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Performance Evaluation of IoT in 5G Technologies for Fire and Spark Activity Detection

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Abstract: Present research is focusing on applications used for Industrial safety using the application of Internet of Things (IoT). With the growing popularity of IoT wireless technologies, 5G technology has emerged as a particularly difficult and exciting research field. With the advent of 5G, this study examines the issues and possibilities that a wide range of communication firms will face. The IoT and the new and evolving technologies that enable it are thoroughly covered in this paper. Low-power networks serve a wider geographic area, and safety issues are taken into account while determining control mechanisms. Fire and spark activity detection and categorization have been performed using an IoT system in this study. Convolution Neural Network (CNN) based deep learning is being used in this research process. The evaluation metrics chosen are Precision, Accuracy and Recall value. A camera is a kind of sensing equipment that captures conventional photos as well as detecting fire and embers.

Keywords: CNN, Fire and Spark, IoT, 5G system, Wireless sensor network

1. Introduction

Interconnected physical items that may be remotely controlled and monitored are known as IoT. Here the vehicles, varied buildings, and programmable sensors are all involved. All of this may be used for data collection and analysis. Connected systems in the IoT make it possible to monitor and operate physical items from a distance, reducing the total cost of digital infrastructures[1]. A 5G network is the internet's next big step forward. This will enable for the most advanced Wi-Fi and automation systems. Many gadgets will not be able to connect at high data transfer speeds, high-capacity levels, or low latency if new cellular networks like LTE are used.

2. IoT

Things with sensors, computing power, and software are part of what we call the IoT. These gadgets may be linked through the Internet or another kind of communication network. Sensors and IoT devices are often used by industrial, transportation, and utility organisations. They have been employed in agriculture, infrastructure, and home automation as part of the digital transformation.

3. Introduction of 5G technologies

The 5th generation of mobile technology is known as "5G". Mobile telecommunication standards 5G represent the next major phase beyond 4G standards. Product engineering, documentation, electronic transactions, and more are all supported by 5G technologies [2]. In an ideal world, a 5G telecommunications network would be able to address the issues that will arise once the 4G model is widely adopted[3].

4. CNN Structure Layers:

- **Convolutional layer:** The activity starts at the convolution layer. The convolution layer's job is to find interesting aspects of a picture. As a rule, it moves from the general to the particular features like face recognition etc.
- **Rectifying Linear Unit layer:** The First layer is extended by the second layer which is rectified unit layer. The main purpose of ReLu algorithm is to increase the image's non-linearity.
- **Pooling layer:** The pooling layer may be used for regression, which minimizes the number of parameters.
- **Full Connected layer:** A feed-forward neural network is used. There are just a few straight lines left before the finish line.

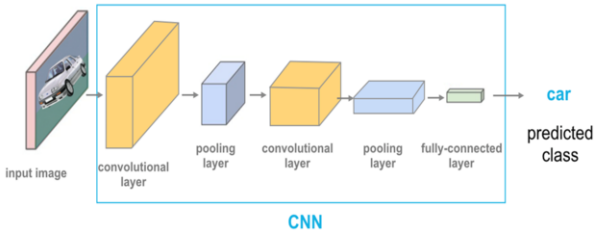

Figure 1. Conversational Neural Network

5. Literature Review

The author compared IoT Blockchain architectures and frameworks. They predict that blockchain will replace cloud computing platforms due to the numerous benefits [4]. In [5] 5G/IoT-enabled UAVs for multimedia distribution in industry-focused applications were presented. The author in [6] Using cryptographic authentication, described a multi-level trust based intelligence scheme. In [7] the priority-based energy efficient routing approach for IoT systems was described. The Smart Healthcare Monitoring System in IoT Environment was developed. In [8] unsupervised intelligent system based on a single class support vector machine was studied. The author presented a comprehensive examination of lightweight cryptography for the security dilemma of resource-constrained devices in the IoT [9]. The author in [10] aimed to achieve both goals by presenting a bi-level genetic algorithm approach of an optimized Ai technique

for agricultural vehicles. The author demonstrated the successful incorporation of embedded hardware usability [11]. A standard architecture for IoT scheduling and optimization in smart cities is offered [12]. The author explained IoMT devices present numerous research challenges and opportunities [13]. In [14] the author focused on determining a safe cutting range of input parameters pertaining to stable chatter.The author obtained an optimum range of turning parameters using the merged wavelet denoising and local mean decomposition technique [15] .

6. Current Research

The proposed work IoT-based paradigm for 5G applications is expected to offer an economical, scalable, and high-performance solution. In final stage we will compare our results with earlier studies using the IoT and 5G. Fire and spark activity detection and categorization have been performed using an IoT system in this research. CNN-based deep learning is being used in the research process. Process flow of current research is shown in figure 2.

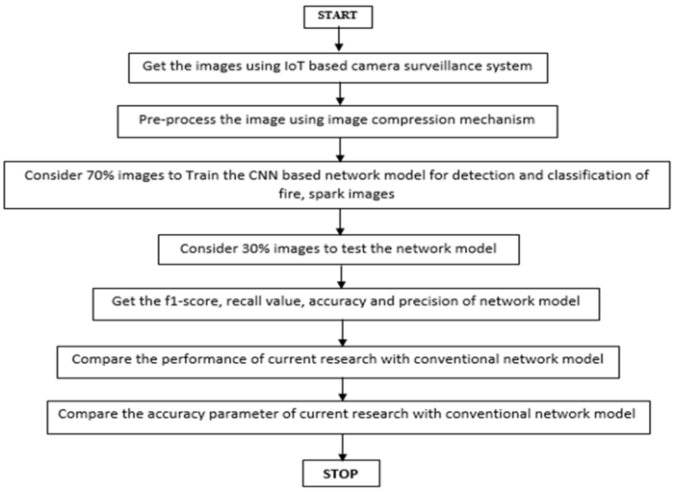

Figure 2. Process flow of current research

7. Result and Discussion

In the current study, an IoT system was employed to detect and classify fire and spark behaviors in an organization. Deep learning mechanisms based on CNN has been used in research. Cameras are employed as sensing devices, recording conventional photos while also detecting fire and sparks. During simulation 4672 images of fire, 3428 image of spark, 5215 normal images are considered for testing. But in case of previous testing only 85% accuracy has been achieved but after filter of images and improving training model by customizing batch size, hidden layer 4006 image out of 4672 fire images were detected, 3002 out of 3428 spark images and 5008 out of 5215 images were detected.

8. Confusion Matrix

The following confusion matrix displays when data is supplied to assess the correctness of the trained network during testing. The total accuracy, precision, F1 score, and recall value may be determined using this confusion matrix. Thus Confusion matrix obtained in case of proposed work is shown below in table1.

Table 1. Confusion matrix

	Fire images	**Spark images**	**Normal**
Fire images	4006	240	426
Spark images	170	3002	256
Normal	177	30	5008

The results are taken from the Confusion Matrix where Accuracy illustrates the degree of accuracy. A classifier's sensitivity or completeness is measured by its recall. A measurement's precision can be derived by calculating its accuracy. For a test to be considered "accurate," the F1 score or F1 measure must be taken into account.
Tp is represented as the True +ve and **Tn** is represented as the True -ve. **Fp** is represented as the False +ve and **Fn** is represented as the False -ve. **Accuracy** can be measured as (Tp + Tn) / (Tp + Tn + Fp + Fn). **Precision values** can be determined by a formula i.e., Tp/ (Tp+Fp) and **recall values** = Tp/ (Tp+Fn). **F-Measure** can be measured as (2 * Precision * Recall) / (Precision + Recall). We have chosen the parameters such as accuracy, precision, recall and f1-measure value and compared with previously reported research with the current research. The overall accuracy we got 90.07%. The model has been simulated using matlab. The comparison analysis is shown below.

9. Comparison Analysis of reported Work to current research

Accuracy, f-score, precision and recall value in case of previous research and current research is compared in this section.

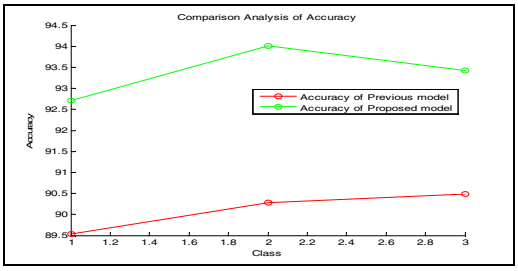

Figure 3. Comparison Analysis of Accuracy for reported research to current research

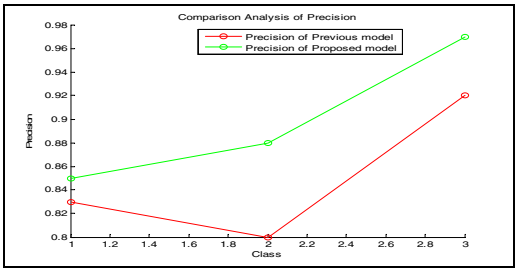

Figure 4. Comparison Analysis of Precision for reported Work to Current research

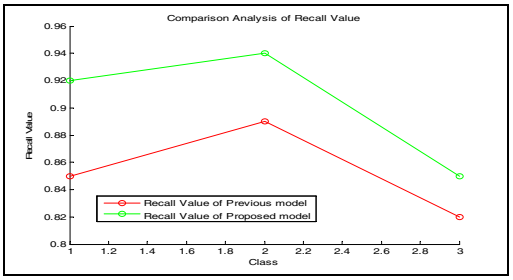

Figure 5. Comparison Analysis of Recall Value for reported Work to Current research

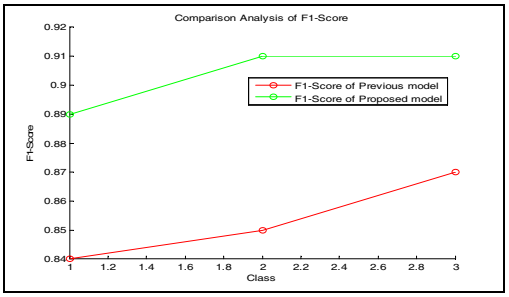

Figure 6. F1-Score comparative analysis between reported and current research

By seeing Fig 3 to 6, it has been observed that the accuracy increases linearly with the class till value 2. As the class increases the precision also increases. Till the time we reach at class value 2 then the precision enhances linearly. At class 2 the recall value drops and it gets saturated thereafter. When the f1-score value of current model is increases up to 2 value and thereafter remains constant.

10. Conclusion

Applications of IoT in 5g technology are discussed in area of industries. The Deep learning based on CNNs is being employed in the present research. Fire and embers may be detected using a camera, which is a kind of sensing equipment. It has been concluded that the current research is superior to previous work in terms of accuracy and overall

performance. Overall accuracy of current research is 90% whereas conventional network model provided 85% accuracy.

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