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APPLICATION OF DEEP LEARNING FRAMEWORK (ARTIFICIAL INTELLIGENCE) FOR CONCRETE GRADATION

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Abstract— Concrete gradation or calculating the strength that a given mix of concrete will give is one of the major concerns of a civil engineering/construction engineering. To find the grade of concrete different destructive and non-destructive method are employed. This calculation of grade of concrete helps in the verification and confirmation of the overall stability and safety of the given structure.
In this study, an attempt has made to apply the deep learning framework of artificial intelligence to predict the grade of hardened concrete mix of life 28 days. A deep learning framework was made to predict the grade of concrete by analysing the photograph of a hardened concrete mix. At a small scale few grades of concrete were designed and casted in the laboratory and the pictorial data was collected under specific conditions. Then this data was used to train the framework and then the framework was used to predict the grade of a random data of concrete.

Keywords— Deep Learning, Artificial Intelligence, Characteristic Strength, Gradation, 28 days strength.

I. INTRODUCTION

A deep learning Framework was constructed using the Neural Networks with a series of breakthrough in the field of the image-classification. This framework has found different applications with specific network in various fields such as object detection, product quality assurance, pattern recognition and many more. This study has attempted to implement this framework along with supervised learning techniques on concrete gradation.
For this purpose, the concrete mix design was performed for grade of M15, M20, M25 and M30. Then the mix ratio was used to collect pictorial data for the above-mentioned gradation of concrete. These images were kept in two set, first set of pictorial data was used to train the framework and the few of the data was kept in set two which was then used to validate the learning abilities of the framework.

II. DEEP LEARNING FRAMEWORK'S ARCHITECTURE

The framework used for the prediction is composed of layers from a Residual Network which is mainly composed of 3 types of layers, which are discussed below in detail.

A. Convolution Layer

It is the frontal most and vital layer of the Residual Network. It contains the learnable kernel that are inherited or processed on the basis of digital data provided through an image, mainly in the form of pixels. When the data hits this layer, it convolves each filter across the spatial dimensionality of the input to produce a 2D activation map. Every input data is to be transformed to a dimension of 224x224 and converted to a grayscale image. The kernel size, padding and stride for each of the layers are set accordingly.
Each of the Convolution layer is provide with a max pooling layer along with it. Pooling layer reduces the dimensionality of the given data. it operates over each activation map using the "MAX" function in the input, and scales itself to provide the output, which further reduces the number of parameters and the computational complexity of the model.

TABLE NO. I: SHOWING THE NEURONS OF OUTPUT LAYER

Neuron	Represented Grade
Out - Neuron 1	M15
Out - Neuron 2	M20
Out - Neuron 3	M25
Out - Neuron 4	M30

B. Linear Layer

This layer also known as feed forward network layer. It uses the output provided by the convolution layer to learn the special data features. The Linear layer contains neurons that are directly connected to the neurons in the two adjacent layers, without being connected to any layers within them. This is analogous to way that neurons are arranged in traditional forms of ANN. The input features and output features are set according to output provided by convolution layer considering dropout as well. Each of the neuron utilizes a Rectified Linear Unit (Relu) function as activation function.

C. Output Layer

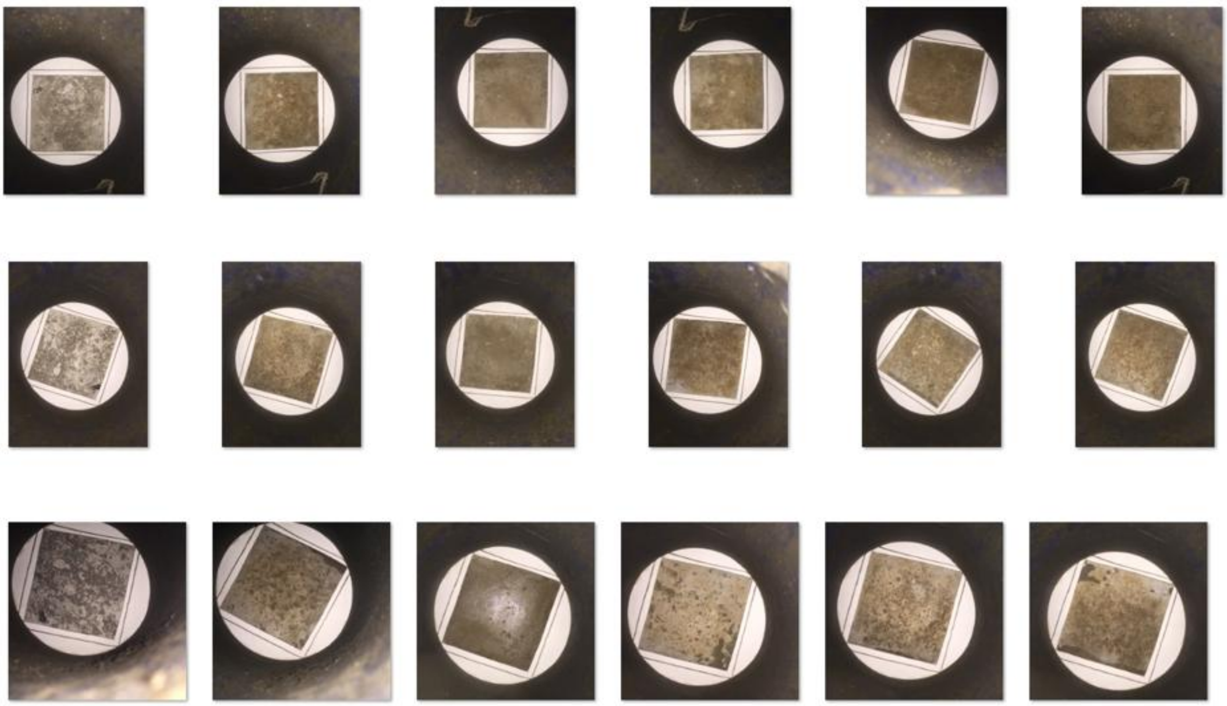
This is the last part of Linear layer network which is composed of 4 neurons as shown in Table No. I. The output provided by this layer is the prediction pf the grade of concrete for the given image of concrete. The ultimate answer is processed by comparing the output of the neurons and the neuron with maximum output is the answer. ingredients.

III. DATA COLLECTION

Our input data-type is pictorial in nature. The pictorial data is the images of the hardened concrete mix in the cubes of 150mmx150mmx150mm on 28 days immediately before the crushing strength test of the cubes. The pictorial data as shown in figure No. I, was taken by placing the slump-cone on the cubes with a white-cardboard with hole in centre of slight less than 150mmx150mm. These pictorial data were collected with following set of guidelines for the training and validation of the above-mentioned framework:

1. To reduce the error due to modification of the information in the pictorial data, a camera was used which does not have a feature of image enhancement due to Artificial Intelligence.
2. To control the effect of light exposure on the concrete, A cone used in slump-test was used to take pictures of the concrete mix with the flash light of the camera.
3. Two Set of Pictorial data was taken each time and then best of the two was used for the analysis.
4. The pictorial data was collected from all the six faces of the cube.

FIGURE NO. I: SHOWING THE NEURONS OF OUTPUT LAYER



For the above data collection twenty cubes of M15, M20, M25, M30 Grade of concrete were casted in the laboratory and then the six pictures of each face of the twenty cubes were taken. After data collection, pictures of 15 cubes were used to train the framework and five of the cubes data were kept in the validation folder for validation the framework result.

IV. TRAINING OF THE FRAMEWORK

For After the collection of the data, Five images were sorted in folders with pictures of different grade of concrete, these pictures were used to train the framework. The visual of the interface providing the input information for the train of the deep learning framework is shown in the figure No. II.

V. VALIDATION OF THE FRAMEWORK

To validate the framework, one picture of any random one face of the cube was placed in the folder of validation set. The validation was performed using these pictorial data. One picture at a time was provided in the framework for the validation as show in the figure No. III.

The framework was validated five time for each of the grade of concrete, i.e. M15, M20, M25, M30 and it was found that the frame work have predicted correct grade of concrete for the cubes each time.

VI. CONCLUSIONS

In the current limited study, where effect of light was not considered by using a slump-cone to avoid the complexity due to light exposure condition at different times of the day and the distance of the cubes from the camera was also limited to the slump-cone height. From the above, limited study at laboratory it can be comprehended that the deep learning framework can be used efficiently for the prediction of grade. The accuracy of the prediction for the limited data and its similarity was found to be precise.

But the framework requires a lot more numbers of data to train it and to generalise it for public and quality control use. This study shows the possibility of Deep learning Framework to be used at a large scale, if sufficient numbers of data is available to train the framework.

FIGURE NO. II SHOWING THE TRAINING INTERFACE OF THE DEEP LEARINING FRAMEWORK

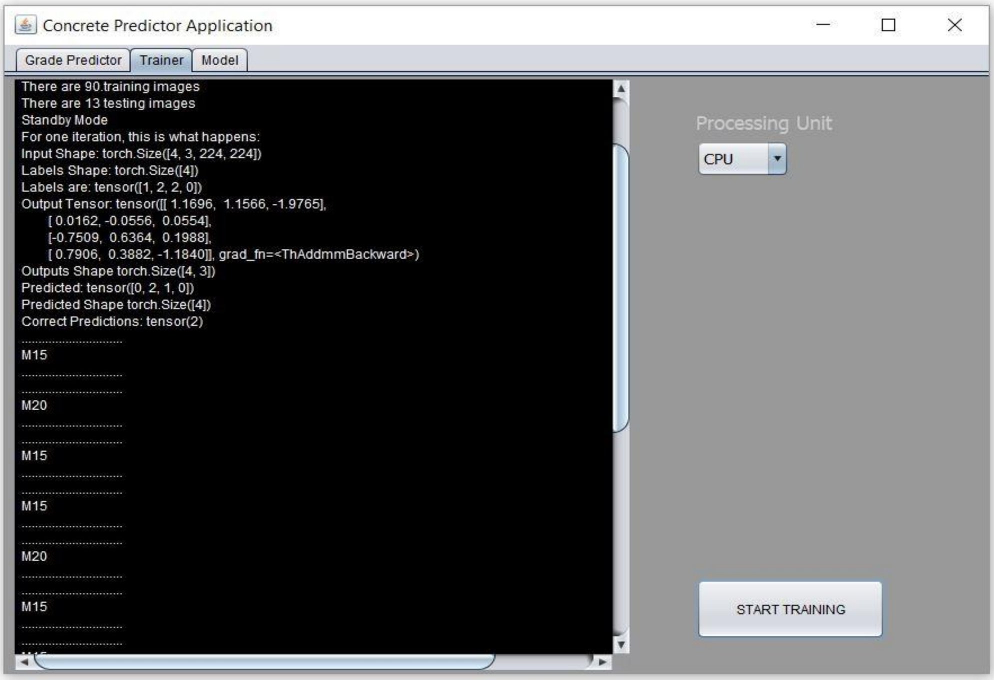
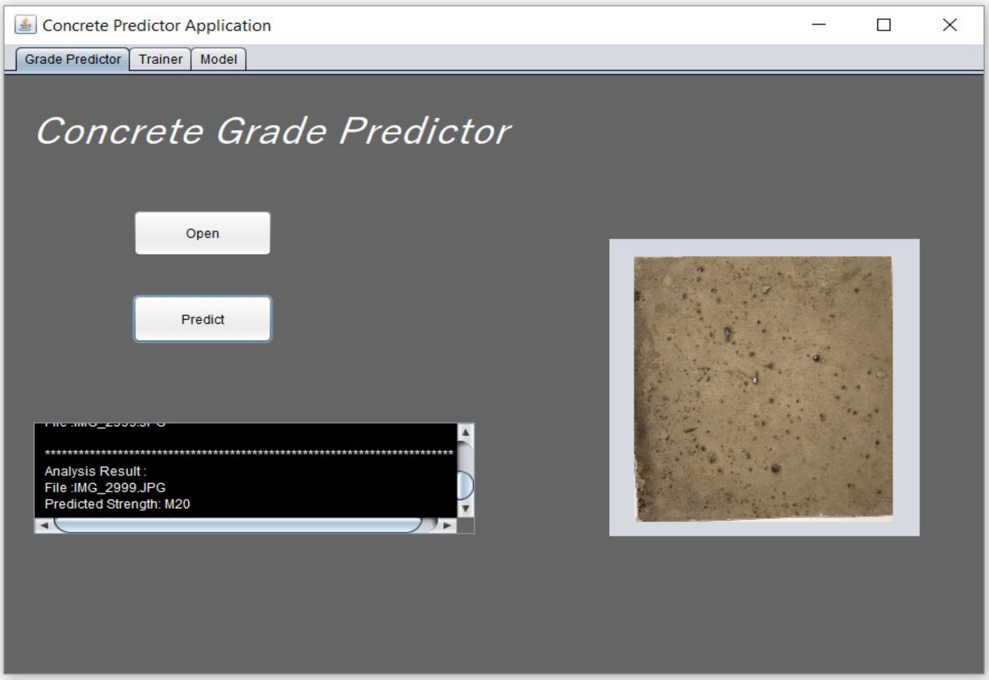


FIGURE NO. II SHOWING THE VALIDATION INTERFACE OF THE DEEP LEARNING FRAMEWORK



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