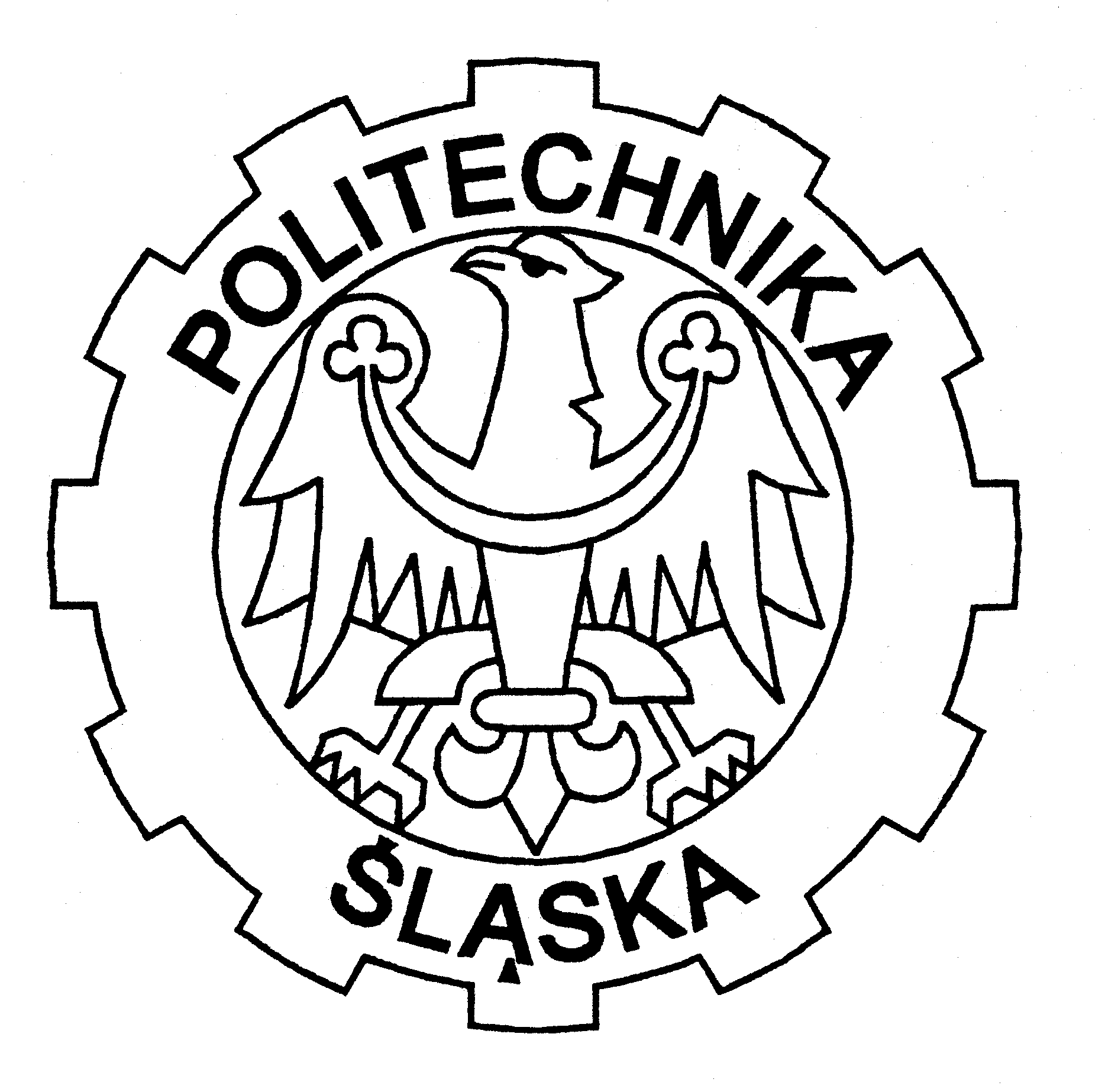
The Silesian University of Technology

– Faculty of Automatic Control, Electronics and Computer Science –



**Master Thesis**

Interactive business cards based

on Augmented Reality idea

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**Chapter 1**

# Introduction

Perception can be certainly considered as an essential factor of human life. Every information about the environment we are living in is received by our senses. Despite of human body imperfections people always tried to improve their perception skills and their inventions helped to find new ways to explore and understand the surrounding world. Augmented Reality idea introduces a new dimension of perception and opens vast new possibilities that will aid nearly every area of human life.

## Problem Definition

In fundamental terms, the Augmented Reality, often abbreviated to **AR** is an area of Mixed Reality that refers to the real-time view of a physical world which is augmented by elements generated or triggered by a computer input and can be considered as the connection between the real world and the virtual one. Given real subject image captured by a camera is processed and combined with virtual layers (such as graphics, sounds, data and even smells which are triggered by computer input).

Most common definition was created by Ronald Azuma which described it as follows: “Augmented reality is an environment that includes both virtual reality and real-world elements. For instance, an AR user might wear translucent goggles; through these, he could see the real world, as well as computer-generated images projected on top of that world.“.

Augmented Reality is commonly mistaken with Virtual Reality, hence to provide better understanding of Augmented Reality the Paul Milgram’s Virtuality Coninuum graph (Figure 1.1.1.) should be introduced to show the general classification of Mixed Reality areas.

**MIXED REALITY(MR)**

**VIRTUAL  
ENVIRONMENT**

**AUGMENTED  
VIRTUALITY (VR)**

**AUGMENTED  
REALITY (AR)**

**REAL  
ENVIRONMENT**

*Figure 1.1.1. Paul Milgram’s Virtuality Continuum graph.*

Nowadays technology based on Mixed Reality is rapidly developed and distinct boundaries of each area is impossible to define. However to remark the main differences between them each one can be described by a short definition and unique features:

* Real environment- view of the real, physical world as it can be perceived directly.
* Augmented Reality(AR)- real world view augmented by a computer- generated inputs which create a possibility of interaction.
* Augmented Virtuality(AV)- virtual space view augmented by a real world inputs most commonly used for Human-Computer Interaction(HCI).
* Virtual Reality(VR)- fully simulated world view which provides environment elements controlled by a real world input.

## History

Augmented Reality in form which is known nowadays was imagined as a technology of the future since the first computer was designed. People could observe multiple applications of AR in science-fiction movies but did not know that this concept was already researched. Rapid development of AR can be noticed within last 10 years and is commonly considered to be the one of the inventions of XXI century.

This belief is incorrect as the beginning of AR is dated for 1962 as Morton Heilig created a bicycle simulator called Sensorama based on multimodal (multi-sense) technology. The machine could provide stereoscopic 3D vision in wide-angle view, body tilt, stereo sound and even wind tracks and smells triggered as the film was displayed. As nearly all senses were involved during the simulation Sensorama gave the general idea of Augmented Reality which was developed further using the computer.

Ivan’s Sutherland invention of the first head-mounted display named Sword of Damocles in 1968 was the next mile step in AR history. Allowing to see computer-generated wireframe rooms according to user head position it gave the background for user interaction with virtual world.

In 1975 Myron Krueger established artificial reality laboratory called Videoplace. Based on cameras, projectors and computer hardware it created an interactive artificial environment for the first time.

These inventions aroused interest of Augmented Reality and from this point it became a popular subject of studies and computer science research. In 1989 Jaron Lanier coined the ‘Virtual Reality’ phrase by leading the company that sold VR goggles and gloves. In 1990 Tom Caudell an aircraft manufacturer popularized ‘Augmented Reality’ phrase.

1994 introduced Paul Milgrim’s Vrtuality Continuum concept (Figure 1.1.1.) and classified Augmented Reality as an area of Mixed Reality specifying it’s boundaries and unique features.

In 1996 Jun Rekimoto presents 2D matrix markers (square-shaped barcodes), one of the first marker systems to allow simultaneously identify real world objects and estimate their coordinate systems.

Commonly known definition of the Augmented Reality term and it’s field was defined by Ronald Azuma in “A Survey of Augmented Reality” in 1997.

The release of the ARToolkit- open source computer vision tracking library developed by Hirokazu Kato at the HITlab was the real milestone for the AR research. It began new wave of interest among developers and opened a new possibilities of AR programming.

The first game based on Augmented Reality concept “ARQuake” was developed in 2002 and started by it’s inventor Bruce H. Thomas. It provided outdoor first-person shooter based on virtual environment generated upon real world captured images.

ARToolkit was redesigned and ported to Adobe Flash (FLARToolkit) by Tomohiko Koyama (Saqoosha) in 2009 bringing Augmented Reality to web browsers and starting a new trend wave of web- based AR applications.

Augmented Reality technology is rapidly developed nowadays for variety of platforms starting with personal computers through mobile devices and ending with touch screens and technical aparatures.

## Applications

Gdzie mozna zastosowac augmented reality

Augmented Reality idea provides variety of new possibilities

## Requirements

- Main detection algorithm written in C++

- High accuracy marker recognition

- Real- time image processing (min 12 FPS)

- Image and video display

- Graphical User Interface

**Chapter 2**

# Augmented Reality problem analysis

W jaki sposob zwykle implementuje sie augmented reality:

## Video capture

-Uzywanie tylko jednej kamery i jej kalibracja.

-Uzywanie dwoch kamer do stworzenia wirtualnej rzeczywistosci 3d

## Marker detection

- Marker tracking na podstawie template’a

- Wykrywanie kwadratu i template’a

- Wykrywanie znakow szczegolnych- kolory

## Square detection

- 3 thresholding methods + contours + approxpoly

- Canny contour finding + Hough line finding + approxpoly

**Chapter 3**

# Project Design

## Library choice

Opis znanych mi bibliotek do tworzenia AR + historia ich powstawania + porownianie ich mozliwosci (plusy I minusy)- na koniec wybor OpenCV- dlaczego

## Development Process

Opis w jakis spoosb powstawal program – krotka notka o google code svn

## Project Algorithm

Pelny opisowy algorytm projektu + schemat blokowy

## GUI

Opis wyboru srodowiska do tworzenia GUI I krotki opis jego powstania

**Chapter 4**

# Internal Specification

## Main program functions

Dokladny opis funkcjio uzytych w programie oraz rozwieniecie teaoretyczne + wzory przy kluczowych funkcjach (thresholding, homograficzna transforacja, podkladanie obrazu itp)

## Graphical User Interface

Dokladniejszy opis GUI I podzial na poszczegolne elementy.

**Chapter 5**

# External Specification

## ‘How to’ instruction

Instrukcja w jaki sposob uzywac aplikacji

## Errors handling

Opis najczestrzych errorow (np brak zaladowanego markera lub obrazka czy wideo)

**Chapter 6**

# Testing and results analysis

## Marker choice analysis

Porownanie roznych markerow I dokladnosci ich wykrywania

## Environment dependencies

Porowanie wynikow wykrycia markera dla roznych srodowisk (jasno, normalnie, ciemno)

## Threshold methods

Rozne metody thresholdu

## Displaying static image and video

Porownanie wyswietlania obrazkow I wideo

## Camera parameters

Wyniki dla roznych kamer (w laptopie, statyczna Logitech, creative social hd z autofocusem)

**Chapter 7**

# Summary

Krotkie podsumowanie calosci

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