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New Arrangement Opportunities and Safety Challenges for Offices of the Future

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Abstract: This paper gives an overview on trends in building automation which have an impact on offices of the future, namely alternative (virtual) desk space arrangements, and work safety (fire prevention and protection), with the usage of Augmented Reality devices such as Google Glass or Microsoft HoloLens.

Keywords: Offices of the Future, Building Automation, Virtual Desks, Fire Protection, Work Safety

1 Introduction

In the last years, the area of building automation has seen an upsurge. The introduction of electronics into buildings led to many innovations. This ranges from clever treatment of queues in front of elevators to intelligent heating and cooling systems, predicting the need for a comfortable temperature in a room and preparing accordingly; from automatic energy saving in currently unused rooms to intrusion detection and defense. Furthermore, the topic of the Internet of Things (IoT), which was defined as "a global infrastructure for the information society, enabling advanced services by interconnecting (physical and virtual) things based on existing and evolving interoperable information and communication technologies" [ITU] brings even more opportunities due to the fact that many previously unrelated sensors and actuators now are able to be accessed in a combined way, netting the building control system a big information advantage compared to older buildings.

This paper focuses on two changes that can be achieved using Augmented Reality (AR) devices like the Google Glass or the Microsoft HoloLens. AR has become available and known to a wider audience due to Google's and Microsoft's advertisements, but also due to the success of the game Pokemon Go [Pok], which is played using a smart phone with GPS. The next Section highlights changes to furniture and layouts in office buildings, Section 3 shows new possibilities for disaster management in buildings, e.g., fires.

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2 Floor plans and room division in modern office buildings

In the last decades, the concept of cubicles (see Fig.1) enforced the uniformity of workplaces, but they also brought some drawbacks, some of them of psychological nature: The employees were alone in their (tiny) cubicles, but in most cases the sounds coming from neighboring cubicles still distracted the worker. The idea was to be able to see neighbors when the employee stood up, but be alone and mostly undisturbed when seated. However, some studies suggest that sitting with an unshielded back (i.e., with the back to the entrance to the cubicle) and deprived of sunlight makes employees depressed [Fr15].

Fig. 1: Cubicles (from [P1])

New ways of arranging desks in open-plan offices led to much more relaxed and roomier work spaces (see Fig.2). This of course brought more noise distractions but helped have a better working atmosphere due to better contact to co-workers [BCK02].

An even roomier arrangement of desks came up a few years ago when the hard connection between a worker and his workspace was cut; any worker can use any workspace and thus change the views and neighbors easily. This was possible due to the finally indeed mostly paperless office; most work activities are carried out at the computer and thus the exact location of the desk of it is not important anymore: All data is not read from files on desks but located on screen, anyway. However, personal memorabilia have to be cleared away at the end of the day in order to potentially offer the work place to another employee the next day. In most companies the employees have

their own mobile file pedestal that can be moved to the desired work space or desk when commencing work.

Fig. 2: Open office space (from [P2])

Google, Facebook, Twitter and other big companies took yet another step. After some studies suggested that employees work much better if they are happy and relaxed, they changed the layout of their employees' offices completely (see Fig. 3a and Fig. 3b, more examples can be found at [OSn). The reason is to make the worker *like* to work in the office and spend time there. If an office resembles a lounge, the boundaries between work and leisure become blurred. Moreover, if relaxation opportunities area available at the work place (such as couches, swimming pools, or even specifically hired massage staff), there is no real need to leave early to get home. In this context, the term "bleisure" is spreading, which is a combination of "business" and "leisure" [Bu17].

The seemingly costly interior fittings help the employees feel welcome, refreshed, relaxed, and foremost, appreciated. In contrast, typical cubicle situations might more likely lead to depressed moods. The daily comic strips of Dilbert (drawn by Scott Adams) [Dil] often picks this out as a central theme.

Fig. 3a: Modern office space which resembles lounges at Twitter (from [P3a])

Fig. 3b: Modern office space which resembles lounges at Nokia (from [P3b])

Current trends now enable the worker to take the whole workspace with him, even

outside the building. This is possible by use of data glasses like the Microsoft HoloLens (see Fig. 4).

Fig. 4: Microsoft HoloLens (from [P4])

There is no need for a desk carrying a monitor, since all displayed data is visible in the holographic device. Only the problem of data manipulation (i.e., access to a keyboard or similar) is yet to be settled. In the near future, comfortable as well as functional chairs with a mounted keyboard and mousepad seem to be the realistic prediction. Later it might even be possible to interact more and more by gestures. Currently, this is still rather part of Science Fiction movies like “Minority Report” with Tom Cruise. A drawback of (prolonged) control by gestures might however be a certain fatigue resulting from the wide arm movements needed.

The idea of the new work space enabled by AR is as follows: The HoloLens or similar Augmented Reality device is able to augment the visible office space by additional items like furniture. When getting nearer, the texture being used is getting more detailed. This can be used to create virtual displays drifting in mid-air which can display anything – the only limiting factor might be the maximum resolution of the AR device being used.

If more virtual display space is needed, e.g., if bigger tables, more data or more windows are to be displayed, it can be created in any free space around the user. This way the user could sit in a circle of displays or even one display encompassing 360 degrees. Furthermore, the space above and below the typical display location can be used to create even more space. However, the typical user will be ready to use only a specific part of his vertical field of vision. Higher or lower parts could only be seen when the user turns his head up and down. The effect would be similar to a video wall (see Fig. 5), but equidistant to the user, and of course invisible to bystanders.

The fact that augmented displays are only visible for users in the same virtual context. Thus different users can reuse the space between them, creating effectively overlapping displays which are not visible to the other.

Fig. 5: Video wall at CES2012 (from [P5])

Surprisingly, this idea was already suggested in 1965 by Ivan E. Sutherland [Su65]. His first prototype which was built in 1968 is depicted in Fig. 6.

A still futuristic step further would be the use of contact lenses instead of a structure worn in front of the eyes like glasses. This would make the use of AR devices be almost invisible to other people and would relieve the user from the currently heavy weight of devices like the HoloLens with can lead to neck pain. However, work seems to be already ongoing: Samsung already applied for a patent for a smart contact lens that puts an embedded display and camera directly in front of the user's eyeballs in 2016 [Sa16].

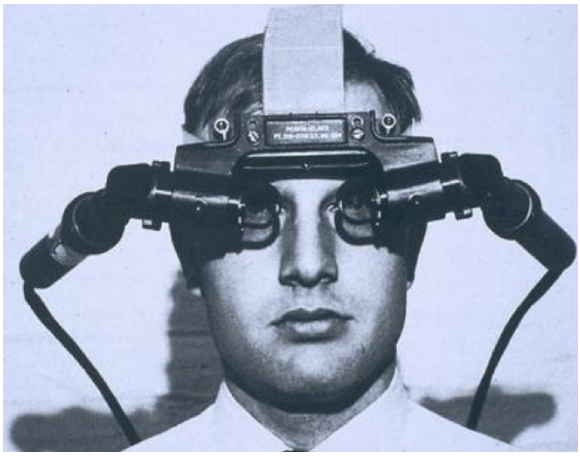

Fig. 6: Sutherland's Sword of Damocles (from [Su65])

3 Firefighter support by use of building automation

In case of a fire or similar catastrophe in a public building the building control system can help the firefighters immensely by giving crucial information. This can consist of floor plans, data about currently unused rooms (which therefore do not have to be checked for victims) [TKO15], or indoor navigation (to show the quickest way to the fire or victims). Furthermore, automatic unlocking of doors on the firefighter's way are very helpful [HM16].

One of the main problems however is the possibly degraded functionality of the building's systems due to the fire: Sensors or actuators might have been destroyed, and even the central control system might have been damaged. This demands for different damage detection and/or prevention schemes. Redundantly installed sensors could for example replace each other in case some get destroyed in the fire. If all sensors are unavailable the detection has to be done by other means, possibly by the firefighter (or his equipment) himself.

The use of augmented reality can help the firefighter immensely. The idea is to download a floor plan or plant layout of the building and then visualize the way (see Fig. 7). This can be achieved by displaying information such as

- The location of the origin of the fire
- The location of possible victims to be rescued
- The location of the water connections to a standpipe
- Currently blocked (crumbled or on fire) passages
- The (temperature) condition of rooms behind closed doors
- The way (like an indoor GPS) through possible mazelike building layouts
- The way to nearest safe exits to be used when a victim is being rescued
- Etc.

Indoor GPS is a topic of many research activities, such as [GKP16,MHJ12]. The results are already promising.

Apart from displaying crucial information to the firefighter the device can be in wireless contact to the outside in order to exchange information about

- The current location of the firefighter
- The current field of view of the firefighter (by adding a camera)
- Near doors that might be locked and be remotely unlocked in order to be opened by the firefighter
- Frequent updates of the current fire situation
- Frequent updates about other firefighters in the building
- Etc.

Fig. 7: Google-Glass-based data injection, in this case a floor plan (from [FC14])

The mentioned data can be read, processed, filtered, and refined for the firefighter in order to provide him with only the currently needed data. In hectic situations such as fires the presented and displayed data needs to be concise, helpful, and foresighted.

These technological possibilities are still in early stages. However, in some years or decades the firefighters all over the world will have a radically changed work situation and have to be trained accordingly.

4 Conclusion

The use of augmented reality (AR) devices is getting more and more common, partly because of AR games like Pokemon Go, and it offers many interesting fields of application in the area of buildings.

In this paper possible scenarios in the area of modern work places were highlighted, namely future office work places replacing common work desks and computer installations as well as future rescuers' (taking a firefighter as an example) styles of work.

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