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Detecting Surface Cracks on Buildings using Computer Vision: An Experimental Comparison of Digital Image Processing and Deep Learning

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AGENDA

RELEVANCE AND NEED FOR THE RESEARCH
What and Why is this research important?

THE RESEARCH METHODOLOGY
How did we go about our idea?

RESEARCH OUTCOMES
What were our results?

CONCLUSION AND FUTURE SCOPE
The path ahead

REFERENCES
Some of the allied research that helped us

Relevance and Need for the Research

What and Why is this research important?

DETECTING DEFECTS

Detect defects in buildings

SAVE TIME

Reduce the need of manual inspection

TENANTS
Will Need a Safe Home

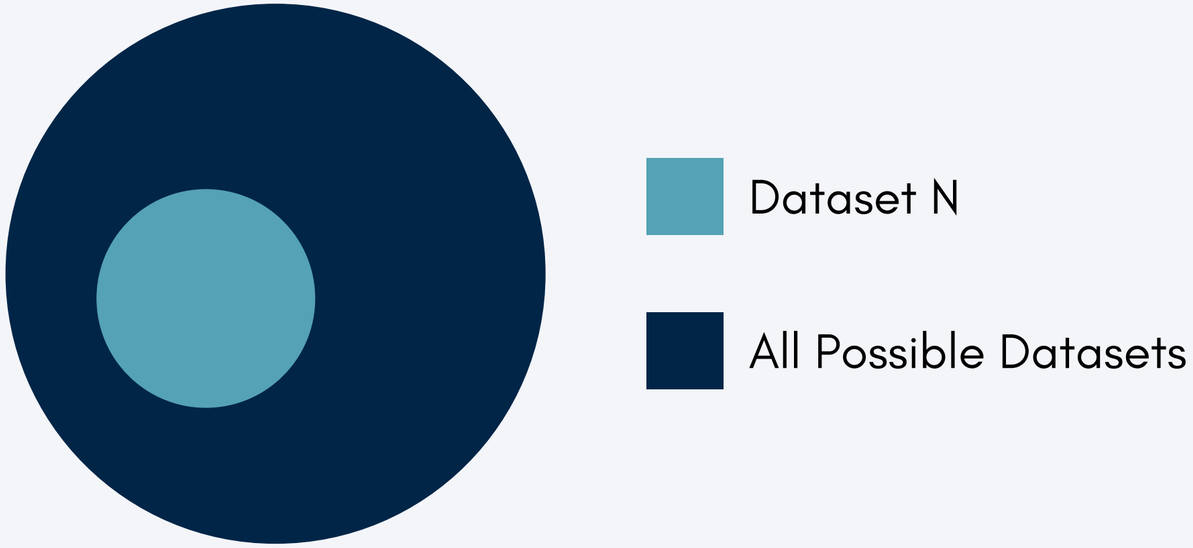
CONSTRUCTION COMPANIES
Will Need to Establish Credibility

GOVERNMENT AGENCIES
Will Need to Evaluate

Relevance and Need for the Research

What and Why is this research important?

> Much of the related work in this field does not account for the **Condition of Generality** i.e each experiment works with a specific set of data acquired with special setups.



The Research Methodology

How did we go about this idea?

The Initial Ideation

- **Domain Study**
- **Project Constraints**
  - **Time**
  - **Available Data**
  - **Cost**

The Research Methodology

How did we go about this idea?

Data Acquisition

40,000	400	<100	42, segmented to 4k and chosen
Ozgenel et. al	Dataturks	Google Images	Handheld Device Data

The Research Methodology

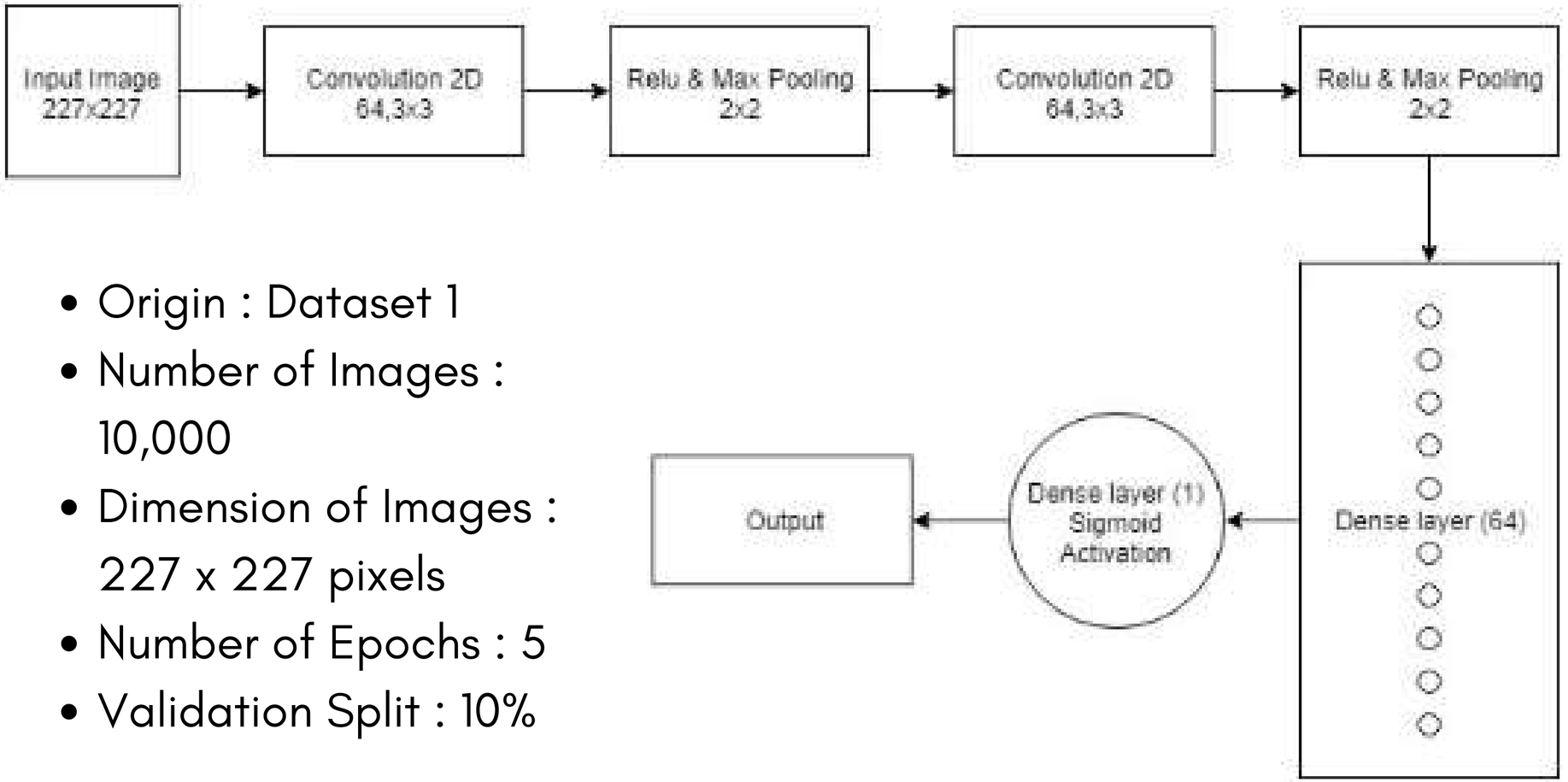
How did we go about this idea?

Building the Classifier

- Digital Image Processing-based Approach
  - Morphological Operations, Thresholding
  - Ratio of white/black pixels
- Deep Learning-based Approach
  - Convolutional Neural Network

Building the Classifier

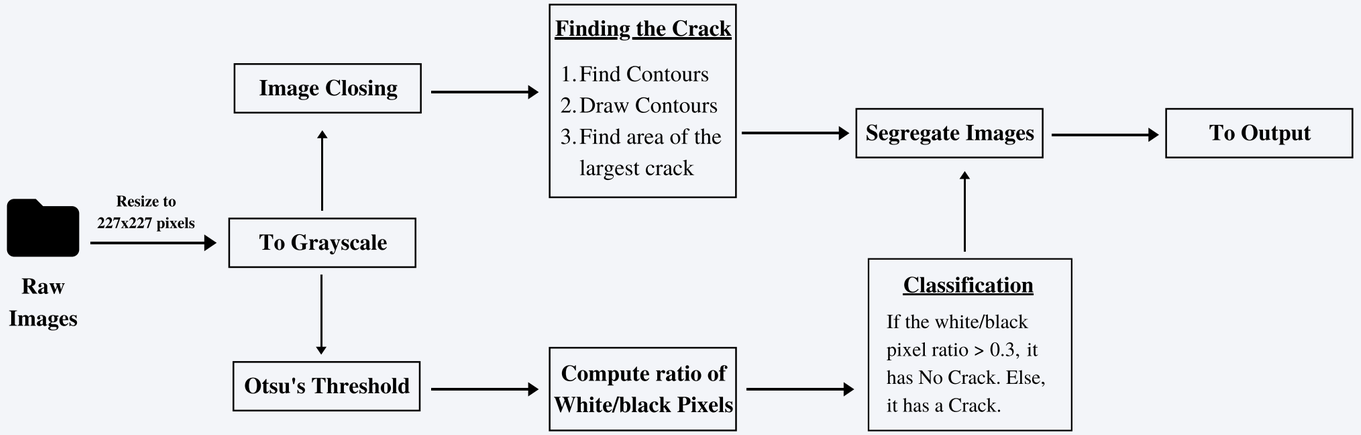
Deep Learning-based Approach



- Origin : Dataset 1
- Number of Images : 10,000
- Dimension of Images : 227 x 227 pixels
- Number of Epochs : 5
- Validation Split : 10%

Building the Classifier

Digital Image Processing-based Approach



Low threshold

High threshold

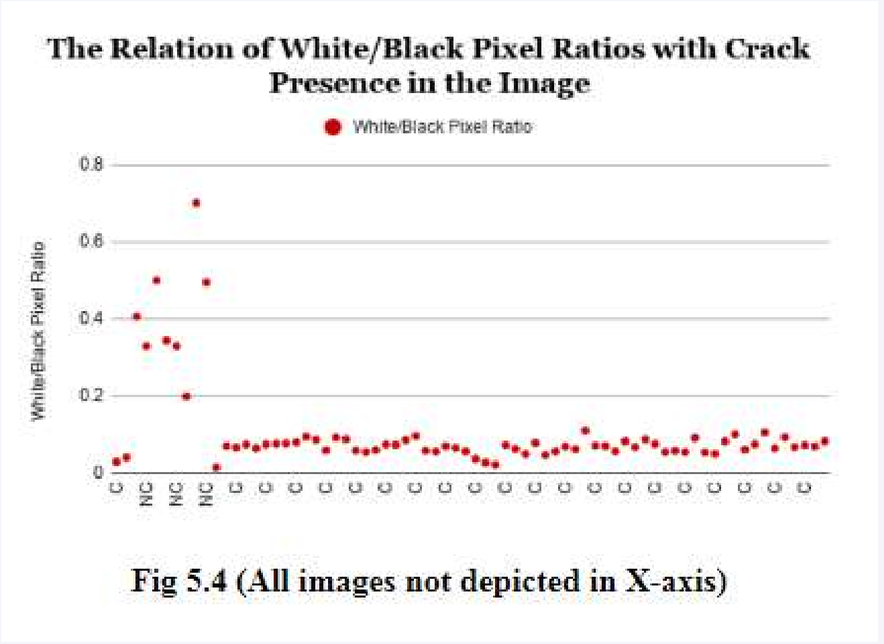


Fig 5.4 (All images not depicted in X-axis)

Based on 72 images in Dataset 2

The Research Methodology

How did we go about this idea?

Evaluation

- Evaluation Metrics
  - Classification Accuracy
  - False Positive Percentage
  - False Negative Percentage

The Research Methodology

How did we go about this idea?

Towards Implementation

- Data stored at https://github.com/skth5199/Surface-Cracks-Detection-Data
- Language Used: Python 3.7
- Cloud Support for CNN: Kaggle kernels, Google Colab

Research Outcomes

What were our results?

Table 1: DIP Method with Otsu Threshold Technique

Dataset	Number of Crack Images	Number of No Crack Images	Classification Accuracy	False Negative Percentage	False Positive Percentage
Dataset 1	500	500	90.2	1.79	17.8
Dataset 2	63	9	97.22	0	22.2
Dataset 3	27	5	100	0	0

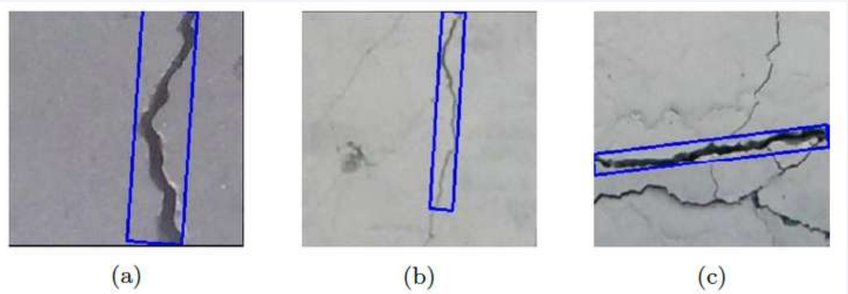


Fig. 7: Most Favourable Results

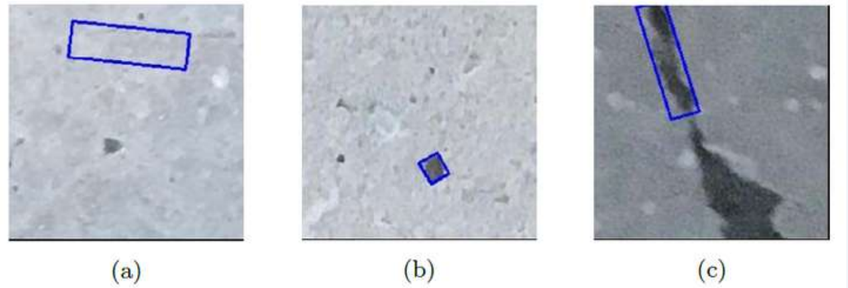


Fig. 8: Least Favourable Results

- "Good" accuracy
- A pessimistic algorithm - Higher FP%
- Common misses include
  - Mistaking stray marks and wires as cracks
  - Can't always find the widest crack

Research Outcomes

What were our results?

Table 2: CNN Performance in Image Classification - No preprocessing

Dataset	Number of Images	Classification Accuracy
Dataset 1	1000	99.1
Dataset 3	31	100

- **CNN was trained on 10,000 images from Dataset 1**
- **"Excellent" accuracy**
- **Common misses include**
  - **Can't judge what it has not seen before(Hence, dataset 2 with wires has been excluded)**

Research Outcomes

What were our results?

Table 4: Comparing performances on the evaluation dataset

Approach	Classification Accuracy
CNN - Without data preprocessing	33.5
CNN - With data preprocessing	49
DIP-based - With Otsu thresholding technique	93.22
DIP-based - With Adaptive thresholding technique	85.59

Evaluation Dataset (Dataset 4)

- 118 images (109 cracked, 9 no-crack)
- 227 x 227 pixels
- Sampled from 4k images (segmented from 42 images)
- Each image of 6 KB

Fair Comparison?

The "No Free Lunch Theorem"

CNN TRAINED

CNN SAW

Conclusion and Future Scope

The path ahead

> While DIP-based methods prefer good accuracy over great accuracy with only little or no data, deep learning-based methods can achieve great accuracy, but only if it is provided with enough data. In the event of building a system as one discussed in the paper, understanding this trade-off between a traditional approach and a state-of-the-art champion will help create a robust, safe and efficient system.

An important future scope of this work can be to identify methods to remove external noise in images like wires, windows etc.

References

Some of the allied research that helped us

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