A Method applied to Animal Detection by YOLO COCO Model using Images

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***Abstract*—** *Leak detection of gas pipelines has attracted extensive attention in recent years because such a leak could result in significant damage to society. This paper proposes an integrated leak detection method using acoustic signals based on wavelet transform and Support Vector Machine (SVM). Specifically, the optimal wavelet basis is selected by the entropy-based algorithm adaptively, with which acoustic signals Gathered by acoustic sensors are first pre-processed by wavelet transform. Then useful features containing leak severity information are extracted from multi-domain components of the acoustic signals. Moreover, for leak detection and severity classification, the Relief-F algorithm is applied to select the most discriminative features. Furthermore, selected features are used as the input of SVM classifiers to identify the leak severity of gas pipelines. The effectiveness of the proposed method is validated using laboratory experiments. The results demonstrate that the proposed method achieves high accuracy of 99.4% to determine the leak state and non-leak state by using the first three most discriminative features and 95.6% to classify the normal and several leak severities conditions by using the first five most discriminant. Inactive features. Therefore, it is effective for leak detection and promising for the development of a real time monitoring system.*

I. INTRODUCTION

Pipeline is one of the most important parts of engineering infrastructures. For example, natural gas pipelines transport gas from field processing facilities to cities or customers. However, leakage of gas pipelines happens frequently due to corrosions, construction defeats, aging or geological deformations, leading to serious contamination to the environment and even potential hazards to circumstances. The pipeline leakage usually leads to some characteristic changes in internal pressures, flow rates, acoustic waves, etc. Therefore, it might be possible to detect a pipeline leakage by monitoring the variation of related quantities. Over the past decades, various technologies have been proposed to detect the leakage of gas pipelines, for example, the real-time transient modeling, tracer gases and the acoustic method. Among them, the acoustic method has been proved to be advantageous due to its high sensitivity, efficiency and accuracy. The acoustic method identifies the sound or vibration of gas pipelines induced by escaping gas caused by the pressure difference between the in-pipe and out-pipe medium. As pressurized gas escapes from the pipe, there is an air-structure coupling between the high-velocity escaping gas and the pipe wall, creating the sound or vibration that travels through the pipe wall, the gas column and to the surface. In terms of the mechanism of leak noise generation, the presence of a leak within a pipeline leads to significant turbulent pressure fluctuations that form acoustic sources, thus generating the sound or vibration. Then the sound or vibration can be captured by corresponding sensors, accelerometer, microphones and listening rods, which is useful for leak detection.

1.1 Artificial Intelligence:

Artificial intelligence (AI) is the ability of a computer program or a machine to think and learn. It is also a field of study which tries to make computers "smart". As machines become increasingly capable, mental facilities once thought to require intelligence are removed from the definition. AI is an area of computer sciences that emphasizes the creation of intelligent machines that work and reacts like humans. Some of the activities computers with artificial intelligence are designed for include: Face recognition, Learning, Planning, Decision making etc.,

Artificial intelligence is the use of computer science programming to imitate human thought and action by analysing data and surroundings, solving or anticipating problems and learning or self-teaching to adapt to a variety of tasks.

1.2 machine Learning

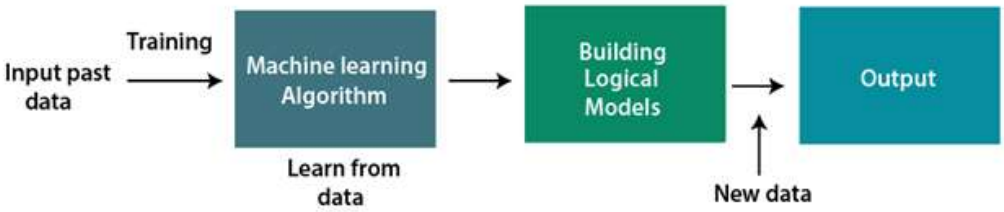
Machine learning is a growing technology which enables computers to learn automatically from past data. Machine learning uses various algorithms **for building mathematical models and making predictions using historical data or information.** Currently, it is being used for various tasks such as **image recognition, speech recognition, email filtering, Facebook auto-tagging, recommender system**, and many more.

Machine Learning is said as a subset of **artificial intelligence** that is mainly concerned with the development of algorithms which allow a computer to learn from the data and past experiences on their own. The term machine learning was first

introduced by **Arthur Samuel in 1959**. We can define it in a summarized way as: "Machine learning enables a machine to automatically learn from data, improve performance from experiences, and predict things without being explicitly programmed".

A Machine Learning system **learns from historical data, builds the prediction models, and whenever it receives new data, predicts the output for it**. The accuracy of predicted output depends upon the amount of data, as the huge amount of data helps to build a better model which predicts the output more accurately.

Suppose we have a complex problem, where we need to perform some predictions, so instead of writing a code for it, we just need to feed the data to generic algorithms, and with the help of these algorithms, machine builds the logic as per the data and predict the output. Machine learning has changed our way of thinking about the problem. The below block diagram explains the working of Machine Learning algorithm:



1.2.1 Features of Machine Learning:

- Machine learning uses data to detect various patterns in a given dataset.
- It can learn from past data and improve automatically.
- It is a data-driven technology.
- Machine learning is much similar to data mining as it also deals with the huge amount of the data.

1.2.2 Classification of Machine Learning

At a broad level, machine learning can be classified into three types:

1. Supervised learning
2. Unsupervised learning
3. Reinforcement learning

1) Supervised Learning

Supervised learning is a type of machine learning method in which we provide sample labelled data to the machine learning system in order to train it, and on that basis, it predicts the output.

The system creates a model using labelled data to understand the datasets and learn about each data, once the training and processing are done then we test the model by providing a sample data to check whether it is predicting the exact output or not.

The goal of supervised learning is to map input data with the output data. The supervised learning is based on supervision, and it is the same as when a student learns things in the supervision of the teacher. The example of supervised learning is **spam filtering**.

It can be further classifieds into two categories of algorithms:

- **Clustering**
- **Association**

OpenCV-Python

OpenCV-Python is a library of Python bindings designed to solve computer vision problems.

Python is a general-purpose programming language started by **Guido van Rossum** that became very popular very quickly, mainly because of its simplicity and code readability. It enables the programmer to express ideas in fewer lines of code without reducing readability.

Compared to languages like C/C++, Python is slower. That said, Python can be easily extended with C/C++, which allows us to write computationally intensive code in C/C++ and create Python wrappers that can be used as Python modules. This gives us two advantages: first, the code is as fast as the original C/C++ code (since it is the actual C++ code working in background) and second, it easier to code in Python than C/C++. Open CV Python is a Python wrapper for the original OpenCV C++ implementation.

OpenCV-Python makes use of Numpy, which is a highly optimized library for numerical operations with a MATLAB-style syntax. All the Open CV array structures are converted to and from Numpy arrays. This also makes it easier to integrate with other libraries that use Numpy such as SciPy and Matplotlib.

pip install opencv-python

pip install numpy

pip install matplotlib

To read the images cv2.imread() method is used. This method loads an image from the specified file. If the image cannot be read (because of missing file, improper permissions, unsupported or invalid format) then this method returns an empty matrix.

Syntax: cv2.imread(path, flag)

Parameters:

path: *A* string representing the path of the image to be read.

flag: It specifies the way in which image should be read. Its default value is

cv2.IMREAD_COLOR

Return Value: *This method returns an image that is loaded from the specified file.*

Note: The image should be in the working directory or a full path of image should be given.

All three types of flags are described below:

cv2.IMREAD_COLOR: *It specifies to load a color image. Any transparency of image will be neglected. It is the default flag. Alternatively, we can pass integer value **1** for this flag.*

cv2.IMREAD_GRAYSCALE: *It specifies to load an image in grayscale mode. Alternatively, we can pass integer value **0** for this flag.*

cv2.IMREAD_UNCHANGED: *It specifies to load an image as such including alpha channel. Alternatively, we can pass integer value **-1** for this flag.*

II. LITERATURE REVIEW

[1]Title: Pipe system diagnosis and leak detection by unsteady-state tests. 1. Harmonic analysis

Author: Marco Ferrante, Bruno Brunone - January 2003

Description: Since leak reduction actually corresponds to the acquirement of new water quality resources, development of leak detection methodologies is a non-trivial scientific and engineering issue for the water resources community.

In this paper and in the companion paper it is shown that unsteady-state tests can be used to pipe diagnosis and leak detection. Specifically, in this part the governing equations for transient flow in pressurized pipes are solved directly in the frequency domain by means of the impulse response method. The analytical expression of the piezometric head spectrum at the downstream end section of a single pipe system during transients is then derived. Within this approach it is shown that the piezometric head spectrum is the product of two terms: the former related only to the manoeuvre characteristics, the latter depending only on the characteristics of the system. In the case of fast linear closure manoeuvres, the analytical expression of both terms is also given. The derived analytical solution of the pressure signal in the frequency domain, allow us to interpret

the data acquired in a single pipe system to have information on its state. Experimental data are compared to the analytic solution.

[2] Title: Pipe system diagnosis and leak detection by unsteady-state tests. 2. Wavelet analysis

Author: Marco Ferrante, Bruno Brunone - January 2003

Description: As shown in Part 1, the analysis of a pressure signal in the frequency domain can give items of information for leak detection even though, moving from time to frequency domain, interesting information about the arrival time of pressure waves are lost. To overcome this limitation and to widen the applicability of transient-test based methodologies for leak detection, the wavelet transform of laboratory experimental data is used. Such data consist of pressure time histories acquired at one measurement section during transients in a single pipe system. The wavelet transform is used to detect local singularities in the pressure time history due to the presence of a leak. The discontinuity occurrence in time reveals the arrival time of the leak reflected pressure wave and is the basis for leak location.

[3] Title: Leak detection in water-filled plastic pipes through the application of tuned wavelet transforms to Acoustic Emission signals

Author: Majid Ahadi, Mehrdad , Sharif Bakhtiar - 7, July 2010

Description: Online reviews are an important asset for users deciding to buy a product, see a movie, or go to a restaurant, as well as for businesses tracking user feedback. However, most reviews are written in a free-text format, and are therefore difficult for computer systems to understand, analyze, and aggregate. One consequence of this lack of structure is that searching text reviews is often frustrating for users. User experience would be greatly improved if the structure and sentiment conveyed in the content of the reviews were taken into account. Our work focuses on identifying this information from free-form text reviews, and using the knowledge to improve user experience in accessing reviews. Specifically, we focused on improving recommendation accuracy in a restaurant review scenario. In this paper, we report on our classification effort, and on the insight on user-reviewing behavior that we gained in the process. We propose new ad-hoc and regression-based recommendation measures, that both take into account the textual component of user reviews**.**

[4] Title: Leak Detection in Subsea Pipeline: A Mechanistic Modeling Approach With Fixed Pressure Boundaries

Author: Rahul Narayanrao Gajbhiye; Seung Ihl Kam - May 05 2008

Description: A subsea pipeline leak has caused a serious concern over the transportation of deepwater oil and gas production to onshore or shallow-water production facilities. Hazardous impact on marine environment and consequential economical loss resulting from the subsea pipeline leak became an important issue of oil and gas industries. Currently more than hundreds of hydrocarbon production projects are ongoing, and Deepwater production is expected to almost double over the next decade in the Gulf of Mexico. Active development of Deepwater activities in the Gulf of Mexico will undoubtedly lead to the expansion of subsea pipelines.

This study, for the first time, shows how a subsea pipeline leak can be modelled in a mechanistic way. Especially, a focus is made to the implication of fixed-pressure boundary conditions at both upstream and downstream locations, which is quite relevant to the way how the majority of field operations are actually operated and managed. The use of fixed-pressure boundary conditions leaves the change in inlet total flowrate (Detin) and the change in outlet total flowrate (Detour) as two possible leak detection indicators that can be monitored on real-time basis. The two-phase flow in subsea pipelines, which is filled with gas and oil mixtures, is analyzed using well-known Beggs and Brill's two-phase correlations. The effect of different parameters on the mechanistic leak detection modeling is investigated accounting for gas compressibility, back pressure of the system, the pressure drops across the system, input fraction of gas and oil phases, and the fraction of gas and oil phases leaking out of the pipeline system through the leak.

The results exhibited the following outcomes:

1. The leak could be more easily detected with increasing leak size no matter which of the two leak indicators (Detin or Detour) were used;
2. The presence of compressible fluid in the pipeline amplified the disturbance to the system in general. This made the use of Dqtout less promising (but the use of Dqtin more promising at the same time) for leak detection;
3. The loss of larger fraction of less dense and less viscous fluid through the leak caused the use of Dqtin less viable but the use of Dqtout more viable; and

4. Combination of larger pressure drop across the system (i.e., the difference between the inlet and outlet pressures) and larger gas fraction at the leak (fgleak) made the use of Dqtout more favorable.

It should be noted that the net effect of the presence of gas phase, by taking gas compressibility, viscosity and density all together into consideration (i.e, (2) and (3) above), was a decrease in? qtin and an increase in? qtout. This means that the presence of gas phase in the subsea pipelines makes the use of qtout more reliable (but the use of qtin less reliable) as a leak detection indicator.

III. EXISTING SYSTEM

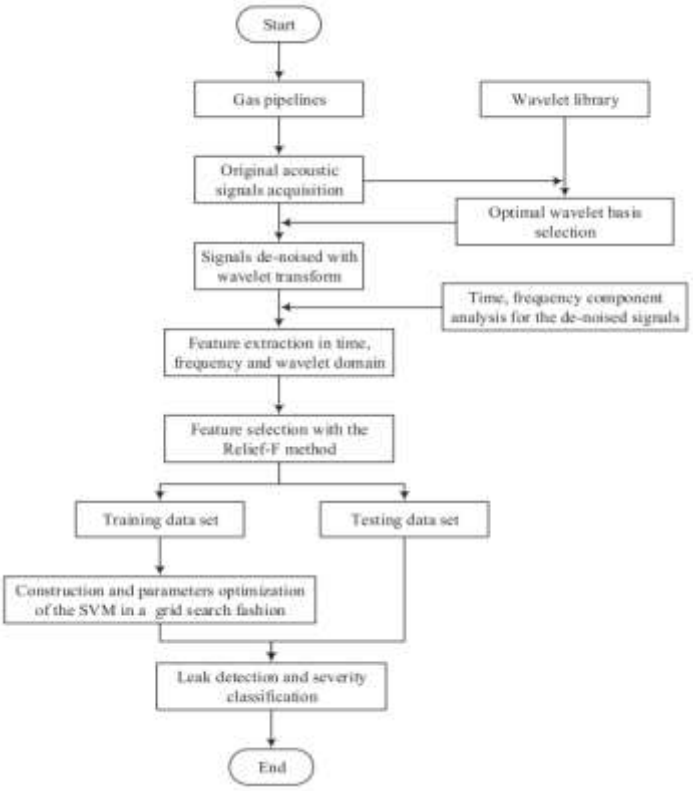
Based on experimental data obtained on acoustic leak detection system for the experimental sodium loop, this project extends the application of wavelet noise elimination in processing of leak signals. We analyse the thresholding methods for decomposing coefficient of wavelet at different layers. The result shows that for acoustic leak detection signal of the fast reactor steam generator, wavelet noise elimination can evidently improve signal-noise ratio of the detection system, and characteristics of leak will become more obvious. Therefore, the adoption of wavelet noise elimination method in detection of leak signals is a highly effective method for timely leak detection of fast reactor steam generator.

It is one of main measures for safe operation of the fast reactor to use acoustic leak detecting technology to realize early detection for water/steam leak of steam generator in fast reactor nuclear power station. Based on experimental data about sodium loop experiment completed by Liquid Metal Laboratory of Tsinghua University, this paper investigates the application of wavelet noise elimination in detection for water/steam leak of fast reactor steam generator. The result shows that wavelet noise elimination can greatly improve signal-noise ratio, and it is really a highly effective method for timely and correct leak detection of the steam generator.

Disadvantage

- It cannot give an accuracy value.
- Less storage
- Less performance

IV. SYSTEM ARCHITECTURE



V. PROPOSED SYSTEM

In this paper, an acoustic leak detection method based on wavelet transform and Support Vector Machine is proposed. A wavelet entropy-based algorithm is applied to select the optimal wavelet basis adaptively. Then, acoustic signals are de-noised by the wavelet transform using the universal threshold rule and the soft thresholding scheme and the characteristics of leak acoustic signals of gas pipelines are investigated. Furthermore, features in time, frequency and wavelet domain that represent interesting information of the de-noised acoustic signals are extracted, and the most discriminative features are selected by the Relief-F method

4.1 Advantages

1. Good Performance
2. Exact accuracy
3. More efficient

System Modules:

- Module 1: Data Exploration
- Module 2: Pre-Processing
- Module 3: EDA
- Module 4: Feature extraction
- Module 5: evaluate

Module 1: Dataset Collection

Data collection is the process of gathering data for use in business decision-making, strategic planning, research and other purposes. It's a crucial part of data analytics applications and research projects: Effective data collection provides the information that's needed to answer questions, analyze business performance or other outcomes, and predict future trends, actions and scenarios.

Module 2: Pre-Processing

Step 1: Load Product review data as input for the system, which consist of positive, negative and neutral reviews on products.

Step 2: Stop word filtering: "Stop words" are the most common words in a language like "the", "a", "on", "is", "all". These words do not carry important meaning and are usually removed from texts. It is possible to remove stop words using Natural Language Toolkit (NLTK), a suite of libraries and programs for symbolic and statistical natural language processing.

Module 3: EDA

EDA stands for **exploratory data analysis**. It's what you do when you first encounter a data set. But it's not a once off process. The past few weeks I've been working on a machine learning project.

Module 4: Feature extraction

Models for evaluation of Multinomial Naive Bayes and Random Forest.

Naive Bayes is a simple, and due to its simplicity, this algorithm might outperform more complex models when the data set isn't large enough, and the categories are kept simple. The training documents are allowed to calculate the class and evidence of the text document where classification is applied on test documents and choosing the class with the maximum probability.

Module 5: Evaluate

The three main metrics used to evaluate a classification model are **accuracy, precision, and recall**. Accuracy is defined as the percentage of correct predictions for the test data. It can be calculated easily by dividing the number of correct predictions by the number of total predictions.

II. CONCLUSION

In this project, an acoustic leak detection method based on wavelet transform and Support Vector Machine is proposed. A wavelet entropy-based algorithm is applied to select the optimal wavelet basis adaptively. Then, acoustic signals are de-noised by the wavelet transform using the universal threshold rule and the soft thresholding scheme and the characteristics of leak acoustic signals of gas pipelines are investigated. Furthermore, features in time, frequency and wavelet domain that represent interesting information of the de-noised acoustic signals are extracted, and the most discriminative features are selected by the Relief-F method. Finally, selected features are used as the input to train SVM classifiers for leak detection. According to the above investigation, the following conclusions can be drawn:

(1) The characteristic frequency band of leak acoustic signals concentrates on the low frequency from 0 to 100 Hz. The wavelet transform can effectively remove noises contained in acoustic signals and reserve the characteristic frequency component with the optimal wavelet basis ('sym17' in this study) selected by the entropy-based algorithm.
(2) Leakage severity results in a change of the frequency structure of acoustic signals, which could be readily discernible once processed using wavelet transform. Moreover, the characteristic leak information of time-varying nonstationary acoustic signals could be effectively extracted by using wavelet transform. The most discriminative features are selected by the Relief-F algorithm. The feature selection result shows that the wavelet mean frequency proposed based on the wavelet transform results is an effective feature that captures the characteristic information and helps to improve the SVM prediction precision.
(3) When using the first three most valuable features, e.g. standard deviation, wavelet mean frequency and absolute mean, the accuracy for classifying leak state and non-leak state of the optimized SVM can reach up to 99.4%. Besides, using the first five features e.g. standard deviation, wavelet mean frequency, absolute mean, frequency centroid and short-term energy, the accuracy for classifying the normal and several leak severities of the optimized SVM can also be up to 95.6%, which is promising as the change of the operating pressure has been taken into consideration.

The results show that the proposed method performs well in leak detection, it not only detects whether the leak occurred but also discovers the severity of leakage of gas pipelines. Therefore, this method has potential application for the development of a real-time leak detection monitoring system.

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