IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Recognition of Machine Sound Data for Efficient Machine Condition Monitoring

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Abstract— Machine condition checking innovation has around for a long time, designed for advancing machine execution and limiting unplanned personal time. Since the appearance of the IoT, nonetheless, there has been development around machine condition observing. An IoT-based model for machine apparatuses condition examination with AI, IoT computerizes and adds knowledge to machine condition checking. In this paper different techniques are studied about machine tools condition analysis and classification. This examination surveys different techniques which are used to classify machine sound data. The center goal is to order the obtained machine sound sign into the comparing machine conditions effectively for example faulty and normal, which is generally a multi-class order issue.

Keywords- Machine tools condition analysis, Machine learning, IoT, Sound data.

I. INTRODUCTION

Machine condition monitoring is the mechanism of tracking a machine's status with the intent of monitoring mechanical wear and failure. Vibration, machine sound and temperature measurements are often used as key indicators of the machine's state. Data factors provide health information about the system and detect machine faults early, helping to prevent unexpected failures and expensive and time consuming repairs. With the developments of science, technology and economic environment, modern industry's production process is becoming greater, continuous, and integrated. To meet these characteristics, the efficiency requirements of the equipment itself, but it can also cause more loss of economy due to its effect on the entire production chain. For this purpose, companies give great importance to the maintenance of equipment and this section includes a lot of infrastructure, material resources, and capital. Unfortunately, due to ineffective maintenance a large amount of investment is wasted in this field.

Many researchers are exploring Condition-based Monitoring (CBM) in depth. CBM is an unique and innovative maintenance strategy that conducts maintenance based on the actual condition of the equipment to avoid unnecessary maintenance, prevent catastrophic faults, increase reliability of the equipment and improve maintenance efficiency [1].

For any company or industry, the purpose of plant maintenance has always been to improve uptime and productivity by better preventive or predictive maintenance and diagnostic condition tracking, so the targeted objectives can be accomplished with increased revenue. It is a standard approach implemented in many industry sectors, but faces some problems such as extremely limited data storage space and especially scalability when multiple machines are operated at different locations [3].

The Industrial Internet of Things, or IIoT, uses the Internet of Things platform to improve industrial operations and sectors. IIoT is a network of communications-based tools designing a framework that records, collects, exchanges and analyzes data and offers useful insights that allow industrial firms to take smarter business decisions immediately. Intelligent resources, i.e. sensors, automatically relay information to the data transmission network, where, for example, it is translated into reliable information to how a certain piece of machinery operates. These data can then be used for predictive management and for the design of business process applications [3] [4] [5].

II. RELATED WORK

In recent year Machine learning become popular research area. There has been some work in the area of machine condition based prediction and monitoring. The most relevant published papers that are analyzed are listed below:

In [1], Yanyu Zhang et al. proposed Online and Remote Machine Condition Monitoring and Fault Diagnosis System Using Wireless Sensor Networks that tracks the status of engines with vibration transmitters, transmits include information by means of WIA-PA arrange, and permits visualizations through the specific master program. Advanced remote control of PC condition and gadget for flaw conclusion utilizing remote sensors.

In [2], D. Ganga et al. proposed an IoT ongoing checking of the condition of electrical machines concentrated on vibration examination by utilizing gateway IoT2040.

In [3], Sana Talmoudi et al. proposed IoT-based failure prediction application for system monitoring using the toorPIA Big Data Engine sensor node used to evaluate the prediction of system failure.

In [4], Yasser Alsouda et al. proposed IoT-based Urban Noise Detection Using Machine Learning: Efficiency of SVM, KNN, Bagging, and Random Forest In which machine learning technique is used for urban noise detection, for audio feature extraction MFCC and supervised learning algorithm is used. To accomplish this the authors used low-power and resource-constrained hardware device Raspberry Pi Zero W.

In [6], H. M. Hashemian et al. discussed the State-of-the-Art Predictive Maintenance Techniques, In which time-based machinery maintenance approaches and predictive monitoring techniques use the latest sensor technology to prevent excessive failure in machine tools, time and expense are also saved. In [7], M. Pan et al. proposed Remote online computer control system in which TCP / IP internet communication interface is used and BCB programming language is used for application coding. The module is trained using ANN backpropagation algorithm.

In [8], W. Wang et al. proposed a Smart Sensing Unit for vibration measurement and machinery condition monitoring, a new signal processing method, wavelet energy spectrum, for bearing fault detection and the max-envelop method and one-scale WT technique is used for feature extraction.

In [9], Z. Zhanf et al. proposed Fault diagnosis and prognosis using wavelet packet decomposition for decomposing the vibration signal, for transforming that signal in frequency domain using Fourier transformation and From the frequency-domain data, they extracted the features to train an ANN.

In [10], S. S. Goundar et al. Designed a wireless monitoring system for industrial motors using vibration and temperature sensors, vibration data converted into frequency domain using FFT and this real time monitoring is done by using IoT.

In [11], D. Jung et al. proposed the algorithm estimates the Remaining Useful Time (RUL) by considering the threshold of difference and projecting the features of the equipment over space to verify whether the projection reaches this threshold. RANSAC's key principle is to shape various basic predictions from a data set, and classify that assumption with the most helpful measurements.

In [20], Swapnil Dol et al. proposed Smart motor for Industry 4.0, in which researchers has led to the establishment of the SMART Motor Kit, which can be mounted to turn it into a SMART Motor inside any engine. The approach has already been tested on crucial motors all over the industry.

III. BACKGROUND

This section provides the overview of relevant background studies on architecture, which provide overview of machine learning and information with respect to the used hardware platform.

Machine learning is closely related to computational statistics, which also focus on prediction making. Now, machine learning is widely used in machine condition monitoring and maintenance.

In the machine learning community, these the sound attributes are considered as a features. Multiple features are often determined to generate a feature set. Based on the number of features in the set, a feature selection algorithm can make further filtering of the set.

The MFCCs, that is, The mel-frequency cepstral coefficient and time domain features are derived from a training data set of sound samples to train models using machine learning algorithms (i.e., SVM, KNN, Random Forest) that are used to predict the kind of sensed environmental sounds. Extraction of features is the first step of an automated sound classification system. MFCCs are a well-known group of features that are usually used in the interpretation of speech as they are well-correlated with what the user can hear.

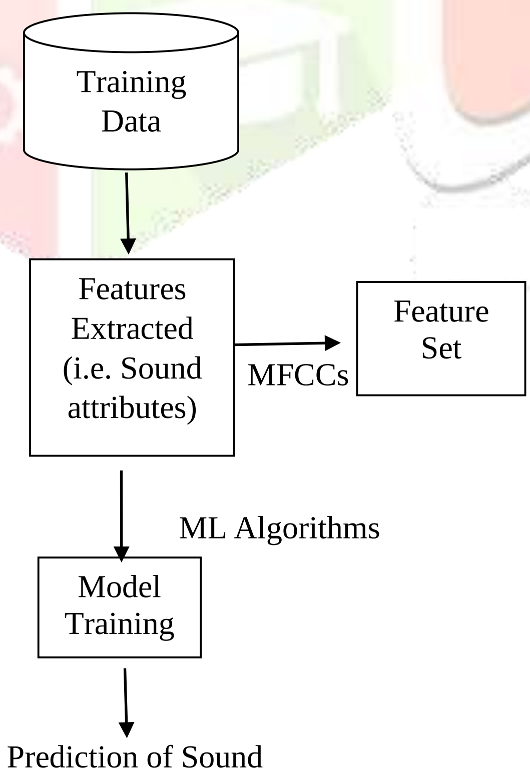

Figure 1: Approach for machine sound identification using machine learning

IV. METHODOLOGY

The core objective is to categorize the acquired machine sound signal into the corresponding machine conditions correctly i.e faulty and normal, which is generally a multi-class classification problem. A typical set-up of the overall framework for this problem is depicted in Figure.

The sampled vibration signal is a large collection of time indexed data point. First acquisition of Machine sound data will be taken for various machine working conditions and its data with its respective labels will be stored and then further used for training and testing purpose of intelligent learning model.

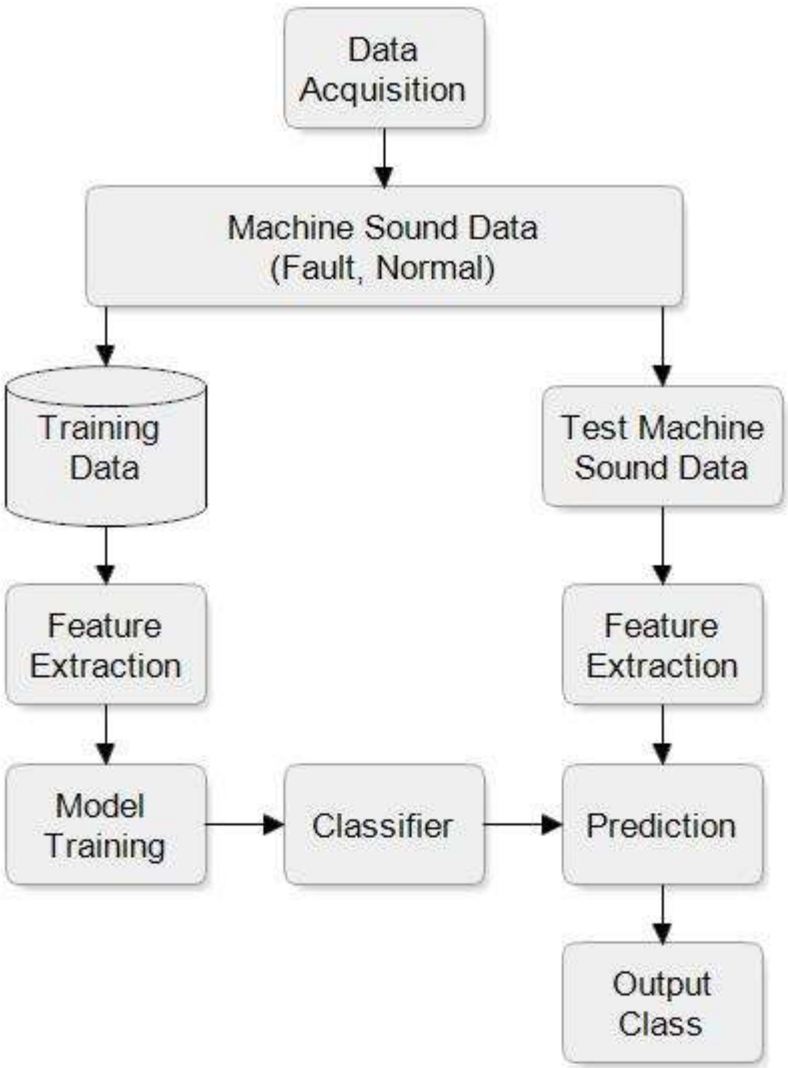

Fig 3: Flow chart for classification

Generally 70-30 percentage ratio used for learning and testing of machine sound data. To make sensible deduction automatically using a intelligent learning based classifier is not an easy task owing to the curse of dimensionality. Instead of processing the raw signals, the common approach is to compute certain attributes of the raw signal that can describe the signal in essence. In the machine learning community, these attributes are referred to as features. At times, multiple features are computed to form a feature sets. Depending on the number of features in the set, one may need to perform further filtering of the set using a feature selection algorithm.

MFCCs i.e. Mel-frequency cepstral coefficient and time domain features are extracted from a training data-set of sound samples to train SVM models that are used to predict the type of sensed environmental sounds.Features extraction is the first step in an automatic sound classification system. MFCCs are a well-known feature set and are widely used in the area of sound classification because they are well-correlated to what the human can hear.

V. CONCLUSION

This study reviews various techniques which are used to classify machine condition by analyzing a machine sound data. The more desirable condition is that we can foresee machine failure in advance and initiate maintenance before the failure happens, so the machines can still operate in a safe condition and perform satisfactory operations. For machine sound classification, different classification techniques are designed and proposed. Machine Learning technique is most used technique for sound classification, Accuracy of all algorithms differ by their parameters.

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