

# Analiza stabilnosti konvolucijskih neuronskih mreža primjenjenih u klasifikaciji slika u svrhu detekcije neispravnosti proizvoda

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**Premec, Jasmina**

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UNIVERSITY OF ZAGREB  
FACULTY OF MECHANICAL ENGINEERING AND  
NAVAL ARCHITECTURE

**MASTER THESIS**

**Jasmina Premec**

Zagreb, 2016.

UNIVERSITY OF ZAGREB  
FACULTY OF MECHANICAL ENGINEERING AND  
NAVAL ARCHITECTURE

# Stability Analysis of Deep Convolutional Neural Networks for Image Classification

## MASTER THESIS

*Supervisors:*

Prof.dr.sc. Dubravko Majetić  
Dr. Michael Klar

*Student:*

Jasmina Premec

Zagreb, 2016.

*I declare that this thesis and the work presented in it are my own. I made this thesis utilizing knowledge gained throughout my studies and literature listed in this work.*

*I thank my family, parents Nina and Zlatko, brother Antun, for all their support throughout my studies.*

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*I thank Dr. Michael Klar for his guidance and support in making this thesis.*

*Jasmina Premec*

# Confidentiality clause

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## DIPLOMSKI ZADATAK

Student: **Jasmina Premec**

Mat. br.: 0035177163

Naslov rada na hrvatskom jeziku: **Analiza stabilnosti konvolucijskih neuronskih mreža primijenjenih u klasifikaciji slika u svrhu detekcije neispravnosti proizvoda**

Naslov rada na engleskom jeziku: **Stability analysis of deep convolutional neural networks for image classification used in detection of products with defect**

Opis zadatka:

Nowadays in scientific community most popular novel Machine Learning tool used for image classification are Convolutional Neural Networks (CNNs). CNNs have shown best accuracy in image classification, but it has been discovered that slight modification of images can cause "confusion" of CNNs. Images that have previously been classified correctly by CNNs get misclassified with extremely high confidence, although applied modifications cannot be visible to the human eye. In this thesis stability of Convolutional Neural Networks applied in image classification for defect detection should be addressed.

In this thesis following tasks have to be conducted:

1. Define at least three different Convolutional Neural Networks for stability analyses and present their architecture in detail.
2. Define strategy for stability analysis – define relevant image modifications, stability measure, stability plots.
3. Implement strategy in accessible mathematical software and Deep Learning Framework.
4. Evaluate stability of CNNs for at least three different datasets.
5. Identify unstable cases.
6. Evaluate different approaches to avoid unstable cases or improve stability for unstable cases.
7. Derive conclusions of the thesis.

Zadatak zadan:

29. rujna 2016.

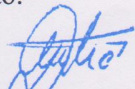
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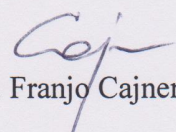
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# Sažetak

U industrijskoj primjeni automatske optičke inspekcije, jedna od metoda detekcije objekata koji sadrže neku vrstu kvara vrši se uzorkovanjem slika objekata te njihovom klasifikacijom. Klasifikacija se provodi korištenjem jednog od raznih algoritama koje za tu primjenu nudi područje strojnog učenja. U ovom radu, korištene su konvolucijske neuronske mreže, trenutno najpopularniji alat u području klasifikacije slika. U istraživanjima provedenim od strane znanstvene zajednice koja se bavi razvojem umjetnih neuronskih mreža ove vrste, otkriveno je da je moguće editirati sliku na način koji uzrokuje promjenu odluke konvolucijske neuronske mreže. Ovaj rad istražuje stabilnost konvolucijskih neuronskih mreža na pojave ove vrste u praktičnoj primjeni.

***Ključne riječi:*** detekcija kvara, industrijsko procesiranje slika, klasifikacija slika, strojno učenje, konvolucije neuronske mreže, ispitivanje stabilnosti