

WROCLAW UNIVERSITY OF TECHNOLOGY

FACULTY OF ELECTRONICS

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INTERMEDIATE PROJECT

# Gesture recognition application based on NI LabVIEW software

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## Abstract

**Goals:** Main goals of the project were to develop a PC application for gesture recognition through a simple USB camera in real-time. The program runs under the NI LabVIEW software or as an executable Windows file.

**Assumptions:** The application should recognise at least 5 hand gestures which indicate chosen letters from the sign language alphabet. The algorithm should be resistant to any lighting changes, different sizes and shapes of users' hands and background patterns.

**Results:** As it is stated within this report, the main goals were reached. The application is capable of the gesture recognition in real-time. Nevertheless, some problems are still to be solved.

# 1 Introduction

The objective of the project was to develop a PC application for the sign gestures recognition in real-time with NI LabVIEW and Sony PS3 Eye camera.

## 1.1 NI LabView

NI LabVIEW is a professional development environment for graphical programming in a so-called 'G' language. This software is being used worldwide for creating hardware testing applications and for a precise control of dataflow when it is crucial. It is also popular in real-time operating systems.

Since the basic tools provided by the environment might not be enough in a professional use, NI LabVIEW brings also a set of additional libraries for advanced computations. For machine vision and scientific imaging applications, the National Instruments Corporation has developed an IMAQ Vision library (also referred as drivers for a hardware), which is a part of the Vision Development Module. To facilitate images processing, the NI Image Acquisition software and the mentioned drivers were used.

*To whom it may concern: this project was done under an official student license activated through the NI web page (<http://poland.ni.com/>) with the student email account (@student.pwr.edu.pl).*

## 1.2 Sony PS3 Eye camera

To capture a video, the Sony PS3 Eye camera was used. It is a digital camera, designed for the PlayStation 3; it's pixel resolution is of 640x480 and maximum video frame rate equals 60 Hz.



Figure 1: Sony PS3 Eye camera.<sup>1</sup>

To communicate with a PC, the camera uses a USB 2.0 standard.

# 2 Gesture recognition algorithm

The process of gesture recognition is mainly divided into three subsequent parts: image acquisition, pretreatment with pattern matching and results presentation. Each part will be discussed in this section.

## 2.1 Program structure

The program structure is presented in Figures 2 and 3.

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<sup>1</sup><https://upload.wikimedia.org/wikipedia/commons/8/80/PlayStation-Eye.png>

The NI LabVIEW programming language - G - consists of operational blocks, so-called VI's, connected with each other by the nodes. Each VI handles different procedure with one or more signals that are set on its inputs. Thus, we can distinguish simple VI's (such as signal summation, multiplication, etc.) and much more complex, which are designed for specific tasks. Moreover, there are also the constant blocks which generate a required value or signal on their output(s).

As it was mentioned before, the gesture recognition program is depicted in Figure 2.

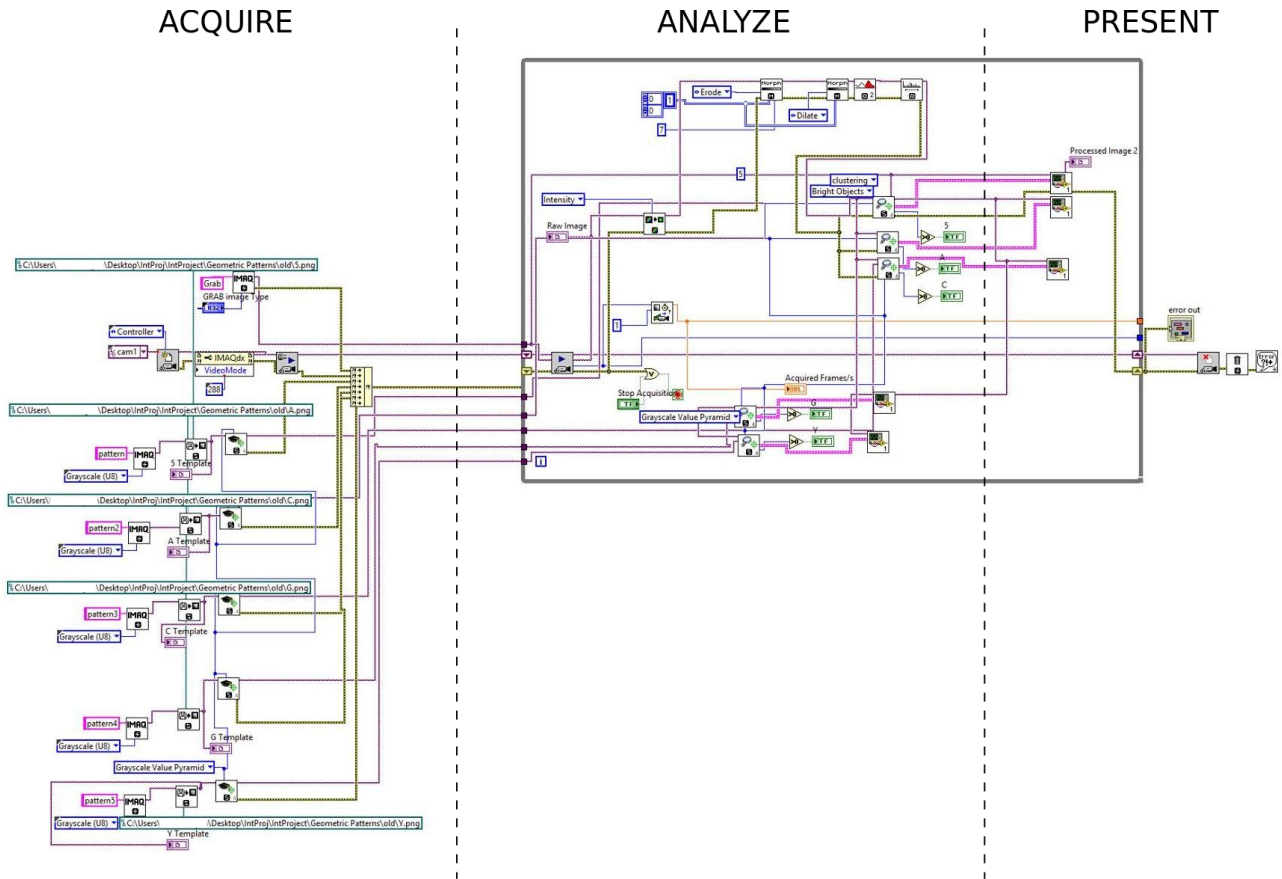


Figure 2: Image processing and gestures recognition algorithm.

The application is based on three main sections:

1. **Acquisition** - a data from the PS3 Eye camera is acquired, an image in IMAQ is initialized and the input parameters for pattern detection algorithms are set. Moreover an error cluster for all of the inputs is created.
2. **Analysis** - the raw image is processed using the following algorithm :
  - (a) Extract single color plane : Intensity
  - (b) Erosion
  - (c) Dilatation
  - (d) Automatic Threshold : Bright objects focus
  - (e) Equalization

On processed image we apply pattern detection algorithm (Grayscale Value Pyramid). When a gesture is detected we overlay a bounding box around it and view the matching score next to it.



The GUI is divided into 3 main sections:

1. (LEFT) Gesture templates and recognition indicators. Each gesture's template is shown in order to inform a user which patterns are possible to be matched. Furthermore, the diode indicators take one of two possible color states:
  - *yellow* - the gesture was not detected,
  - *green* - the gesture was detected.
2. (MIDDLE) Raw and processed images displays.
  - *Raw Image* - displays a raw, unprocessed images (video) from the PlayStation PS3 Eye camera,
  - *Processed Image 2* - displays a processed images (video), i.e. ready to be searched for pattern. If a pattern is found, the program draws a so-called 'pattern-matching' box, with a score value which represents the correctness of the match (it happens when a score exceeds a certain threshold).
3. (BOTTOM) Acquisition settings and an error indicator. Within this section, a user can start/stop images acquisition, select the threshold mode or grabbed image type. Moreover, the 'error out' field informs a user whether an error during the algorithm computation has occurred or not.

### 3 Results

Within this section, the results of gestures recognition by the developed application, are presented. Both successful and unsuccessful outcomes are discussed.

#### 3.1 Successful gestures recognition

The successful gestures recognitions are presented in Figures 5 - 9.

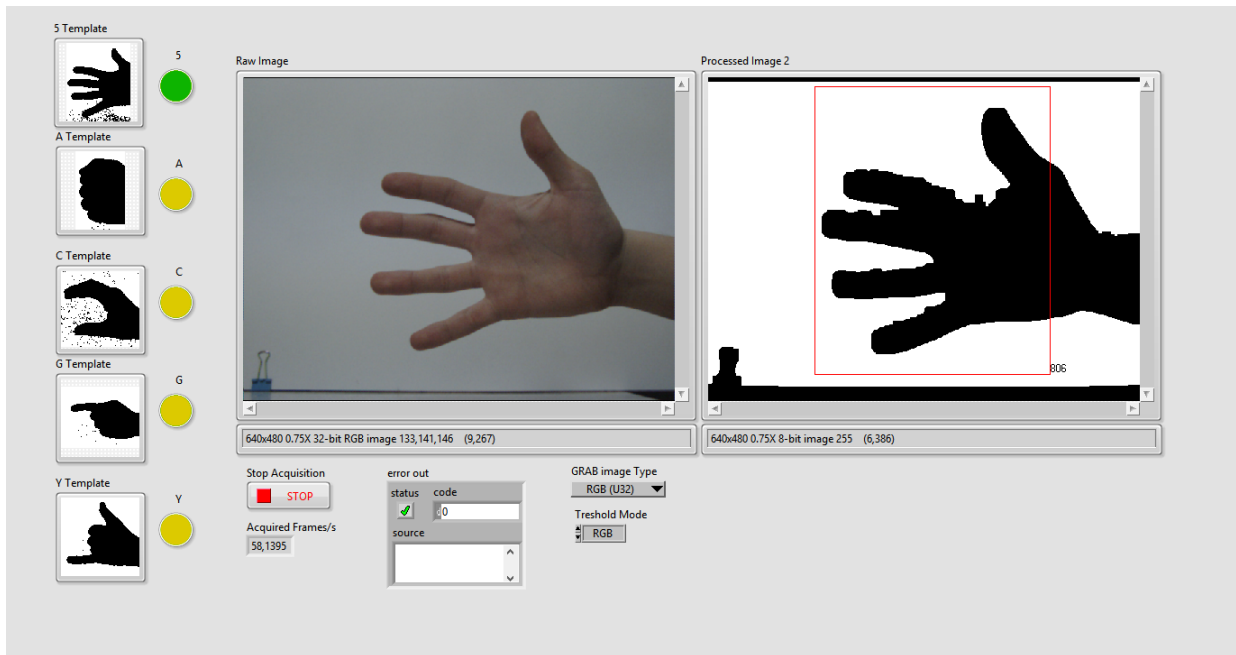


Figure 5: Number '5' successful recognition.

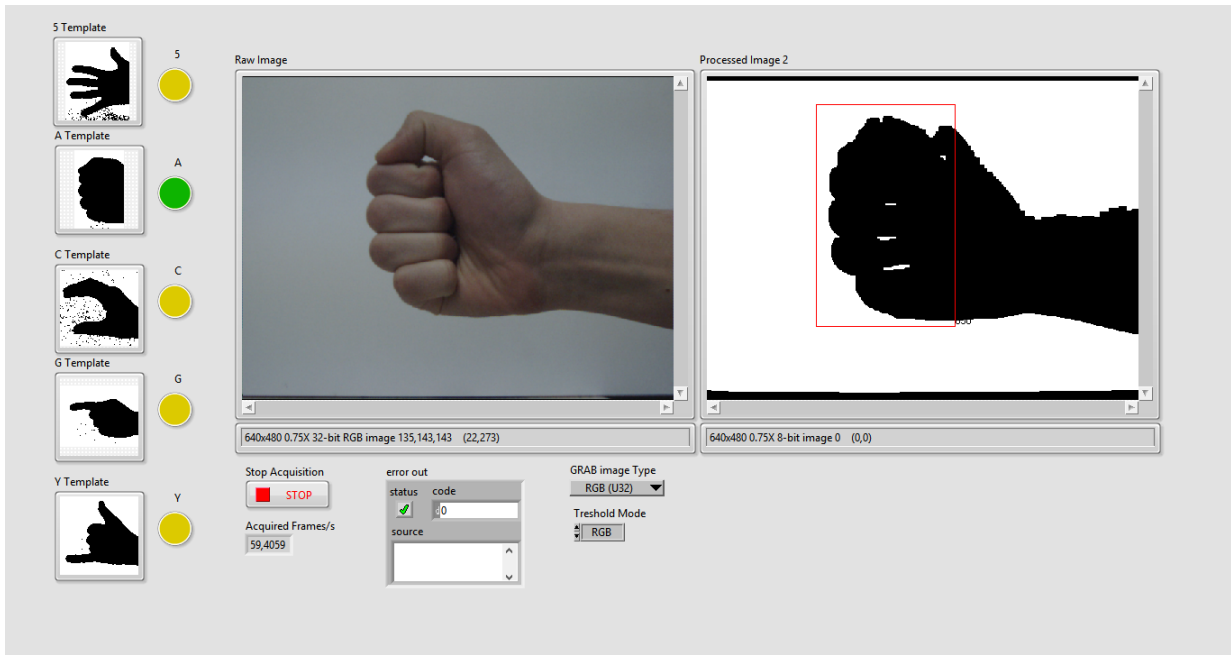


Figure 6: Letter 'A' successful recognition.

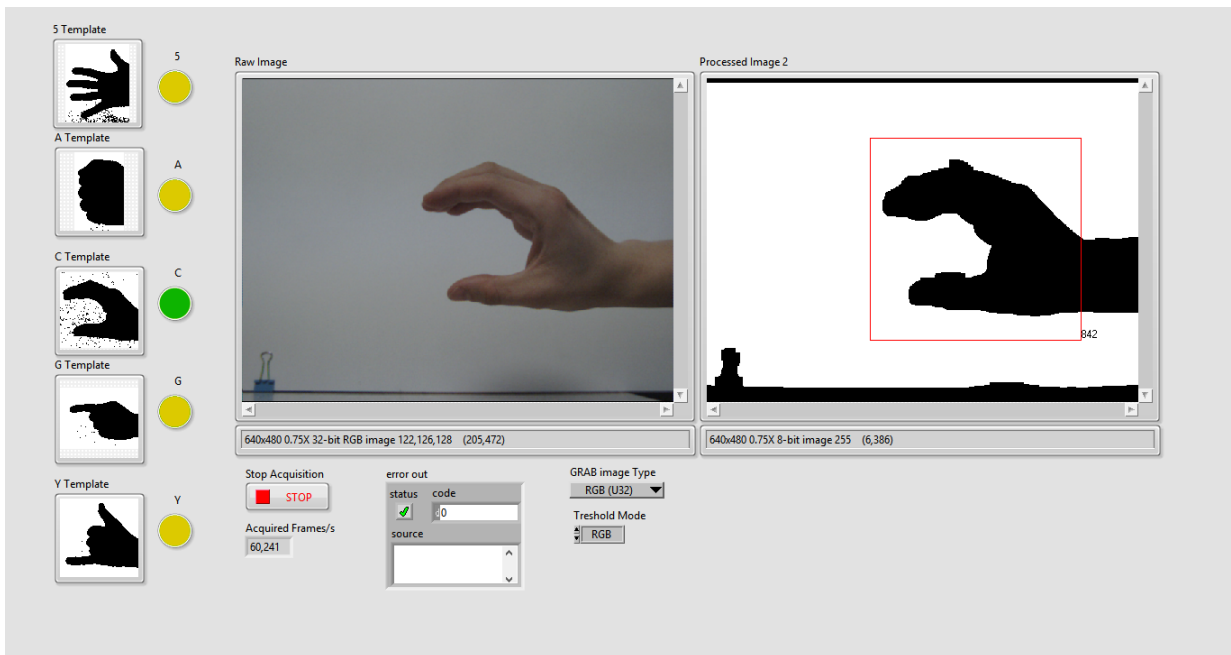


Figure 7: Letter 'C' successful recognition.

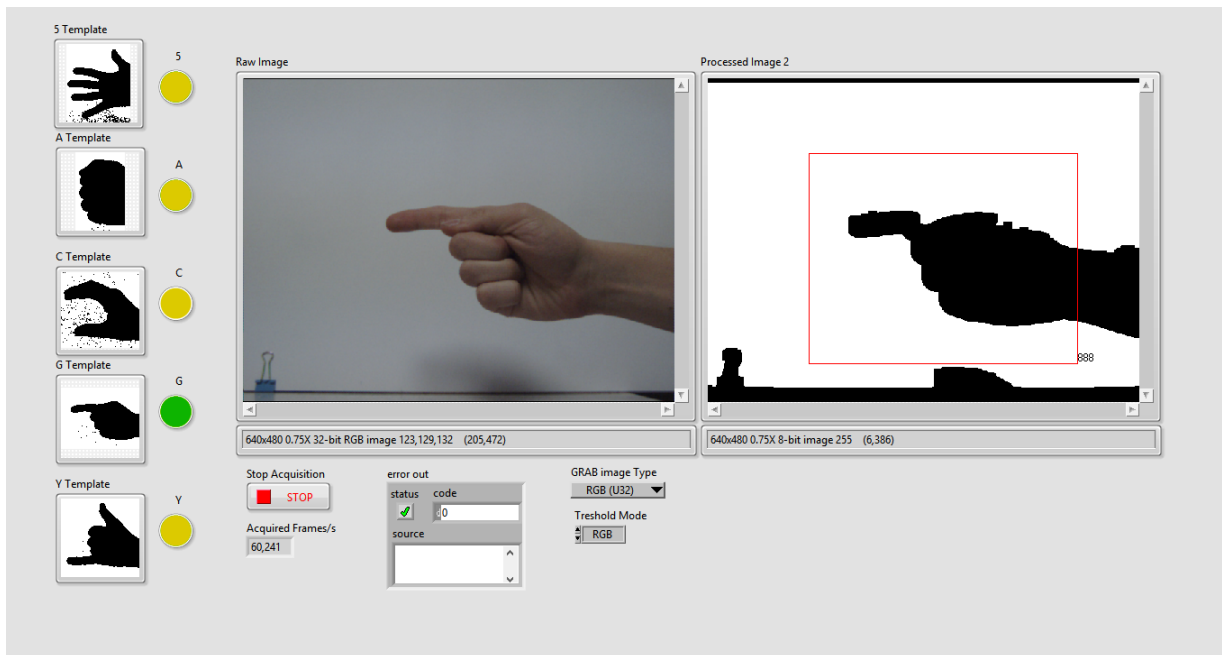


Figure 8: Letter 'G' successful recognition.

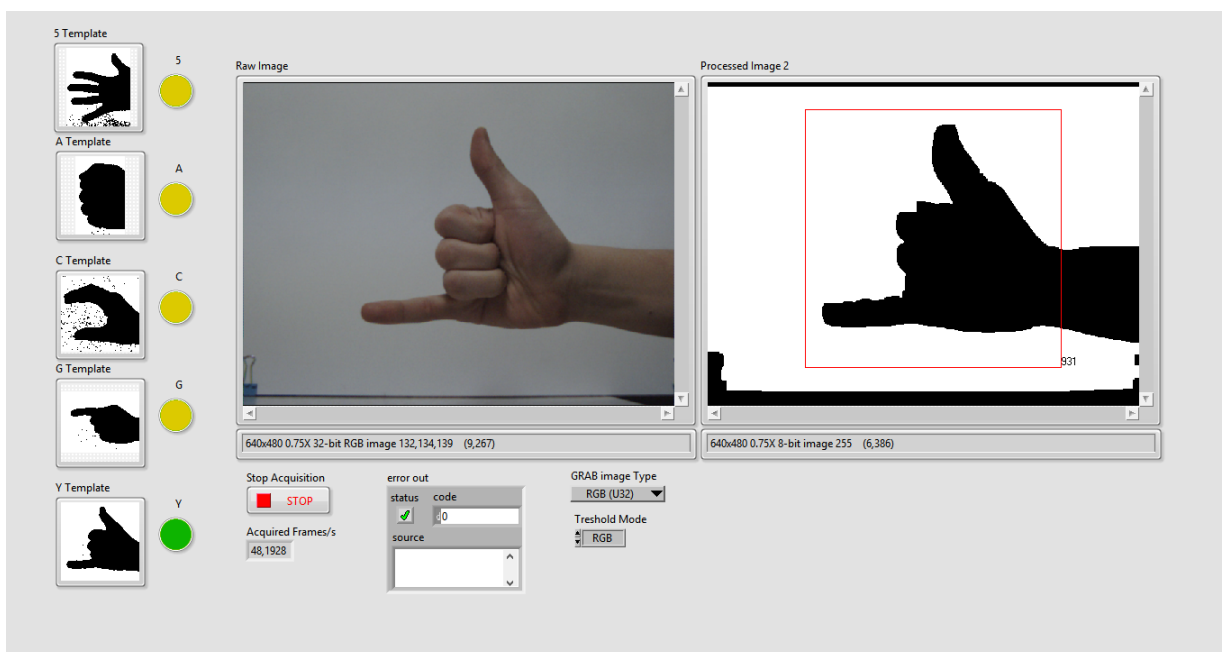


Figure 9: Letter 'Y' successful recognition.

### 3.2 Unsuccessful gestures recognition

The unsuccessful gesture recognition is presented in Figure 10. The application classified the gesture both as the letter 'A' and 'Y'. This happened due to the fact, that in order to provide a flexible gesture recognition, applied to different physical structures of users' hands, the threshold for each gesture must be sufficiently small. On the other hand, it cannot be too small; in such case no gesture would be correctly classified. It must be a compromise between the reliability and the universality of the application.



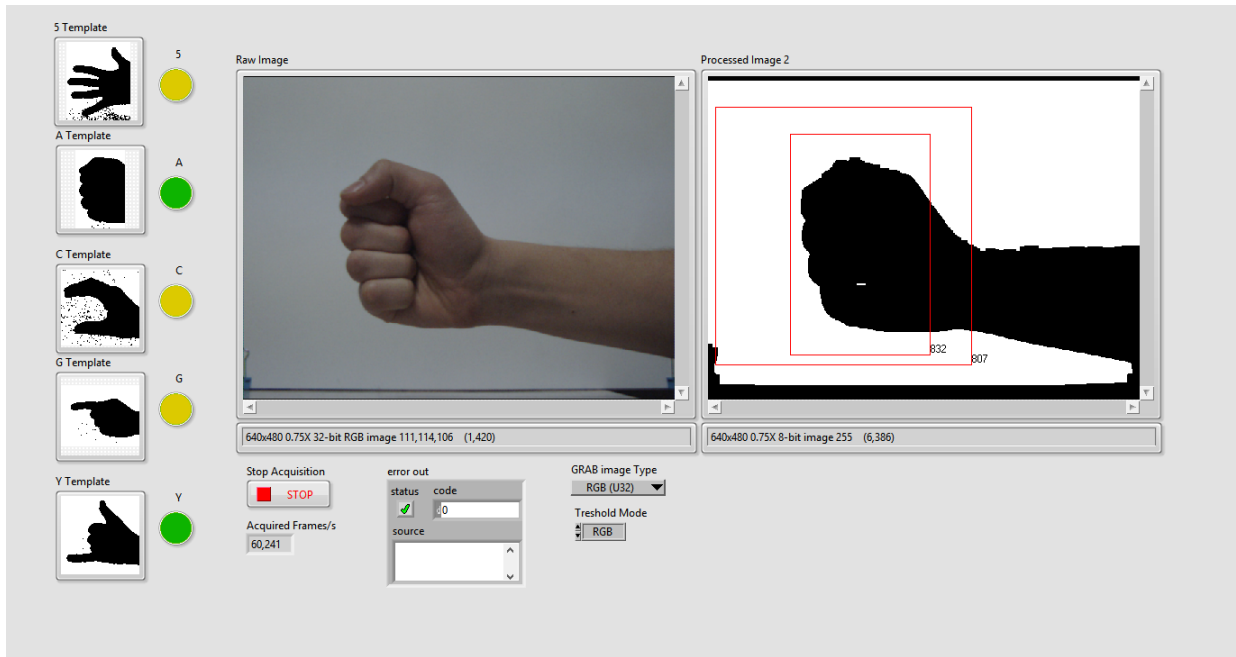


Figure 10: Unsuccessful recognition - double pattern.

## 4 Conclusions and summary

The gesture recognition problem is a complex task to be solved. There are many circumstances that must be taken into account while developing such application: lighting conditions, image background or differences in physical shapes of users' hands. Facing these problems, we can conclude that the results obtained by us are rather satisfactory.

We managed to distinguish 5 gestures from the sign language alphabet by the program. After a series of tests we found the compromise described in 3.2. Nevertheless, a user must be told how to correctly use the application in order to facilitate the recognition process.

Even though we have eliminated the lighting and the background problem by placing a white, uniform board behind a hand, there is still an issue that is only partially worked out: different hands shapes. To solve it, a geometric pattern matching should be applied. This algorithm allows to match a pattern for a scaled image. Nonetheless, its implication would require an additional time for the program development.

In the future this application can be modified to control the robot or be a part of a bigger detection system, since it implies a basic, universal operations for a pattern matching.

## 5 References

1. <http://poland.ni.com/>
2. <http://www.ni.com/vision/>
3. D.Devasena, P.Lakshana, A.Poovizhiarasi, D.Velvizhi, (2013) 'Controlling Of Electronic Equipment Using Gesture Recognition', International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-3, Issue-2, pp. 312 - 315.
4. Jianjie Zhang, Hao Lin, Mingguo Zhao, (2009) 'A Fast Algorithm for Hand Gesture Recognition Using Relief', Sixth International Conference on Fuzzy Systems and Knowledge Discovery, IEEE computer society, pp. 8-12.