Towards Contagious Animal Disease Detection using Machine Learning

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Background

- Sensors are used increasingly in livestock farming for monitoring the production process (smart farming)
- Automated interpretation of large amounts of digital data by Machine Learning (ML) is becoming more and more common

Can sensor data be used for the automated monitoring of animal diseases?

Need for Animal Disease Monitoring

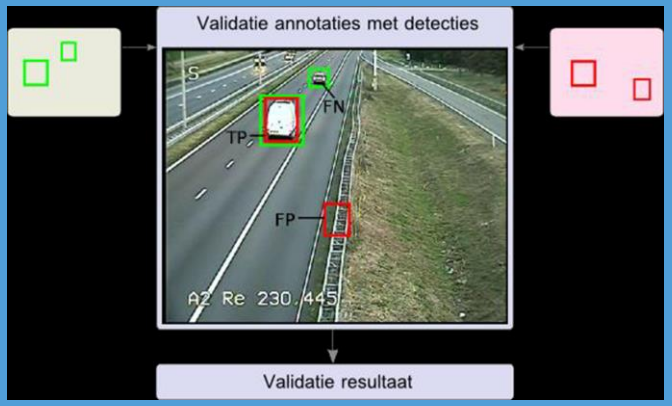
Contagious Animal Disease epidemics in the Netherlands

- Classical swine fever (CSF)
- Foot and Mouth Disease (FMD)
- Highly Pathogenic Avian Influenza (HPAI)
- Bluetongue virus (BTV)
- Q Fever
- Schmallenberg virus (SBV)

1997. CSF
1998. CSF
1999.
2000.
2001. FMD
2002.
2003. HPAI
2004.
2005.
2006. BTV
2007. BTV
2008.
2009. Q FEVER
2010. Q FEVER
2011. SBV
2012. SBV
2013.
2014. HPAI
2015.
2016. HPAI
2017. HPAI
2018. HPAI

Feasibility of Automated Monitoring

Smart Monitoring



Rijkswaterstaat

Inspired by the Neighbours

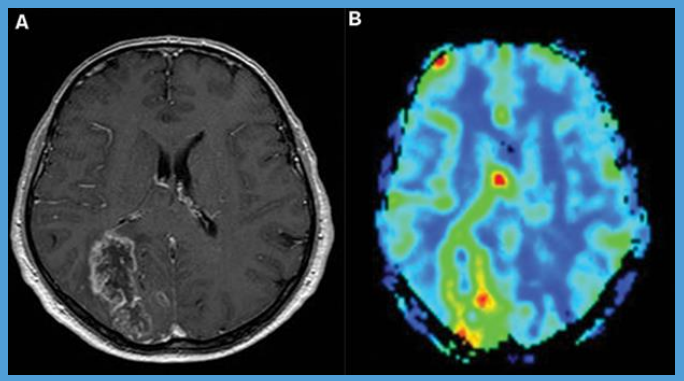
Plant Health

Blue River Technology

Smart Farming

Canadian telco Bell MTS

Human Health



Neurooncology

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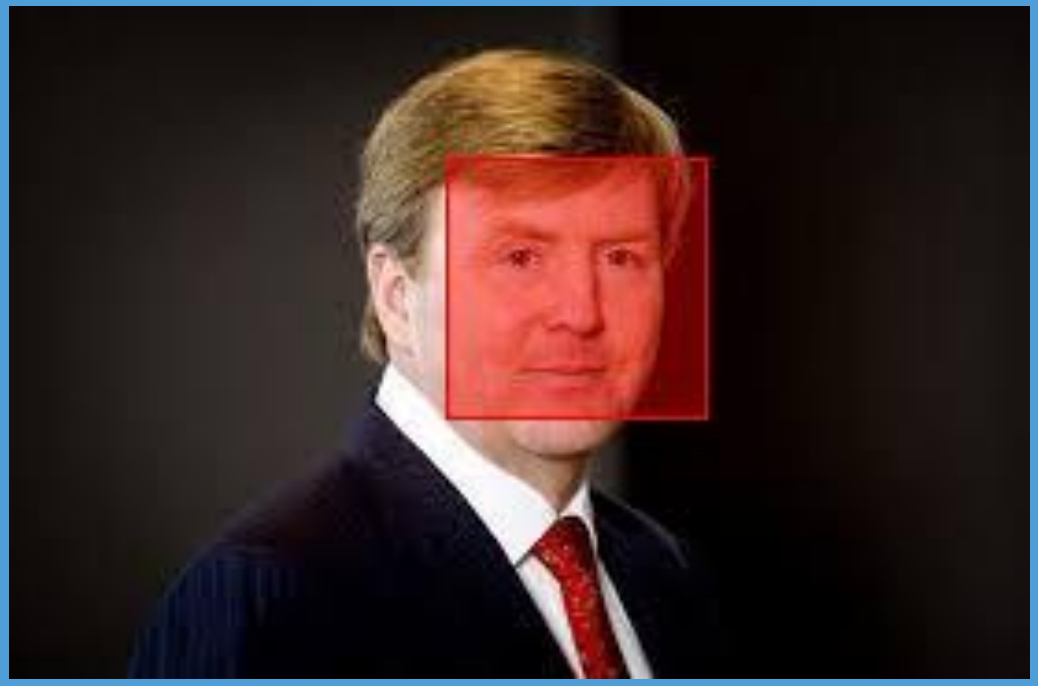
Availability of Easy to Use ML Software

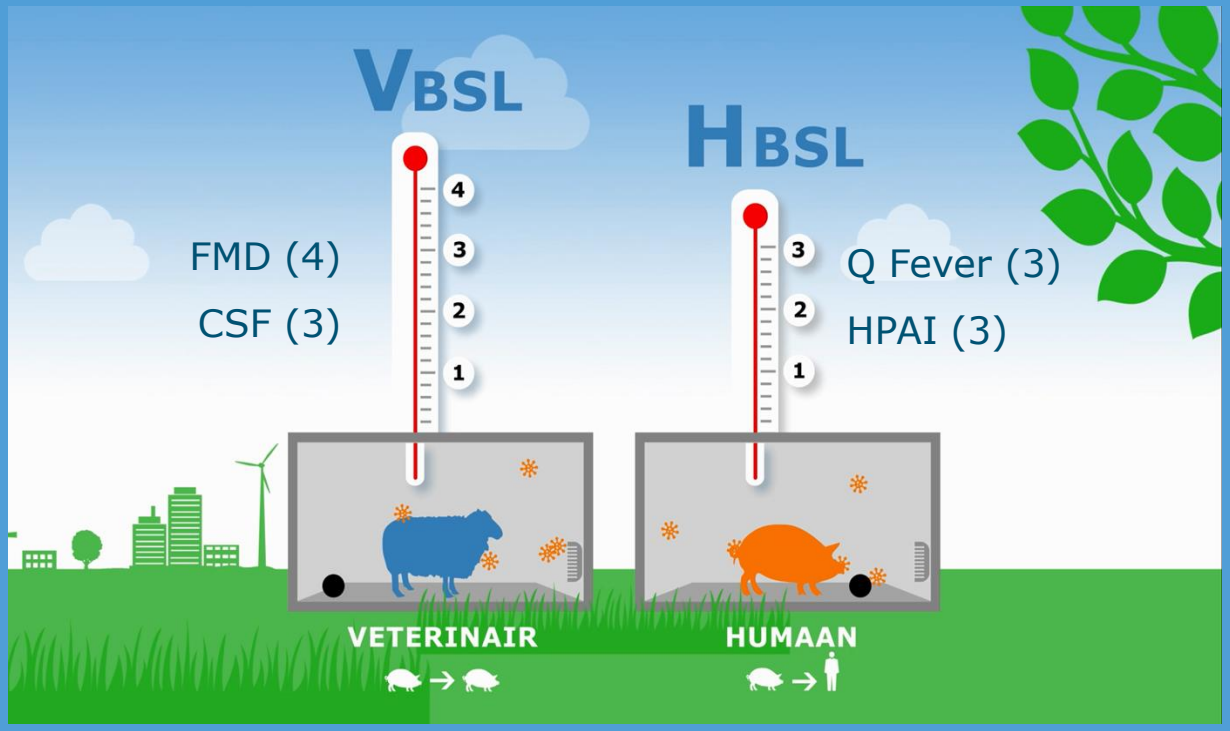


- Find Face
- Age Estimation
- Gender Estimation

Age: 47 (30-64)

Gender: Male (99.9%)

Feasibility to Monitor Animal Diseases



Contagious Animal Diseases can be investigated in the High Containment Unit of

WBVR in Lelystad

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Sensing Animal Disease

Syndromic Aspect	Sensor
Vision	Photo Camera
Movement	Video Camera
Sound	Microphone
Temperature	Infrared Camera
Smell	Electronic Nose

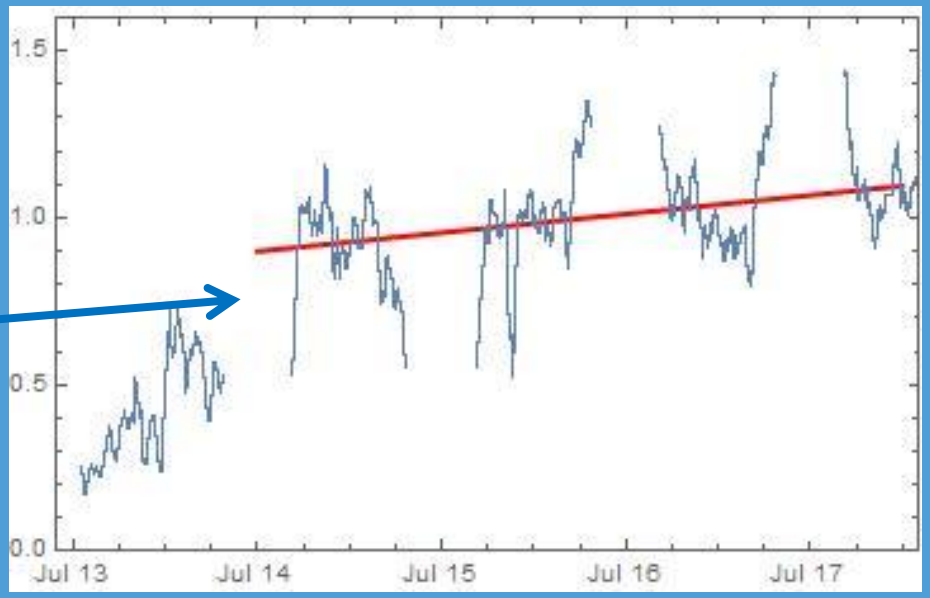
Sensing: Movement

- Input
  - video (Tinka Jelsma 13-17 July 2017)
  - Chicken Challenge experiment (at WBVR)
  - IBV (Infectious Bronchitis Virus)
- Methods
  - Dynamics of Animals (Optical Flow)
- Output
  - **Digital Animal Dynamics Diagnostics**

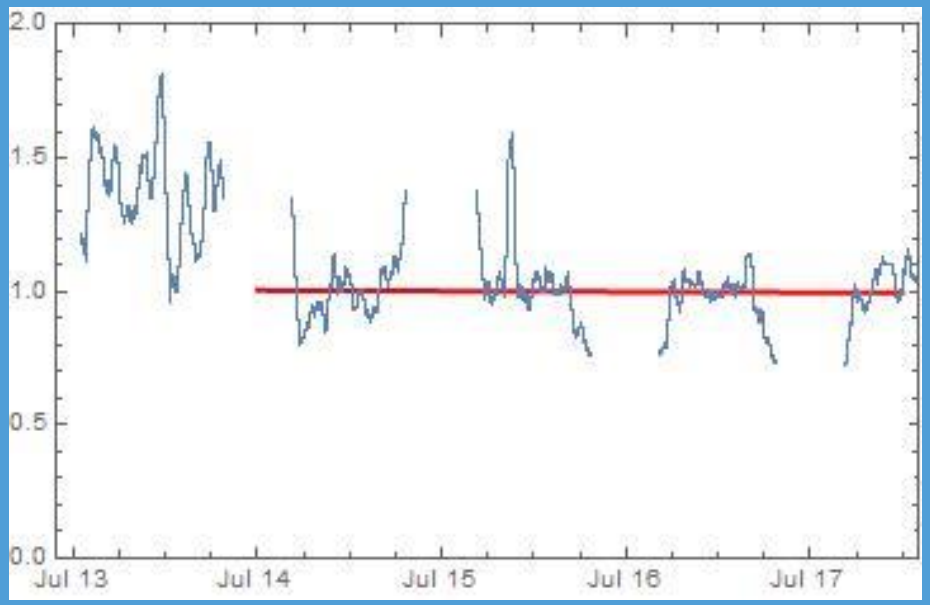
Movement Quantification

Mean group motion:
+5.5% per day

Start of the experiment



Inhomogeneity group motion:
constant



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Sensing: Image Analysis

- Input
  - Images (before and after infection) (Aldo Dekker)
  - Cattle (several experiments)
  - FMD (Foot and Mouth Disease)
- Methods
  - Image Selection by Image instance Query
  - FMD Detection by Classification
- Output
  - **Digital Diagnostic Test for FMD Cattle**

Image Selection

Cattle

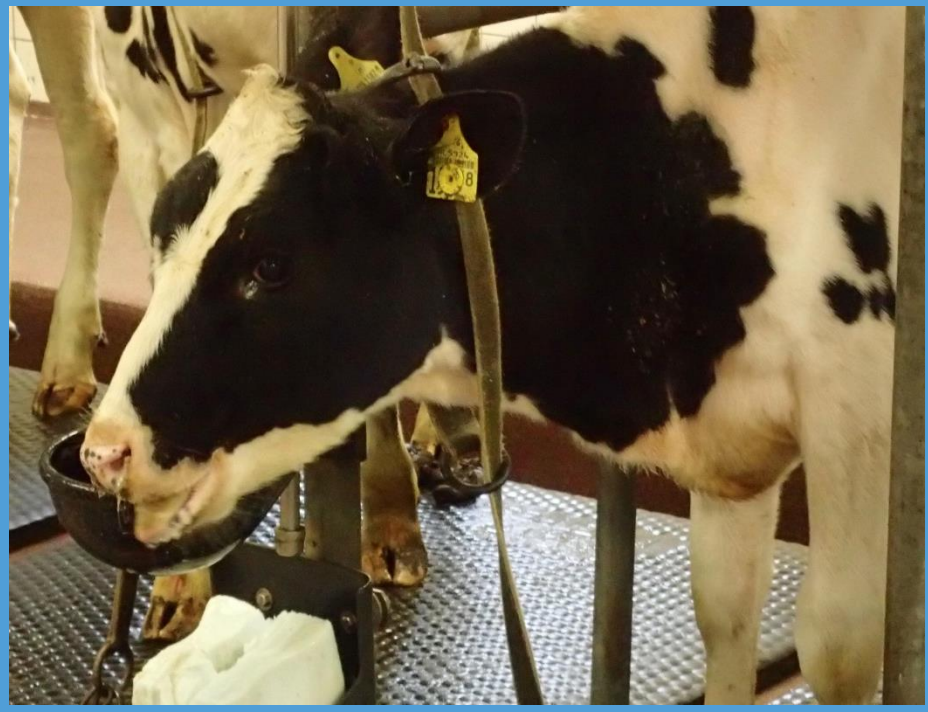
Pig

Artifact

ImageInstanceQ

Category: {cattle, domestic pig, artifact}

FMD Cattle Image Classification (I)



Before Infection

57 images

After Infection

54 images

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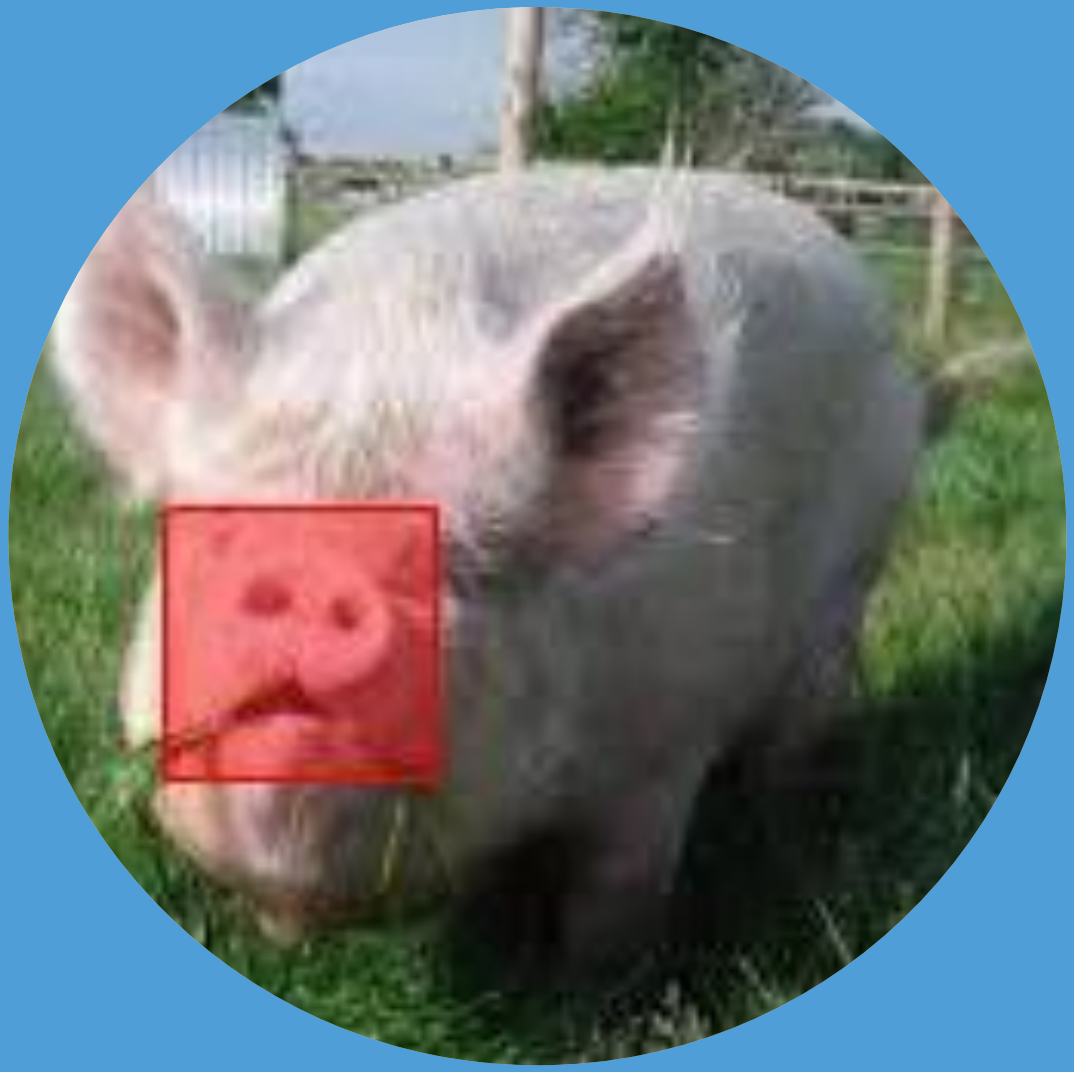
Digital Diagnostic Test for FMD Cattle

- Machine Learning Classification
  - 25 images before infection
  - 25 images after infection
- Validation:
  - Sensitivity (True Positive Rate) about 70 %
  - Specificity (True Negative Rate) about 70 %

Aspects of Improvement

- Uniformity of data for infected and susceptible animals
- Larger dataset to improve the ML
- Linkage of experimental findings and practical applications
- Combination of multiple sensors
    - Microphone for animal sound classification
    - Infrared camera for temperature measurement
    - Electronic Nose for air composition

Thank for your attention



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