METAL SURFACE DEFECT CLASSIFICATION

Team Members

Rishav Arjun:	170100051
Anjali Nainani:	17D110024
Sudhansu Srivastava:	193110008
Sunil Chandel:	180100116
S.P. Joshi:	203370008

TABLE OF CONTENTS

01

Project Motivation

There are different techniques for detecting which surface defect is present on the surface of metals. But these techniques are highly costly and require heavy equipment (ex - Eddy current testing). Therefore, for optimizing the cost, time and space for metal processing industries we propose a ML model with high amount of accuracy to classify the surface defects. .

02

Problem Definition

- We have developed a deep learning model which effectively define and classify the following six surface defects in steel-
  a. Inclusion (In)
  b. Scratches (Sc)
  c. Pitted (Ps)
  d. Rolled (RS)
  e. Crazing (Cr)
  f. Patches (Pa)

- A lot of research work is going on in this field and many more ML and deep learning models are there for instance, **Deep residual neural networks , real time detection by YOLO detection.**

- Focused differentiators of our model**: Accuray , size of detectable defects, Low contrast defects**.

- USP of our model is successful detection of and distinguishing of mixed defects i.e two or more defects are on same locations.

- **Business case:** online event and expo organization for introduction of product, free access of software to research and industrial organizations, advertising on google platform, on youtube

03 Conceptual Design

ML Model Selection

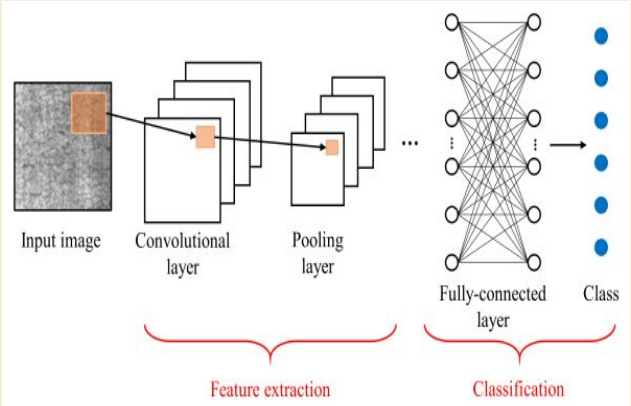
It has been found out that CNN (convolutional neural network) performs much better than conventional ML models.

Number of layers

10 layers used for feature extraction and classification.

Types of layers used

2D convolutional layers, along with maxpool, dropout and sense layers.



ML DATASET SELECTION

Total 1800 number of images of surface defects

300 images of each of total 6 classes

Resolution of each image is 200x200

All the images are grayscale

Dataset link - http://faculty.neu.edu.cn/yunhyan/NEU_surface_defect_database.html

TOOLS USED FOR CODING

LIBRARIES

- Numpy
- Pandas
- Matplotlib
- Tensorflow
- Sklearn

CODING LANGUAGE

PYTHON

CODING ENVIRONMENT

- Colaboratory
- Jupyter Notebook

04

Market Research

Potential Customer Base:

- Automotive Industry
- Aviation
- Construction
- Steel Manufacturing

Market Sizing

- The surface inspection market to grow from **USD 3.7 billion** in 2020 to **USD 5.3 billion** by 2025
- Compound Annual Growth Rate (CAGR) of 7.4% during the forecast period.

Barriers to Entry

- Legal
  Patents or Licensing restrictions
  (Highly Improbable)

- Brand Loyalty
  Trust and assurity of quality from existing players
  (Can be broken based on accuracy of results)

- Technical Barriers
  High Startup costs, monopoly of existing players
  (Major barrier)

- Strategic Barrier
  Predatory Pricing
  (Mild Barrier since quality is more important than pricing)

Service Marketing

- Reaching out to IITB professors with relevant knowledge in the field for validation of the quality and reliability of the results

- Contacting industries to showcase the accuracy of the results compared to existing solutions

- Organizing various workshops for different people of industries to demonstrate working of our product.

05

Technology Landscape Assessment

PATENTS

Patents
Following inventions inspired us to undertake this study:

A kind of Cold-strip Steel Surface defect online detection method and detecting system (2017)

Real-time adaptive control of additive manufacturing processes using machine learning (2017)

Image recognition-based rail wagon fire-proof plate fault recognition method (2019)

PUBLISHED LITERATURES

Published Literature:
Latest research on the use of ML in defect diagnostics:

A noise robust method based on completed local binary patterns for hot-rolled steel strip surface defects (2013)

An End-to-end Steel Surface Defect Detection Approach via Fusing Multiple Hierarchical Features (2020)

PGA-Net: Pyramid Feature Fusion and Global Context Attention Network for Automated Surface Defect Detection (2020)

06

Model Architecture & Results

Model Specifications

Input image's pixel values are scaled with a factor of 1/255 to normalize image Tensor.

Loss Function
Categorical Cross-Entropy

Optimizer
RMSprop

Metrics
Accuracy

Layer-wise Model Summary

Layer (type)	Output Shape	Param #
conv2d_3 (Conv2D)	(None, 199, 199, 32)	416
max_pooling2d_3 (MaxPooling2	(None, 99, 99, 32)	0
conv2d_4 (Conv2D)	(None, 98, 98, 64)	8256
max_pooling2d_4 (MaxPooling2	(None, 49, 49, 64)	0
conv2d_5 (Conv2D)	(None, 48, 48, 128)	32896
max_pooling2d_5 (MaxPooling2	(None, 24, 24, 128)	0
flatten_1 (Flatten)	(None, 73728)	0
dense_2 (Dense)	(None, 256)	18874624
dropout_1 (Dropout)	(None, 256)	0
dense_3 (Dense)	(None, 6)	1542

Total params: 18,917,734
Trainable params: 18,917,734

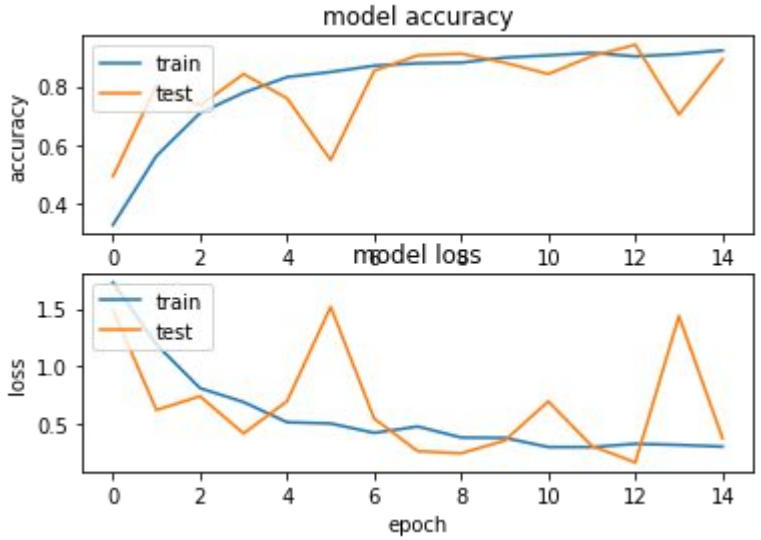
Results

We have 300 images for each class in our dataset. We used splitted data in **80:20** for creating training and test data respectively.

The model is run for **15 epochs** after which accuray saturates. We trained our model in a **batch size** of **32**.

Test Accuracy
89.16 %

Loss and Accuracy Vs Epoch plot



Model Output on random sample of Test images

Correctly classified

Misclassified