are comfortable for extended periods of time while others are not due to their weight and form factors. Devices have varying fields of view. An appropriate field of view for the particular application should be pursued. However, there are also applications where peripheral vision is still necessary for safety reasons. Additionally, there are several different ways to interact with ARVR devices. Hand gestures, voice commands, and controls are all viable ways to interact with applications, but they need to be straight forward for the particular use case. As an example, voice commands are unlikely to work well when the device will be used in noisy environments.

Choosing a Device

Choosing a device is a particular challenge in the ARVR space. One may be tempted to equate it to the smart phone world, but it is not a fair comparison. Smart phones do have their differences between vendors. Camera quality, processor speed, operating system, and perhaps some gimmicks may play into consumer decisions when it comes to smart phones. Some of this can be compared to devices capable of ARVR. Some smart phones can even support augmented and virtual reality applications. However, smart phones have a fairly standardized set of hardware and sensors which is not true of all ARVR devices. Consumers can expect to see GPS navigation systems, a typical flat screen, gyroscope, accelerometer, and other sensors in smart phones. The same cannot be said for all ARVR devices. Some devices are only built for virtual reality while others can handle augmented or mixed reality. Some devices are hand-held and some are head-mounted. HMDs come in various form factors like smart glasses and helmet mounted displays. Inputs to interact with devices also vary. Some methods include voice commands, hand gestures, handheld controllers, and more. Additionally, the hardware space of ARVR is still changing rapidly as companies vie to become the next market dominator. Utilities must choose devices bearing in mind the problem they are trying to solve, device capabilities and cost, hardware style, and likelihood of device scalability and stability as the market changes.

When choosing a device, consider the challenge being resolved though augmented or virtual reality. When the challenge is related to communicating what something will look like to a customer, it may not make sense to use a device that will require them to physically walk around extended distances in the environment. Many times space is a constraint in that scenario. Similarly, a device that requires a user to hold it with their hands may not make sense if the task requires both hands to complete. HMDs and hand-held devices both have strengths and weakness. HMDs are generally very helpful for applications where users must have access to their hands to complete a task. They may or may not be tethered to a PC. Devices are typically more powerful if they are tethered to a PC, but users do not have as much flexibility to move around while wearing the device. Handheld devices, such as smart phones, tend to support applications that are relatively inexpensive to implement. Most employees have access to devices like this already which makes adoption easier. HMD hardware is generally more expensive than handheld hardware, but it is also generally more powerful and immersive. As a result, form factor plays a significant role in device selection.

When it comes to an immersive experience, utilities must evaluate how immersive the experience must be for the application to be successful. Virtual reality obviously tends to be the most immersive

experience in comparison to augmented or mixed reality. Applications meant for training and instances where the user does not require much interaction with other employees while performing a task tend to be most successful in virtual reality. Augmented and mixed reality tend to be most successful in the context of a task that requires an employee to move about the environment or physically perform other tasks. Training on switching procedures is an awkward example in that there are benefits to both approaches. An employee could experience the feel of a hot stick in their hand during a switching a procedure using augmented or mixed reality, but less space is required if they rely on virtual reality instead.

Conclusion

By deploying virtual and augmented reality in utility design, engineering, construction and operations, electric utilities can inspire innovation across disciplines and drive progressive change. Digital reality can and should serve as a transitional lifeline of sorts for utilities to engage and optimize their new generation of workers. Much of the utility workforce will transition from operations personnel, skilled craftsmen, and line workers, to software engineers, analytics experts, technical specialists, and innovative leaders. The next generation of workers will interact with their workplace environment differently than any who have come before. Field specialists will grow to be multi-disciplinary, technical engineers may become more suited to sit behind a computer than walk through a substation, and immersive global communications will be accessible anytime and anywhere. While there are still many challenges for utilities to mitigate in the ARVR space, there are also numerous viable opportunities for implementations of the technology today. A strong change management strategy and consideration of user experience can lead to very successful outcomes. The opportunities for efficiency and improvements to information availability are nearly endless. The important thing is to take the first step toward using this technology on common tasks or processes in which improvements will be easily tracked. Simply, it will become part of the way employees work daily.

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