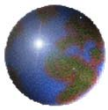
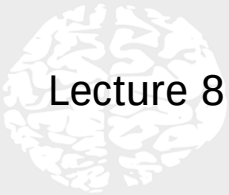
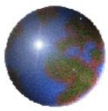


Multilayer Perceptron and Application



1



Defect Detection and Classification using BP Based Classifier

2

Motivation

- Venture into Interdisciplinary Project
- Project Domain – Advanced Manufacturing Technologies

3

Problem Definition

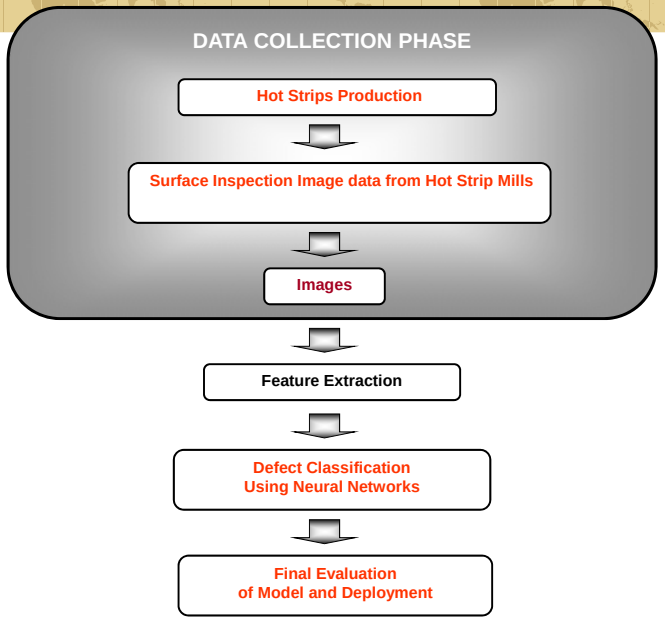
- Visual Inspection of Hot Strip
- Surface Defects

4

Objectives

- Best way to encode **image features** of **surface inspection data** of hot strip mills
- Proper **choice** of neural networks (NN) model
- Optimal **clustering** (if required) and separability of **defect classes**.
- NN **reliability** of diagnosed defect class.
- Finally **demonstrate the developed system** for **automatic surface inspection** for hot strip mills

5



6

Data Collection Phase

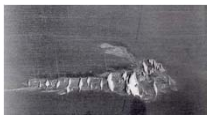
- Leading Steel Industry of India

7

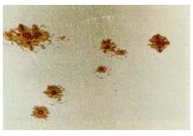
Typical Surface Defects

Coil Break

Coiling slip-marks

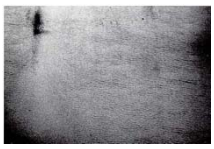


Holes

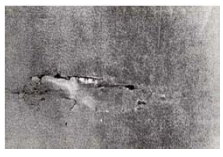


Rust

Scale-pits



Scale-residue



Shell

8

Image Processing

- **Standard Format** - 600 X 400 pixels
- **Binary** - Binary images creation from indexed, intensity, or RGB images. These are images with only black and white pixels

9

Image Processing (Contd.)

- **Morphing** - majority morphing to take care of noise in the image.
- It sets a pixel to 1 if five or more pixels in its 3-by-3 neighborhood are 1's; otherwise, it sets the pixel to 0

Original image

Morphed with "majority morphing"

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Image Processing (Contd.)

- **Salt & pepper:**

Original image

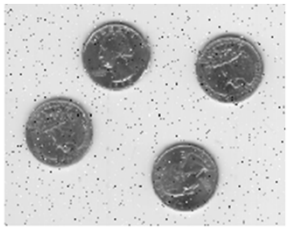

Image with added 'salt and pepper' noise

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Image Processing (Contd.)

- **Speckle:** It is a multiplicative noise added to the image I, using the equation J (noisy image) = I+n*I, where n is **uniformly distributed random noise** with mean 0 and variance v.

- **Gaussian:**Gaussian white noise of mean m and variance v is added to the image.

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Feature Extraction

- Number of Objects
- Euler Number
- Perimeter
- Area

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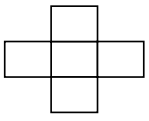
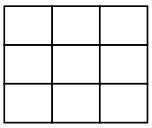
Feature Extraction (Contd.)

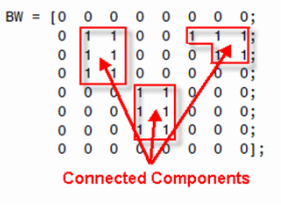
- **Number of Objects:** It is the number of connected white pixels.

4-Connected



8-Connected





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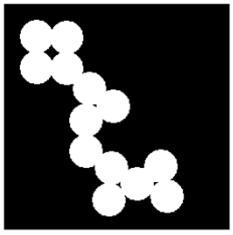
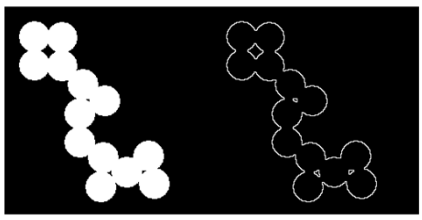
Feature Extraction (Contd.)

- **Euler Number:** is a scalar whose value is the total number of objects in the image minus the total number of holes in those objects. It can have a 4-connected objects and 8-connected objects.



Feature Extraction (Contd.)

- **Perimeter:** The image is changed to a perimeter image. A pixel is part of the perimeter if its value is 1 and there is at least one zero-valued pixel in its neighborhood.



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Feature Extraction (Contd.)

- **Area:** It is the area of all of the on pixels in an image. The area of an individual pixel is determined by looking at its 2-by-2 neighborhood.
  - Patterns with zero on pixels (area = 0)
  - Patterns with one on pixel (area = 1/4)
  - Patterns with two adjacent on pixels (area = 1/2)
  - Patterns with two diagonal on pixels (area = 3/4)
  - Patterns with three on pixels (area = 7/8)
  - Patterns with all four on pixels (area = 1)

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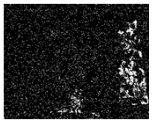
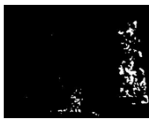
Example of Noise Removal

Image Processing	Example	
Standard image (Without noise)		
After 'salt and pepper' noise	**Area = 2600.2, Perimeter = 1986.2, No. of objects = 203 Euler. no. = 195**	
After processing with 'majority morphing'	**Area = 2028 Perimeter = 1255, No. of objects = 63 Euler no. = 63**	

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Dataset Details

Dataset	Data Processing	Samples
Dataset A	The images chosen for modeling from the images collected from the mill.	15
Dataset B	Dataset A + “salt and pepper” noise.	30
Dataset C	Dataset A + “Speckle” noise	30
Dataset D	Dataset A with three different intensity of the “salt and pepper” noise.	45
Dataset E	Dataset A with three different intensity of the “Speckle” noise	45
Dataset F	Dataset D + Dataset E.	90

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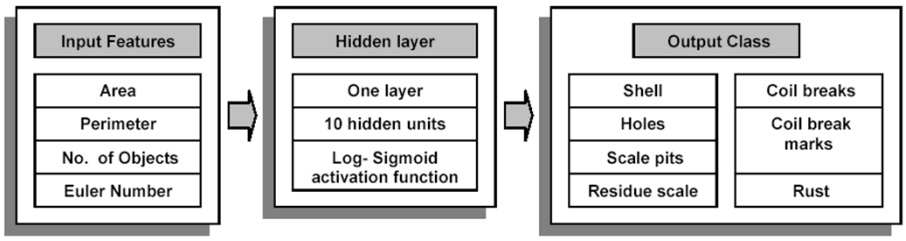
Machine Leaning Model



- Resilient Back propagation algorithm
  - Mean Square Error (MSE)

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Results

Training	Testing	Misclassification	% Accuracy	Remarks on misclassification
Dataset A	Dataset B	0 of 15	100	-
Dataset B	Dataset A	1 of 15	93.33	Correct answer included
Dataset D	Dataset A	1 of 45	97.77	Correct answer included
Dataset E	Dataset A	0 or 45	100	-
Dataset F	Dataset A	0 of 90	100	-

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Validation of Model

- Cross-validation – **Leave-one-out**

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Leave-one-out (Dataset F)

Exercise number	Number of Misclassification
1	6
2	5
3	5
4	5
5	7
6	5
7	5
8	5
9	5
10	5
Total misclassification out of (90)*10 = 900 images	53 *Accuracy = 94.11 %*

Leave-one-out (Dataset F) Tested on Dataset A

Exercise number	Number of Misclassification
1	24
2	15
3	15
4	15
5	24
6	15
7	15
8	15
9	15
10	15
Total misclassification out of (90*15)*10 =13500 images	168 *Accuracy = 98.75 %*

Discussion

- Data collection **difficulty** from the field
- **Understanding** the problem for various mills
- Model **Performance – Image Processing**
- Image capturing at such a **high speed of 10-15 m/sec**
- **Wavelet analysis** in image processing

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Commercial Applications

- Guidelines
- Integrated Decision Support System

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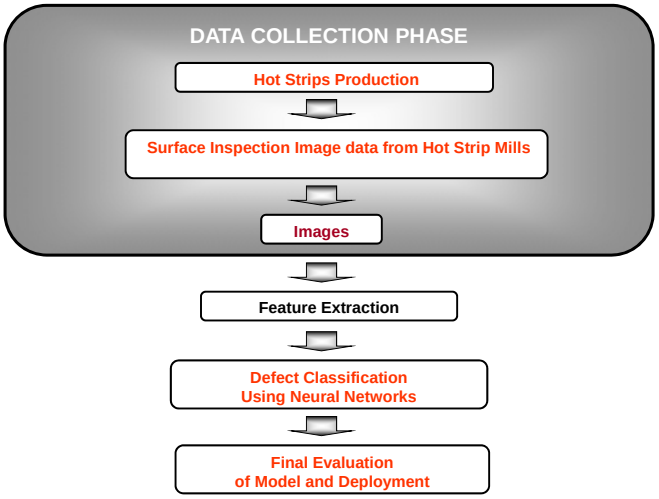
Summary



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Radiographic System

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