



Stichting NIOC

Stichting NIOC en de NIOC kennisbank

Stichting NIOC (www.nioc.nl) stelt zich conform zijn statuten tot doel: het realiseren van congressen over informatica onderwijs en voorts al hetgeen met een en ander rechtstreeks of zijdelings verband houdt of daartoe bevorderlijk kan zijn, alles in de ruimste zin des woords.

De stichting NIOC neemt de archivering van de resultaten van de congressen voor zijn rekening. De website www.nioc.nl ontsluit onder "Eerdere congressen" de gearchiveerde websites van eerdere congressen. De vele afzonderlijke congresbijdragen zijn opgenomen in een kennisbank die via dezelfde website onder "NIOC kennisbank" ontsloten wordt.

Op dit moment bevat de NIOC kennisbank alle bijdragen, incl. die van het laatste congres (NIOC2025, gehouden op donderdag 27 maart 2025 jl. en georganiseerd door Hogeschool Windesheim). Bij elkaar zo'n 1500 bijdragen!

We roepen je op, na het lezen van het document dat door jou is gedownload, de auteur(s) feedback te geven. Dit kan door je te registreren als gebruiker van de NIOC kennisbank. Na registratie krijg je bericht hoe in te loggen op de NIOC kennisbank.

Het eerstvolgende NIOC vindt plaats op 18 maart 2027 in Arnhem en wordt georganiseerd door HAN University of Applied Sciences.

Reacties over de NIOC kennisbank en de inhoud daarvan kun je richten aan de beheerder:

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Vermeld bij reacties jouw naam en telefoonnummer voor nader contact.

NIOC 2013

Ground-truth creation for end-user trainable machine vision systems

Applied to antibiotic disc print reading

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This research is part of a project for BD Kiestra

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- Computer Vision
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NHL University of Applied Sciences

Institute: Techniek

Department: Engineering

Center of Expertise Computer Vision

Bachelors

Information Science

Technical Information Science

Electrical Engineering

Mechanical Engineering



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Computer Vision

Automation of visual inspections



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Cameras



Area scan



Thermo



3D / Time Of Flight



3D / Stereo



BlueCOUGAR-P
Intelligent



Line scan



Surround

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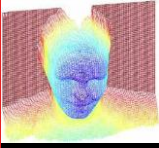
Images



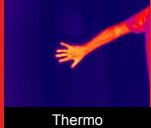
Surround



3D / Stereo



3D / Time of Flight



Thermo

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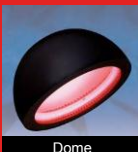
Lenses



Ringlight



Backlight



Dome



NHL Center of Expertise Computer Vision

Background:

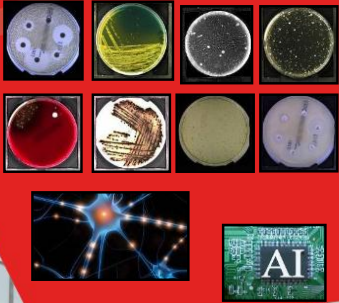
- Founded 1996
- 4,5 FTE
- 170 industrial projects, > 3.000.000 euro
- Course Computer Vision

Goals

- Extending knowledge and expertise
- Professional networks and market exploration
- Transfer of knowledge to companies
- Education



Microbiology

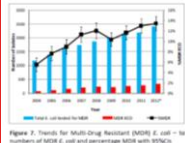


Microbiology

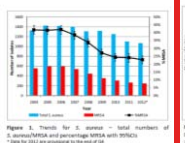


Pilot application

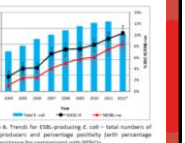
- Antibiotic Susceptibility Testing.
 - EARS-Net Report for Quarter 4 2012 [1]



Multi drug resistant (MDR) E. coli



Methicillin resistant Staph. aureus MRSA

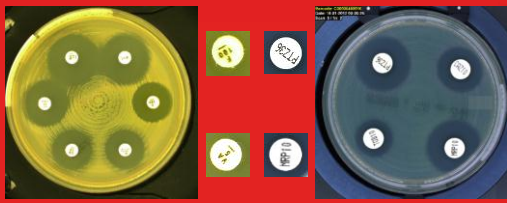


ESBL producing E. coli



Pilot application

- Antibiotic Susceptibility Testing:
 1. Diameter of circular zone determines antibiotic sensitivity
 2. Disc print determines antibiotic



Disc print reading is used as a pilot application

Blob matching demo



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Motivation / Problem definition

Domain expert != Technical expert

- Two strategies for automating classification applications:
 - Domain expert trained in technical knowledge
 - End-user software engineering (EUSE) [2]
 - Application Specific Language
 - Programming by Example
 - Visual Programming
 - Natural Programming
 - Technical expert trained in domain knowledge
 - Investigate demands
 - Software design
 - Train algorithms on ground-truth input

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Aims and Objectives

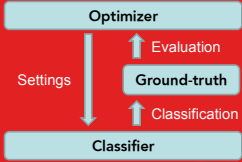
- End-user trainability
 - Minimize domain knowledge needed by technology expert
 - Minimize technical knowledge needed by domain expert
 - Maximize classifier's performance
- Roles
 - Technical expert: Limit the solution space by specifying *which* classification algorithm to use
 - Domain expert: Make a ground-truth to specify *what* the system needs to do
 - Artificial Intelligence: Find technical parameters evaluated using only the ground truth to determine *how* this is done.

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Optimization framework

- Classifier is used to classify objects
- Optimizer is used to converge to more optimal classifiers
- Ground-truth is used to evaluate classifiers

General framework:



```
graph TD; Optimizer[Optimizer] -- Settings --> Classifier[Classifier]; Classifier -- Classification --> GT[Ground-truth]; GT -- Evaluation --> Optimizer
```

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Rules for an end-user trainable machine vision system

- Steps by the *technical expert*:
 - Choose algorithms using the following criteria:
 - Few parameters, to limit possible solutions.
 - Robust, which limits dependence on parameters.
 - Heuristics, determine rules for setting the parameters.
 - Prior knowledge, to limit solution space.
 - For remaining parameters choose an optimization method with:
 - Few parameters and for all others use heuristics.
- Steps by the *domain expert*:
 - Create a ground-truth.
 - Entice the end-user, to minimize errors.

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Technical expert:
Disc print segmentation

- Robust



Original image

- Few parameters
- Heuristics



Hough circle Transform [3]



Local adaptive threshold [3]

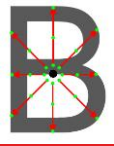
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Technical expert:

Disc print classification using the Blob Matcher

- Uses a single pattern as a model for the rest
- Exterior matching using the contour (less accurate, faster)
- Interior matching by sampling points (more accurate, slower)
- Matching error $e_{total} = e_{exterior} * f + e_{interior}$
- example: nr of rotations = 8
 fill sample size = 3

- Prior knowledge



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Technical expert:

Blob Matcher optimization using a Genetic Algorithm

- Optimization algorithm based on natural selection [4]

Mutate and Cross
blob matcher settings

Evaluate and select
best blob matcher

Current best

Blob Matcher
settings

- Few parameters

- Heuristics

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Domain expert:

Ground-truth creation using Surprise-Explain-Reward

- Making ground-truth more appealing:
 1. Tedious work
 2. Human error
 3. Inter-operator bias
 4. Intra-operator bias
- EUSE [2]
 1. *Surprise* end-user
 2. *Explain* what this means
 3. *Reward* the end-user

Entice the end-user

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Demostration ground tool

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Ground-truth creation using
Surprise-Explain-Reward

1. End-user specifies disc print annotation
2. Current partial ground-truth is used to propose annotation
 - Surprise
3. Classification becomes better while *in the process* of ground-truth creation
 - Explain
4. Less annotation has to be specified by end-user and ground-truth creation becomes easier
 - Reward

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Ground-truth creation using
Surprise-Explain-Reward

1. Tedious work
 - Becomes less tedious because end-user is helped
2. Human error
 - Is reduced because blob matcher is able to detect geometrically different disc prints
3. Inter-operator bias and intra-operator bias
 - Less prominent in this pilot application, because disc prints are not ambiguous

Prior knowledge

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Ground-truth creation using Surprise-Explain-Reward

- Proposed annotation is accompanied by a confidence from the blob matcher:
 - Proposed annotation has a high confidence
 - Annotation is automatically accepted
 - Proposed annotation has a low confidence and is correct
 - Annotation should be accepted by end-user
 - Proposed annotation is incorrect
 - Annotation is corrected by the end-user and single class optimization is performed on the incorrect class


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Ground-truth creation using Surprise-Explain-Reward

- Single class optimization:

```
min_error_sum = infinity
For a = 0 to count(patterns) - 1
  For b = 0 to count(patterns) - 1
    error_sum += match(patterns[a], patterns[b]).error
  End
  If error_sum < min_error_sum
    best = a
    min_error_sum = error_sum
  End
End
```

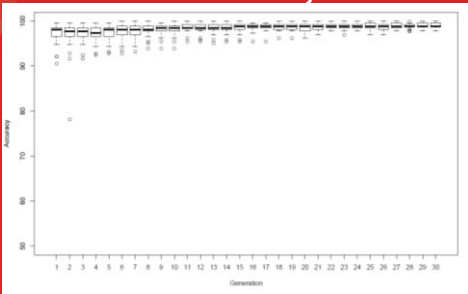



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Demonstration optimization


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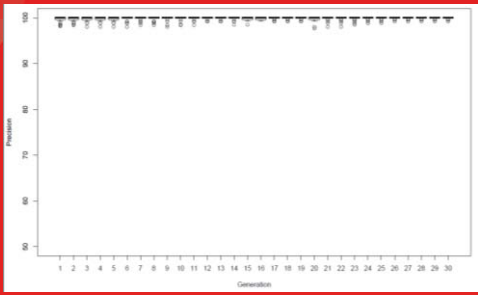
Results: Accuracy



37 different discs
17 samples per class
5 folds 5 repetitions


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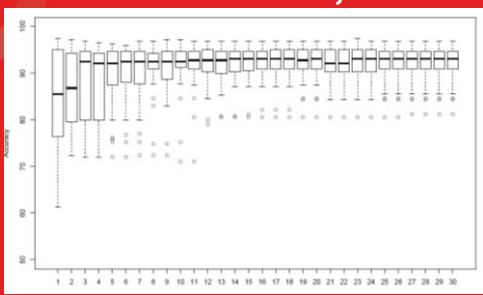
Results: Precision



37 different discs
17 samples per class
5 folds 5 repetitions

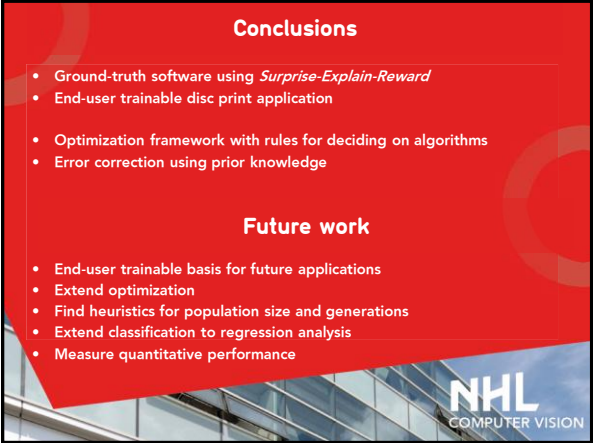
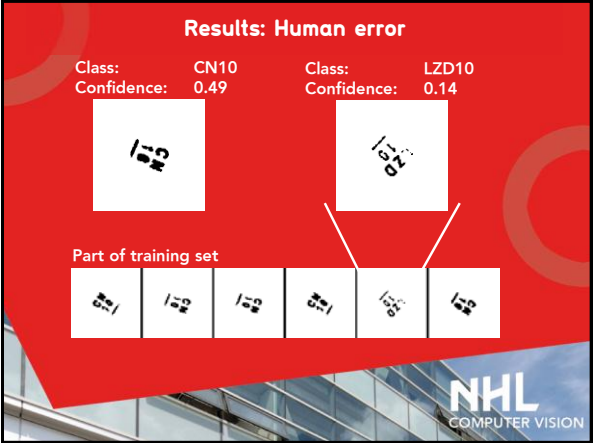
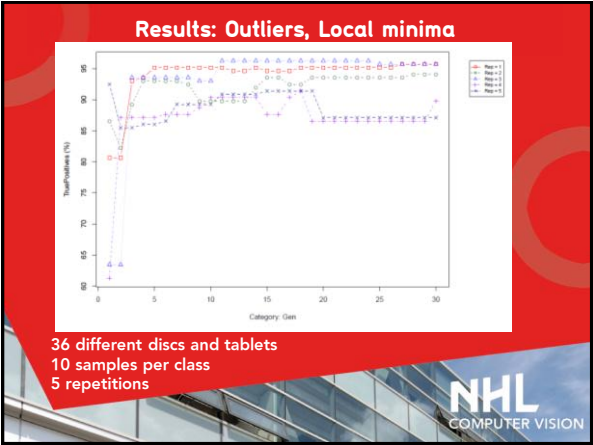
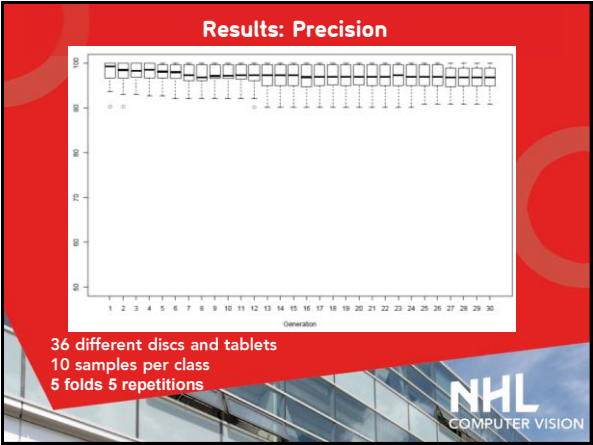

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Results: Accuracy



36 different discs and tablets
10 samples per class
5 folds 5 repetitions


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References

[1] European Antimicrobial Resistance Surveillance Network, 2012. *Report for Quarter 4 2012*. Health Protection Surveillance Center, Available at: <<http://www.hpsc.ie/hpsc/A-Z/Microbiology/AntimicrobialResistance/EuropeanAntimicrobialResistanceSurveillanceSystemEARSS/EARSSSurveillanceReports/2012Reports/File,13921,en.pdf>> [Accessed 3 April 2013].

[2] Ko, A. J., Abraham, R., Beckwith, L., Blackwell, A., Burnett, M., Erwig, M., Scaffidi, C., Lawrance, J., Lieberman, H., Myers, B., Rosson, M. B., Rothermel, G., Shaw, M., and Wiedenbeck, S. The state of the art in end-user software engineering. *Computing Surveys* 43 (2011).

[3] van de Loosdrecht, J. (2013), 'Course Computer Vision', Available at: <http://www.vlmv.nl/course> [Accessed 11 March 2013]. 2013

[4] Eiben, A. E. & Smith, J. E. (2007), *Introduction to Evolutionary Computing*, 2nd edn, Springer.

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