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MASTER OF SCIENCE THESIS

Augmented reality goggles in robotic applications

Zastosowanie okularów rozszerzonej rzeczywistości
w aplikacjach robotycznych

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Chapter 1

Introduction

Robots become more an more often seen in our environment. Starting from nowadays standard industrial applications and ending on home appliances robots. They all have more or less user friendly interface created to programm or control them. In factories can be seen most often stationary or handheld controllers and in consumer appliances, smartphone almost every time is used. Problem is that, this kind of interaction is not natural for humans. For comparison, communication between two employes working together is mostly done by voice, gestures and sometime touch. That is why modern controllers should been using these. This could improve a way of interaction on human-machine level.

A few years ago, a revolution called Industry 4.0 began which most important statement was to not replace peoples in factories by machines, but allow them to cooperate at production line. From that time companies are trying to simplyfy teaching process of robots and give them ability to sense the changing environment. Also enhancements are done on the other side. Employees are equipped with many solutions with are extending they perception. This is allowing to get better undersatnding what machines are doing or even see what they are "thinking".

1.1 Purpose and scope of work

This thesis will focus on Augmented Reality and they ussage in modern factories and research facilities. At the beginning, different types of AR technologies will be compared to give overall view on how this is working. Then industrial or commercial products which are available right now on the market will be presented. The last part of topic studies will try to present selected solutions with are already used in real world applications.

Research part of this thesis will try to present simple examples of implementation AR in robotic applications. The topic will cover the issue of planing movement of robotic arm and also controlling and presenting data from mobile robot. This should give more or less understanding what this technology is capable and whats are its current limitations.

Chapter 2

Introduction to Augmented Reality

The perception of our surroundings is made to a large extent by the organ of sight. Thanks to that we are able to navigate and operate in our real environment. But what if we will try to trick him by placing displays in front of our eyes? Depending on content generated by computer it could simply show some additional information or create ilusion of being completely somewhere else. To distinguish types of immersion the concept of a "Reality-Virtuality Continuum" was created. It graphical representation is shown on figure 2.1.

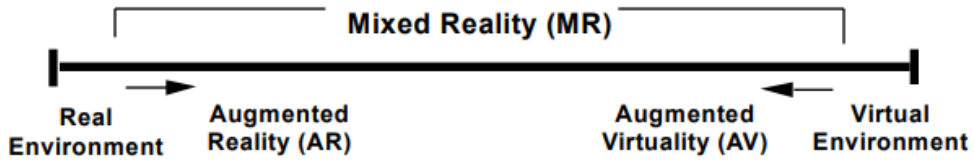


Figure 2.1 Reality-Virtuality (RV) Continuum {fig:RVCont

On the most left side of this line there is our real environment with real objects in no way disturbed by computer graphics. On the other hand on the most right side there is Virtual Reality with fully 3D generated world that could even in example not holding known by us laws of physics. Between two of those is everything with is mixing one part with another. Depending on what balance is, then we will talk about Augmented Reality or Augmented Virtuality. For example when there operator is getting some simulated cues to augment his natural feedback then it is AR. When in virtual world appears some real life objects or persons then it is called AV. Good example for that are modern news where reporters are working at green screen and in television they appear in 3D generated studios. As this paper will only discuss topic of using Augmented Reality in robotics applications that is why technical aspects of Augmented Virtuality or Virtual Reality will be not considered.

2.1 Technology overview

AR devices can take many different forms but way of processing data is almost always the same. In the simplest way it could be explained as following process. First device need to capture an image and localize itself or the user in environment then mix those data with CG objects and at the end display them on a screen. Figure 2.2 presents this pipeline in graphical form with few additional steps.

Figure 2.2 Simplified AR pipeline

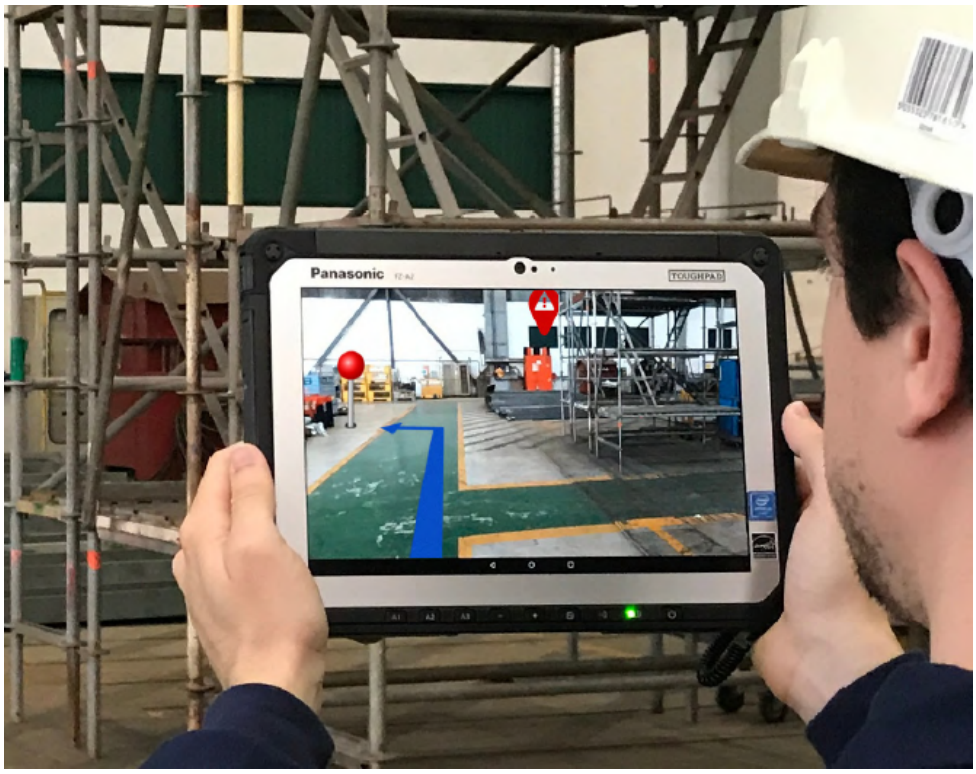
{fig:ARpipe

This section will show different types of technologies with where used at implementation of individual elements of this process.

2.1.1 Types of image projection

There is several way of displaying virtual objects in our environment. Depending on its type they could be more or less immersive for the user.

The most popular and the simplest types of projection is video-mixing. It involves the usage of devices equipped with a camera and standard display to present AR content. In most cases smartphones or tablets are used because they have built-in every needed component and they are very portable. Figure 2.3 present example of such projection. The great advantage of this approach compared to others is that you can use one device in cooperation with other people, which could result in a significant reduction of operating costs. The disadvantages should be mentioned that the employee is not able to observe the environment and use both hands to do his job. Therefore, this type of projection is most often used in devices used to supervise the operation of machines.



g:tabletAR}

Figure 2.3 Worker using tablet as video-mixing device

Second type of projection is slightly different than first one. It is called spatial display. In this case virtual objects are shown directly on real environment surfaces by usage of digital projectors. It could be realised on two way. We could have handheld device with will work similar to flashlight or stationary mounted projector.

2.1.2 Positioning and location

2.1.3 User control and interaction

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Chapter 3

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Chapter 4

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