University of Pannonia

Faculty of Information Technology

THESIS

Motion Detection and Aperture Problem Solution  
with Support of Artificial Neural Network

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# Introduction

Through my thesis labour I worked on an alternate solution of aperture problem during motion detection. On camera records it is a problem to determine whether the individual pixel on a specific frame is part of a background or part of a moving object.

## Motion detection

Motion detection is a process to determine the observed object relative movement to its motionless background. Motion can be detected by various items, such as infrared sensors, radar, lidar, electromagnetic sensor and camera. Application area is in wide range since the generality if definition. Magnetic sensors are commonly used on automotive industry to determine wheel speed based on the motion of a magnetic encoder. Optical motion detection are presented in surveillance camera and alarm systems.

## Problem description

In my thesis I work with object detection on camera. The task is to determine the movement on pixel level, and make a decision on every pixel whether it is background or foreground. The main stream is to decide based on the history of pixel value through frames. There are several problems on this method. Background pixels shall be those which are not changed for a while. But there are essential changes on background such as shadows, or changes of light.

The aperture problem also makes the task challenging. Aperture problem, when a bigger object is moving on frames, or coming toward the perception system, and the contours are detected, but the pixels inside the curvature of object make no visible movement, and detected as a background faulty.

## Suggested solution

On pixel level the aperture problem is hard to solve. My suggestion as a solution is to investigate the extended Mixture of Gaussians method, described in following article [Czúni, Utasi: Reducing the Foreground Aperture Problem in Mixture of Gaussians Based Motion Detection] and extend the solution with artificial neural network.

# Artificial neural network

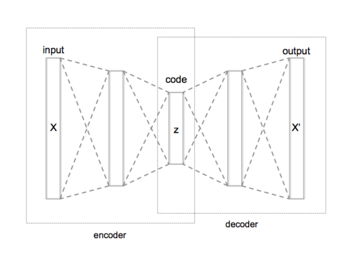
Artificial Neural Network (ANN) is a populate field of computer science, also it is not a new machine learning concept. The model is based on biology fundamentals. Biologists researching the neuron behaviour in living organisms and created the basic model of it. In computer science such a model is the base of the artificial neural networks

## Fields of use

Artificial neural networks are a common used machine learning method. There is a wide range of usage including image processing, data mining, decision making systems, control systems, expert systems, etc… For image processing it is widely used in computer vision problems.

## Autoencoder

Autoencoder is a special type of artificial neural networks. It’s main purpose is to learn a way to compress the input data and restore it from a small code such a way it causes the least damage on original data.



## Convolutional neural network

Convolution is often used in image processing and pre-processing. Convolution is a method where a kernel is used to iterate over the pixels and operations can applied on pixels. Convolutional neural network also uses a kernel window and these gives the information for the input nodes of neural network.

# Development environment

For choosing the best development environment, I need to consider the usage of ANNs. Since in python these concepts are widely spread and intensively developed, it was a common sense to choose this. There are plenty of library for constructing networks and these are well optimised.

## Python

Python is an interpreted high level programming language.

### Numpy

### Tensor flow

# Algorithm

## Basic mixture of gaussian

## Extended mixture of gaussians

### Background model

### Foreground model

# Implementation

## Multidimensional array

## Array operations

### Einsum()

# Measurements

## Runtime

## Compared to OpenCV solution

# Accomplishment

## Test images

# Future improvement