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Towards the Development of a Real-time Deep Surveillance Industrial Scene Human Activity Recognition System to Mitigate Gas Pipe-lines Vandalization

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Abstract:- Human activity detection and recognition (HADR) is an important field of study in computer vision, due to it wide application areas like security surveillance, robotics, human computer interaction, content based retrieval and annotation, human fall detection etc.,. The essence of HADR is to automatically understand and recognized what kind of action (human behavior and activities) is performed by human in a video captured by a surveillance system. This is really a difficult problem due to many challenges involved in HADR. These challenges include: cluttered backgrounds, variation in motion and human shape, variation in illumination conditions, occlusion, and viewpoint variations. However, the intensity of these challenges may vary depending on the category of an activity under consideration. Generally, the activities are grouped into four classes which constituent, human-gestures, actions, interactions, and group activities, this division is mainly based on complexity and duration of the activities. Due to the advancement in sensor and visual technology, HADR based systems have been widely used in many real-world applications. Specifically, the increase of small size sensors have enabled the smart devices to recognize the human activities in a context-aware manner.

Hence, with HADR numerous application area we propose a deep surveillance industrial scene human activity detection to fight against gas pipe-line vandalizing, where, the recognition scheme can effectively detect any suspicious activity and report via sending a notification to the authorities for immediate action.

Keywords:- *Component; Real-Time Surveillance; Human Activity Recognition; KNN; Wireless Sensor Networks.*

I. INTRODUCTION

Gas and oil pipeline vandalization in Nigerian has significantly affected the oil sector and the country at large in numerous ways which includes huge economic losses from pipeline & plant shutdown, pollution of environment, by oil spillage, fire outbreaks usually resulting in loss of lives amongst others. Thus, shortage and scarcity, of petroleum products as well as decrease in electricity supply, with the attendant socio-economic problems can also be attributed to pipeline vandalism [10]. Petroleum products in Nigeria, are mostly transported via a network of pipeline running across various part of the country through remote area to populated areas however, these pipelines are poorly secured thereby attracting various forms of repetitive attacks targets by vandals. Countless measure have been taken by government to ensure efficient service delivery but the problems appear to be increasing [11]. Hence, our goal is to present a modern and holistic approach to addressing this problem by adopting state of the art digital surveillance and efficient machine learning algorithms. The rest of this paper, is structured as follows, in section II, literatures related to the works are presented in brief, while in section III, methodology adopted for the proposed work is equally presented, and finally section IV concludes the proposed study.

II. REVIEW OF RELATED WORKS

A number of research interest is drawn to the area of pipeline surveillance due to the economic importance of pipelines as well as the health and safety implications of pipeline incidents. Thus, Wireless Sensor Network (WSN) has been identified and presented as a suitable solution for addressing pipeline surveillance related problem via sensing the environment and it is cost-effective. Asides pipeline surveillance, other related applications domain for WSN in oil and gas sector ranges from detecting leakage in pipelines, monitoring tank level, Equipment Condition Based Monitoring (CBM), Pipeline Pressure Relief Value Monitoring (PRV), Refineries Pressure Relief Value Monitoring (PRV) and Well head Automation and Monitoring. However, most pipeline surveillance systems are focused on leak detection [1]; [2], few pipeline

surveillance systems have tried to address threat detection in pipelines. Sun and Wen [3] conducted a study on pipeline threat detection and security, thereby developing a pre-warning scheme for pipeline security using multi-seismic sensors. Liang et. al [4] performed a risk assessment studies on pipelines based on malicious and accidental threats. Furthermore, fault tree was used by the authors to decide the risk assessment index, thereafter a self-organizing map scheme (SOM) was employed to perform risk level classification on various section of the pipeline. An effective WSN based framework for integrated oil pipeline monitoring aimed at threat mitigation for architectural model in pipelines is presented by Jawhar et al. [5] while, in Seema and Reisslein [6] a wire1ess-video sensor node architecture scheme was developed (WVSNP). The hardware and software requirements for WVSNP were discussed. Thus, various WSN models have been developed, while the dynamic linear configuration model is identified to be as the more suitable for pipelines due to its linear nature Mohamed and Jawhar [7] and Jawhar et. al [5]. Utilizing the present day technology, Wireless sensor networks having a wide range of applications. Hence, WSN used for intelligent transportation system will relatively differ from those used for telemedicine and other services in various ways. WSN used for pipeline surveillance should be effective in detecting leakages and threats to pipelines and localize such events with certain degree of accuracy. In designing an effective WSN for pipeline surveillance system, three (3) key features are considered they consist of the following: adequate wireless mote, topology for deployment, and data mining technique [12]. Oil and gas pipelines by nature pass through large geographical areas. Therefore, wireless motes utilized for pipeline surveillance should employ power optimization systems for the purpose of energy conservation while being able to transmit over a considerable distance. In WSN these factors considered during design depend on the specific task at hand even though a lot of factors are generic for various tasks [12]. In Boonjun et al [8] a real-time automatic object detection technique was developed using template matching for pipeline protection, while in the work of Goel et al [9] an on-line scheme for temporal detection of human daily-living activities using a long untrimmed video streams is presented.

However the reviewed techniques did not employ any machine learning algorithm to train, classify and enable the system detect and even predict any vandalism and other illegal activities before they occur. Our proposed system intends to address that challenge as the emphasis is on prevention by developing a system that not only detects but also predicts possible occurrence.

III. METHODOLOGY

Deep surveillance system in industrial scene will be made up of of three modules which include client module, application module and database server module. In the client section, it will include an android based application for receiving various notifications from the scene detection scheme, such as anomaly event detection notification, this will be receive only by authorized user. The Application phase (module), will be made up of the core human activity detection and recognition system. Whereas at the database end, a Google-server and apache tomcat local-server would be integrated to handle activity recognitions of the proposed scheme, for gas pipe-line vandalism, legal and illegal industrial human activity scenario, dataset would be created at industrial environment. If actions like pipe-vandalism or any illegal activity are detected by the system, it forwards a message signal to the user with registered and installed android based application as notification. Video sequence sense from an industrial environment is taken as input to system, followed by performing grayscale conversion and various forms of pre-processing, then feature extraction is performed using scale invariant feature transform (SIFT). The extracted features are used for action classification purpose. SVM and KNN classifiers are used for activity classification.

Firebase cloud messaging (FCM) would be incorporated in the developed deep surveillance industrial scene human activity detection and recognition scheme for sending notification to registered device. This service would be utilized for transferring a payload of up to about 4KB to a client application using FCM for an instant messaging to inform the client about the detected suspicious action and it location.

The outlined methodology would be carried out in the development of deep surveillance industrial scene human activity recognition to mitigate vandalizing gas pipe-lines.

- Data Collection
- Pre-processing
- Feature Extraction
- Clustering and Classification
- Pattern/template Matching
- Activity Recognition

A. Data Collection

Our video surveillance system would monitor the environment (pipeline installation route) and capture various forms of activities, behavior, or other changing information, usually, of people from a distance by means of sensing device. This is the first step towards prevention, reaction, detection, intervention. The data captured is transmitted in real time to a base facility.

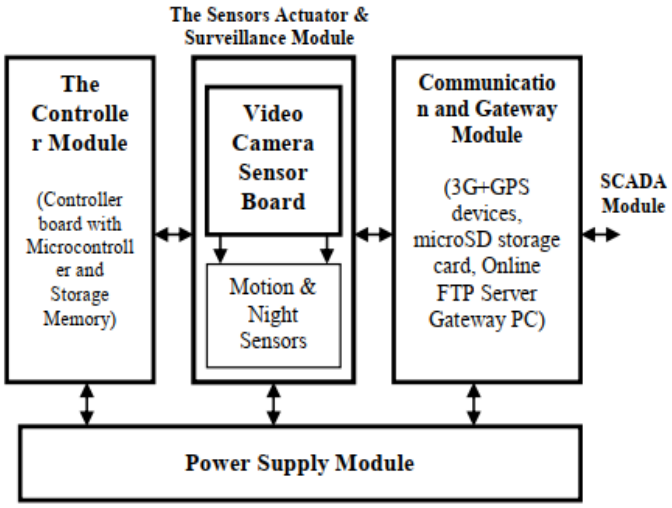

Fig 1:- Hardware Setup for Data Collection

B. Pre-processing

It is critical to carry out the data processing on the collected surveillance feed as the quality of the surveillance might be affected by weather, poor lighting signal interference and so on. Some of the preprocessing activities includes, compression, de-noising, segmentation, equalization etc.

C. Feature Extraction

Feature extraction is carried out on the preprocessed surveillance feed. First of all the background subtraction operation is done on the surveillance, then the feature of interest is extracted for clustering and classification.

D. Clustering and Activity Classification

The Support Vector Machine (SVM) and K-Nearest Neighbor (KNN) are the machine learning tools that would be employed to cluster, classify and train the system based on the collected surveillance dataset on different activities, movements and positions etc. Unlike conventional approaches this technique would enable the system make smart and intelligent inferences and predictions on possible threats even before they occur. Equation 1 shows the mathematical model of KNN prediction.

$$Y = \frac{1}{K}\sum_{i=1}^{k} y_i \qquad (1)$$

Here, y_i is define as the ith case of the examples sample and y denoted to be the prediction (outcome) of the query point.

E. Activity Recognition

Our system would track individual as they pass through the field of vision of the camera, and with machine learning algorithms to classify the motion and activities of every passerby that walks a stipulated radius to our pipeline infrastructure. The tracking is accomplished through the development of a position and velocity path characteristic. With this information, our system would report any threat or suspected threat to the attention of human security personnel.

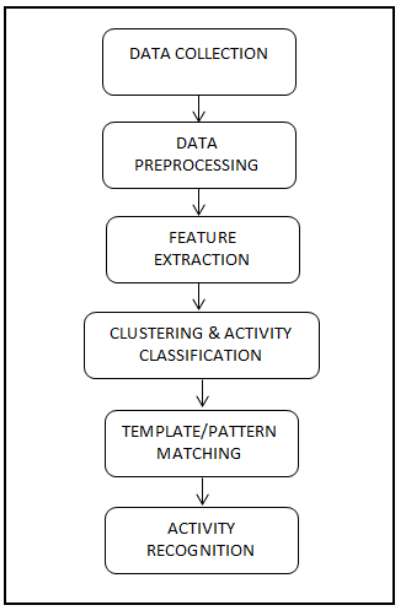

Fig 2:- Block Diagram of Deep Surveillance Human Activity Recognition System.

IV. CONCLUSION

The impacts of this research are numerous. Some of the benefits are; prevention of pipeline vandalism, reduction in financial losses, alleviation of environmental degradation, security and safety, increased oil revenue amongst. By adopting state of the art surveillance devices and a robust machine learning algorithm, the proposed system would be able to completely solve the problem of pipeline vandalism which poses a major threat to the operations and optimal yield of our oil and gas industry.

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