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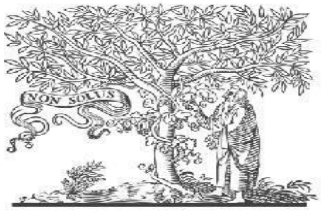

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GLASS CLASSIFICATION USING MACHINE LEARNING ALGORITHM

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ABSTRACT: There are different types of glasses in the world and our project is to specify the type of glass according to the elements in the refraction index like sodium, magnesium, and aluminum. Glass classification specifies the type of glass according to the properties of the glass namely refractive index and its types. Glass is a non-crystalline, amorphous solid that is most often transparent. There are lots of uses of glass, where classification of glass is vital for different applications. However every product and application needs a unique glass, for that reason within the industrial world there square measure differing kinds of glass that may create your domestic and industrial life easier. Hence in this work, Glass classification using machine learning algorithm is presented. The main aim of this project is to specify the type of glass according to the properties of the glass. In this work machine learning algorithms are used with a python programming language to identify the type of glass such as vehicle windows, building windows, tableware, headlamps, etc. In this work, Artificial Neural Network (ANN) is used to classify and generate the glass based on the properties uploaded by the user. The glass type is the result of the Application, and that result is helpful to identify the purpose of the glass which means it gives whether the glass is used for building windows, containers, tableware, headlamps, and vehicle windows.

KEYWORDS: Glass, Classification, glass properties, Industrial Applications, Machine Learning, Artificial Neural Network (ANN).

I. INTRODUCTION

Glass is a transparent, non-crystalline, amorphous solid. Glass Industry is considered one of the most important industries in the world. The Glass is used everywhere, from water bottles to X-Ray and Gamma Rays protection. Glass is a non-crystalline, amorphous solid that is most often transparent.

There are lots of uses of glass, and during investigation in a crime scene, the investigators need to know what is type of glass in a scene [7]. Glass is a valuable material evidence to witness the trade exchanges of the early Silk Road.

Since the introduction of Western Asia and other regions into China, glass manufacturing technology has been localized in China, and its chemical composition has also changed greatly. Because of the different cosolvents added in the refining process, the chemical composition of the glass produced is also different, such as high potassium glass and lead barium glass. At the same time, ancient glass is easily weathered by the influence of burial environment. Weathering will change the composition proportion of glass, thus affecting the judgment of glass category. Therefore, it is of great significance to study the factors that will affect the weathering of glass, find more detailed glass classification standards, and explore the methods to identify glass [2].

Magnesium(Mg), Potassium(K), Barium(Ba), Sodium(Na), Calcium(Ca), Silicon(Si), Iron(Fe), Aluminum(Al) are the elements utilized in the manufacture of several types of glasses (K). In addition, the Refractive Index (RI) is an essential factor in distinguishing between many types of glass and their applications.

According to their intended function, the glasses in this dataset are divided into seven categories. Containers, Float glass for building windows, Float glass for vehicle windows, no float glass for building windows, dinnerware, and top lights. A sheet of glass generated by floating molten glass on a liquid metal substrate is termed as float glass. This glass is often of high quality, requires no finishing, and structural flexibility during the production process. This process produces a sheet with a consistent thickness and extremely flat surfaces [1].

Metallic glasses (MGs), especially bulk metallic glasses (BMG), have attracted increasing attention due to its unique disordered structure compared to its crystalline counterpart alloys and its excellent mechanical, magnetic and corrosion resistance properties and so on. However, one of the biggest obstacles for the widely application is its poor glass-forming ability (GFA). Bulk metallic glasses (BMGs) usually have outstanding mechanical and physical properties due to their amorphous structure. Glass-forming ability (GFA) represents the ability of an alloy to form the amorphous structure at a given cooling rate and GFA can be quantitatively measured by the critical casting diameter *D*max, below which an alloy is formed BMG and beyond which the alloy will be crystallized [5].

The study of the glass classification problem is motivated by criminological investigation. At the crime scene, the glass left can be used as evidence when correctly identified. A frequent use-case is comparing glass from a crime scene with glass particles associated with a suspect. Such glass particles are often exceedingly small. It is essential to identify and compare these small glass fragments that may be significant in a forensic context [3].

Due to the rapid development of computational science and artificial intelligence, machine learning (ML) as a data-driven approach has begun to be applied to material genetic engineering, including new MGs design in recent years. By analyzing existing material data, and finding out the inherent relationship in material data which is difficult for human brains, ML can establish a predictive and analytical model to accelerate materials design.

Recently, there are some applications of machine learning for MGs prediction and understanding. For example, classifier algorithms such as support vector classifier, random forest classifier, and backpropagation neural network, have been utilized to label MGs into different categories, and regression algorithms such as support vector regression, random forest regression, correlation-based neural network (CBNN), have been used to construct the compositions-properties predictive models to assess critical casting thickness (*Dmax*), reduced glass transition (*Trg*), and elastic moduli (*EM*) [6].

Machine Learning (ML) algorithms can extract useful knowledge, providing important insights into composition-property maps. A key step in glass composition design is to identify their physical-chemical properties, such as the glass transition temperature [8]. Hence in this work, glass classification using Machine learning algorithm is presented. The remaining work is arranged as follows: The section II describes the literature survey. The section III demonstrates the glass classification using Machine learning algorithm. The section IV evaluates the result analysis of presented approach. Eventually the conclusion is provided in section V.

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II. LITERATURE SURVEY

Omer Kaspi, Olga Girshevitz, Hanoch Sen derowitz et. al., [4] presents PIXE based, Machine-Learning (PIXEL) supported workflow for glass fragments classification. They demonstrate that this workflow can produce models with high (>80%) accuracy in identifying glass fragment's origins and provide a test-case demonstrating how the model can be applied in real-life forensic events. They provide a standard, reproducible methodology that can be used in many forensic domains beyond glass fragments, for example, Gun Shot Residue, flammable liquids, illegal substances, and more.

J. Park, H. Riaz, H. Kim, J. Kim et. al., [9] presents Advanced cover glass defect detection and classification based on multi-DNN model. A deep-learning neural network (DLNN)-based defect inspection system is described. The DLNN has advantages over traditional computer vision- or human-based inspection in terms of flexibility and performance. Authors introduced a weighted multi-DLNN inspection system capable of efficiently utilizing multi-channel measurement data, with a detection rate of up to 99% and a false pass rate below 1%.

Y. T. Sun, H. Y. Bai,, M. Z. Li, and W. H. Wang et. al., [10] describes Machine Learning Approach for Prediction and Understanding of Glass-Forming Ability. They described models for predicting the GFA of binary metallic alloys from random compositions. The effect of different input descriptors on GFA were evaluated, and the best prediction model was selected, which shows that the information related to liquidus temperatures plays a key role in the GFA of alloys. On the basis of this model, good glass formers can be predicted with high efficiency. The prediction efficiency can be further enhanced by improving larger database and refined input descriptor selection. The findings suggest that machine learning is very powerful and efficient and has great potential for discovering new metallic glasses with good GFA.

III. GLASS CLASSIFICATION USING MACHINE LEARNING ALGORITHM

In this section, glass classification using machine learning algorithm is presented. The main goal is to classify correctly a single fragment of glass based upon the main component measured. The system architecture is shown in Fig. 1. The System Architecture has eight main components, each component representing each step of this Glass classification using machine learning algorithms.

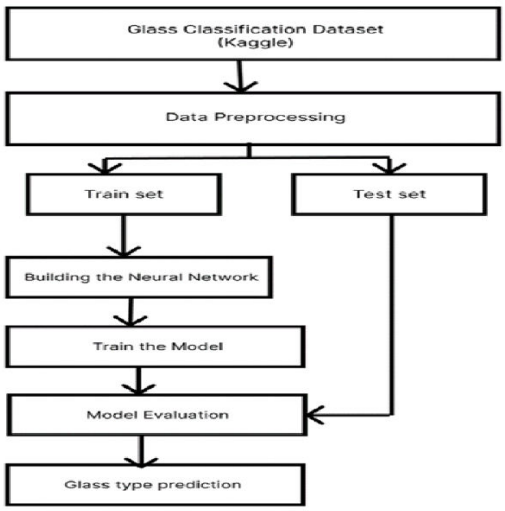

Fig. 1: System Architecture of Classification of Glass using ML Algorithms

This work consists of a new set of Glass Classification features and behaviours. Data set are collected from various sources of the Internet. The dataset's objective is to forecast Glass based on the provided factors (Id category, RI, Na, Mg, Al, Si, K, Ca, Ba), with all columns save the Id columns playing a vital part in defining the Glass type, which is also our desired variable. A glass dataset with ten input attributes and one output attribute is

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available (Type of glass). Information on Attributes (Input attributes) Identifier, RI stands for refractive index. Sodium (Na), Magnesium (Mg), Aluminum (Al), Silicon (Si), Potassium (K), Calcium (Ca), Barium (Ba), and Iron (Fe).

Data pre - processing techniques like finding missing values and replacing them with mean, median etc. After that the data set is divided into train set and test set and applied some feature selection techniques. The training data is the biggest (in -size) subset of the original dataset, which is used to train or fit the machine learning model. Firstly, the training data is fed to the ML algorithms, which lets them learn how to make predictions for the given task.

Once the model is trained with the training dataset, it's time to test the model with the test dataset. This dataset evaluates the performance of the model and ensures that the model can generalize well with the new or unseen dataset. The test dataset is another subset of original data, which is independent of the training dataset.

This system can easily maintain records and it can give correct values by giving the properties of the glass. It gives the purpose of the glass as output. It is easy to use for everyone and easy to handle Neural Network is the biological structure inspired by the working of human nervous system. Artificial Neural Network (ANN) is being applied widely on different application areas due to its learning ability i.e. capability to extract rules and learn from the data and create a network model which can be used for classification.

A neural network is a collection of algorithms that aims to recognize underlying links in a large amount of data in a way that replicates how the human brain works. The biological structure generated by the operation of the human nervous system is known as a neural network. Artificial Neural Network (ANN) is a deep learning algorithm that is particularly inspired by the working of a biological brain. It has a multilayer struc ture that is comprised of (a) an input layer, (b) an output layer, and (c) multiple hidden layers. Several neurons are connected with each other to make up a layer. Every neuron consists of a non-linear transformation operator (sigmoid function) that relates the signal being received from the neurons of the previous layer to a response signal that gets transmitted to the neurons of the subsequent layer. This consists of forward transmission as well as reverse transmission.

The pre-processed training dataset is used to train our model using ANN algorithm and generates suitable type of glass. The user needs to upload the properties of glass. As a result ANN generates the glass based on the properties entered by the user. Hence in this way, this approach classifies the glass types based on their properties.

IV. RESULT ANALYSIS

In this section, glass classification using machine learning algorithm is implemented using python. The result analysis of presented approach is evaluated here. In this analysis, dataset is collected from various websites and internet. The collected data is pre-processed and spiltted as training set and testing set. ANN classifier is used to classify the glass type.

The user has to upload properties (RI, Na, Mg, Al, Si, K, Ca, Ba) of glass for which it will generate the type of glass. The generated type of the glass is viewed by the user. The results screen is shown in Fig. 2.

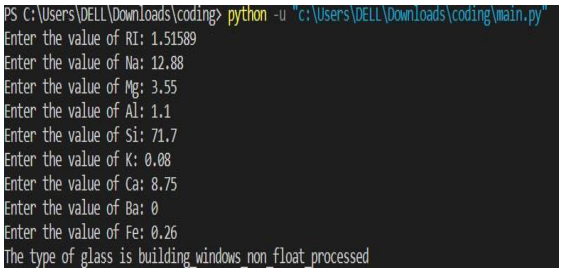

Fig. 2: Classification of Glass

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The Fig. 3 shows the tableware glass type classification based on the properties uploaded by the user.

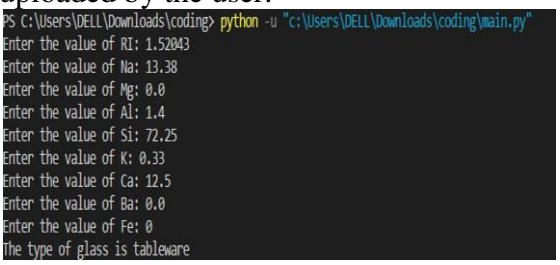

Fig. 3: Tableware Glass Classification

The Fig. 4 shows the vehicle windows float processed glass type classification based on the properties uploaded by the user.

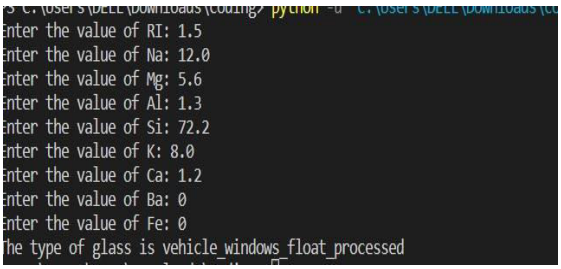

Fig. 4: Vehicle Windows Float Processed Glass Type Classification

The Fig. 5 shows the headlamps type glass based on the properties uploaded by the user.

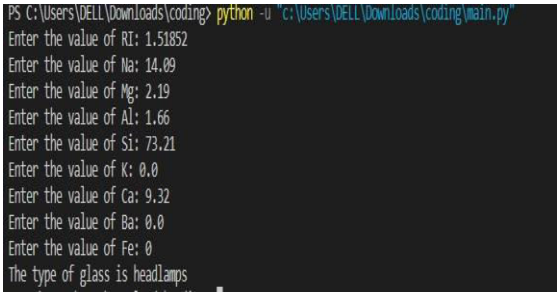

Fig. 5: Head lamps type Glass Classification

The Fig. 6 shows the accuracy comparison of different approaches.

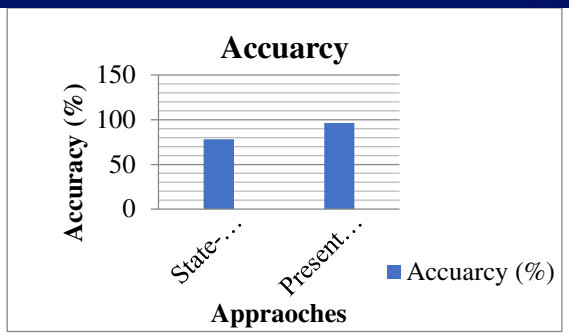

Fig. 6: Comparative Graph for Accuracy

Compared to state of art approaches, presented ANN algorithm has better accuracy for glass classification.

V. CONCLUSION

In this work, glass classification using machine learning algorithm is presented. The data set is taken from internet is pre-processed and divided into two subsets: training (70%) and test (30%). The classifiers are built on the training dataset, and the relative performance of the classifier is obtained on the test data. The Artificial Neural Network is employed to classify the glass type. This approach classified the glass as tableware glass, head lamps type, windows float processed glass type and Windows not float processed glass type. The performance of presented approach is measured in terms of accuracy. It has been found that as the number of times we train our network model the average error decreases as observed. ANN is suitable for glass type classification. The accuracy of ANN is 96.7% which promising percentage for glass type classifications.

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