

MALABAR INSTITUTE OF TECHNOLOGY, ANJARAKANDY
DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING



ROBOT VISION MODEL BASED ON MULTI-NEURAL NETWORK FUSION

Candidate

Badira P P

Guide

Mrs. Anita

Assistant Professor, CSE

November 30, 2020

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Abstract

- neural networks are widely used to recognize working targets.
- reliability will decrease due to: illumination, background, camera orientation and so on..
- To solve this problem , this paper establishes two back-propagation neural networks.
- convolution neural network corresponding to the textures .
- fuses the recognition results of three neural networks with the D-S evidence theory.
- can be used in automatic control systems: feeding, assembly, sorting and tracking of industrial robots..

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Introduction

- Neural networks are widely used for target recognition.
- Vision is an important way for robots to perceive working targets.
- Robot vision for target recognition includes three steps:
 - Target image acquisition
 - Feature extraction
 - Target recognition
- Target image acquisition is accomplished by visual sensors.
- Target recognition needs to design a good model as classifier.

- Target feature extraction is key step, three kinds of extraction methods:
 - Shape – based
 - Color – based
 - Texture – based

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SegNet-image segment application

- SegNet, a fully convolutional network for image segmentation applications.
- semantic pixel-wise classification layer.
- decoder network-map the low resolution
- encoder-maps for pixelwise classification.

Hand-eye coordination for robotic grasping with deep learning.

- Learning based approach to hand-eye coordination for robotic grasping from monocular images.
- Use only monocular images independent of camera calibration.
- Spatial relationship between the gripper and objects in the scene
- Servo the gripper in real time to achieve successful grasps

Neural network-based robot visual positioning for intelligent assembly

- Fundamental task in robotic assembly is pick and place operation.
- Visual positioning system that addresses feature extraction issues for a class .
- Visual sensor consists of an arm mounted camera and grid pattern projector.
- Visual feedback guides the robot to the target from any arbitrary location in the workspace.

Deep learning for detecting robotics grasps.

- This solves RGB-D view of scene containing objects.
- Two step cascaded structure with two deep deep networks.
- Structured regularisation on the weights.
- Based on multimodal group regularization.

A novel training algorithm for convolutional neural network.

- A novel training algorithm which can avoid complete retraining of neural network architecture.
- Can reduce the training time under transfer learning.

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- BP Neural Network Model for Color – based Target Recognition
- Convolutional Neural Network Model for Texture – based Target Recognition
- BP Neural Network Model for Shape – based Target Recognition
- Fusion of Multi - Neural Network for Target Recognition

BP Neural network model for Color – based Target Recognition

- It contains,
 - Standard Color Reference Template
 - Neural Network Structure of Color – based Recognition
 - The Training of Color – based Neural Network

Standard Color Reference Template

- Acquired target image is true color
- color value reaches 2^{24} , complicated to image processing Solution is Color Reduction
- Color is approximated to several colors by Color Clustering
- After coloring, normalized color histogram obtained as expression of target color

Target color reference template



Figure: Target color reference template

Neural network structure of Color – based Recognition

- 16 color histogram generated after color clustering
- Histogram of background should be removed in image preprocessing
- Output dimension of BPNN depends on category of target to be classified
- Normalized histogram used as input of BPNN forms 15-dimensional

- BPNN adopts three layers: input layer, hidden layer, output layer
- Classifier uses Back Propagation Neural Network (BPNN)
- There are only 15 colors as target feature

color based BP neural network for target recognition

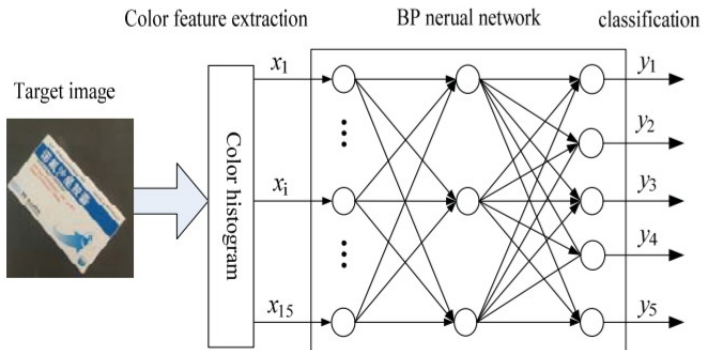


Figure: color based BP neural network for target recognition.

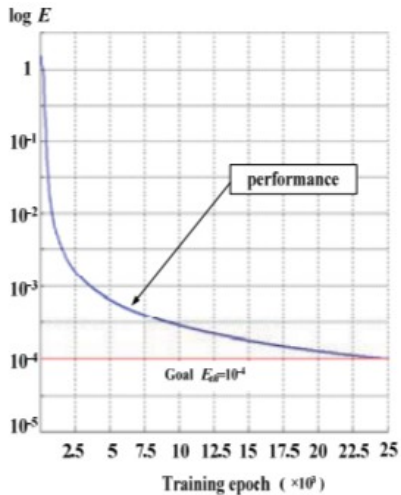
The training of color – based neural network



Figure: Samples to be trained color-based BPNN

- Color histogram of target calculated according to standard 16-color reference
- Index table can be obtained by establishing index image
- Color can be converted into index image with 16 colors
- Performance of BPNN expressed by sum of squares of errors E , goal of E , E_{th} , set to 0.0001

Train curve of BPNN



Convolutional Neural Network model for Texture – based target recognition

- The structure of CNN for robot texture recognition
- Training of CNN for texture recognition
- CNN improves accuracy of target recognition and Image classification
- Was used to solve handwritten postcode recognition problems
- Now uses in target image recognition

The structure of CNN for robot texture recognition

- Pooling layer S introduced after each convolution layer
- Three pairs of C – S connections (C1 – S1 – C2 – S2 – C3 – S3) used to form local connection of CNN for feature extraction
- Last layer of local connection S3, stacks into feature vectors and input into FC BPNN
- Fully connected BPNN consists of input layer (FC1), hidden layer (FC2), output layer (O) as a classifier for robot vision

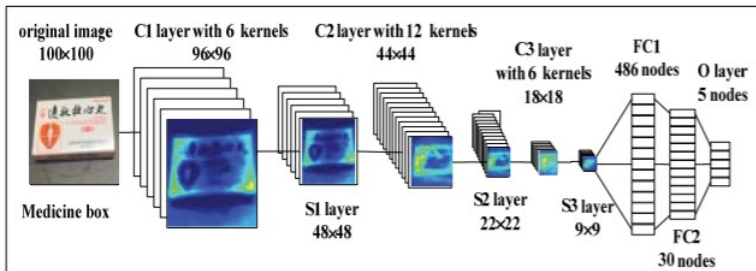


Figure: 10 layer CNN structure for target texture recognition

Training of CNN for texture recognition

- Training data set of CNN network consist of 1200 image samples and their class labels
- Gradient descent method used to train CNN
- Performance measure is sum of squares of network output error E
- Takes performance goal $E_i=0.001$

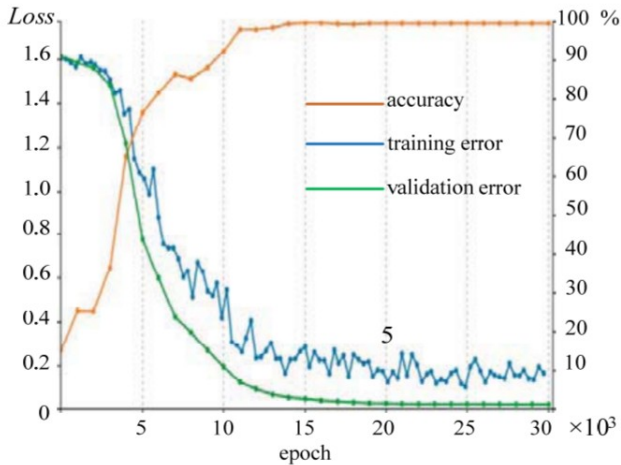


Figure: The training curve of CNN

BP neural network model for shape based target recognition

- Region and boundary converted into binary image
- Shape expressed by external boundary of target



(a) Sample images



(b) Region of target binary image

Fusion of multi – neural network for target recognition

- Visual perception of robots modeled by combining shape, color and texture
- Accuracy and robustness of single neural network for target recognition decreases
- Due to illumination of robot environment changes and orientation of camera is different
- To solve this, combined vision model of multi – neural network forms by integrating three neural networks of color, shape and texture

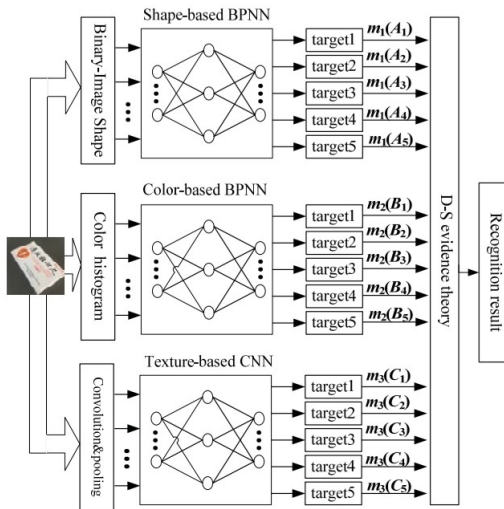


Figure: Combination Of color,shape and texture neural network

- Three models used to identify identical target at same time
- Better way to solve evidence conflict is D – S Evidence Theory
- Used for the fusion of three neural networks
- Effective method to deal with multiple sources of evidence, especially when evidence conflicts with each other

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Advantages Of The System

- Improves reliability of target recognition
- Used in automatic controlled system
- Improves performance of robot vision
- Improves performance of robot vision

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Future Scope

- Robot vision is future promising technology
- Highly efficient
- Reserves the application and data integrity
- Infinite and huge
- Automation anywhere

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- Color based, shape based and texture based neural network is established.
- Color based neural networks uses color histogram of target image as input feature vector.
- Shape based neural network uses binary image of target region as input.
- Texture recognition uses 10 layer CNN three kinds of networks .

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Thank You