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Study Committee B2

Overhead Lines

10138_2022

Wildfire detection system using artificial intelligence with the collaboration of the web society

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Motivation

- Society has been pressuring against O&M procedures and the construction of new OHL on their land (see Figure 1).
- The website wildfire images not only allow users on the web to confirm alarms automatically generated by the system with artificial intelligence, but also to monitor the camera images in real time and indicate the presence or not of smoke or fire.

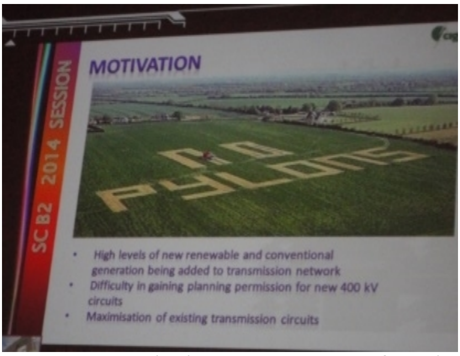

Figure 1 - Society has been pressuring against O&M and construction of new OHL on their land.

Objects of investigation

- This work was developed through the Brazilian Energy Agency of R&D named "Environmental monitoring using real images of areas covered by overhead transmission lines using pattern recognition".
- In this way, placing this important asset of overhead lines and networks with one more noble role in the search for reducing wildfires (see Figure 2).

Figure 2 - Video camera on Lattice Tower of 138 kV and webpage interphace of algoritms AI system for the detection of fire and smoke interaction with web society.

Experimental software setup

- Images and videos of fire or smoke were collected from the Internet and installed places for the development and validation of the system.
- Convolutional Neural Network (CNN) trained on an augmented version of the database containing thousands of labeled images.

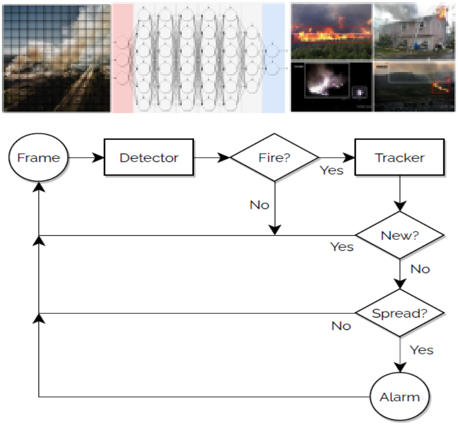

Figure 3 - The basic blocks of algorithms developed: i) oriented to characteristic extraction, ii) black box (using AI) and temporal analysis.

Conclusion

- In this paper, a computer system for environmental monitoring using cameras and computer vision was presented.
- The artificial intelligence is a convolutional neural network with an architecture called scaled YOLO version 4.
- The website & APP applications have been created with the aim of promoting the interaction between web society and the computer vision system.
- This paper showed the intangible and innovative efforts to bring the web society collaboration for better acceptance for OHL with society worried about climate changes.
- Monitoring the wildfires using assets of OHL brings a second important use in addition to supplying electricity only.

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Experimental hardware setup

- A pilot project was carried out for tests in real environments. For that, the following equipment was used: 2 routers (mainboard + mini-PCI wireless card), two cameras, two media converters, 4 coolers, and a computer with x86 CPU (see Figure 4).
- It is possible to include third-owner cameras into the system, in order to reduce investment in new installation of hardware (see Figure 5).
- The use of OHL assets and sites has the potential to help scale the observation area across the country land.

Method and Detection

- Firstly, images and videos containing fire or smoke were collected from the Internet and installation places for the development and validation of the system
- The work focused on daytime images captured under different lighting conditions and focal lengths, but it works in the night too (see Figure 6).
- Artificial intelligence is trained with the image dataset, and it can detect smoke and fire at the same time.
- A temporal analysis is performed on the artificial intelligence output in order to reduce false alarms.

Discussion of Hardwares

- The optical fiber in OPGW could be used to transport camera streams.
- In addition, streams could have radio transmission to internet, so that, even if the optical link could not be shared, communication to remote sites is still guaranteed.
- The energy supply to camera continues to be hard task to do in such remote places. The use of conventional batteries and photovoltaic panels do not seem to be the ultimate solution in large scale (see Figure 7).
- Troubles to be solved are: i) how should the use of video information be assessed for data protection reasons, ii) Vandalism aspects, iii) limitation of PoF energy capabilities and iv) cyber issues for remote cameras installed in tower of OHL must be considered in the design of the infrastructure.

Figure 4 - Set of equipment used in first pilot tests: BHTec site, focus on UFMG´s forest, and Serra Verde State Park site, view is possible through cameras installed in MG Governor´s Building.

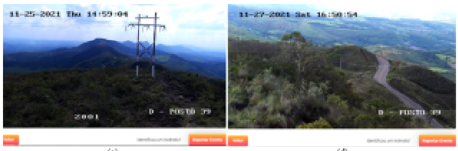

Figure 5 – Example of the sensitive green area that the camera's infrastructure third-owner (Rola Moça Park) will bring as benefits to all stakeholders involved.

Figure 6 - Challenging in sharing infrastructure of cameras into OHL assets.

Figure 7 - Challenging in sharing infrastructure of cameras into OHL assets.

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Experimental webpage

- The first website-intranet application was created with the aim of promoting the interaction between developers only and the trial computer vision system.
- Through the website-intranet access, the cameras provided streams to fire-smoke characteristics-based algorithms that generated alarms manually confirmed or rejected, which helped researchers learn about the problem in real conditions.
- The second and third version of website & APP applications have been created with the aim of promoting the interaction between web society and the computer vision system.
- Through the website, web users can access the cameras and generate manual or just confirm alarms that help them improve machine learning into system detections (see Figure 8).

Experimental wildfire detection

- It is expected to reach 80% accuracy with the increase of the image dataset and improvement of training techniques.
- Avoiding false alarms has been a challenge and the most frequent confusions are (i) sun rays, reflections in water, raindrops and fog recognized as smoke and (ii) sunsets and lights detected as fire (See Figure 9).

Discussion

- The experiences of the users were obtained by Design Thinking methodology applying in a set of voluntary web users to define requirements on the third version of website & APP applications.
- Since 2012 this project has been receiving unrestricted support from several institutions, public and private, which voluntarily web collaborated.
- The intuitive increase the number of volunteers users is focus on companies interested in environmental protection, schools, universities, public authorities responsible for early detection and fighting wildfires.
- Figure 10 shows some real events of false alarms.
- Nowadays, it is still not possible to use hyperspectral cameras on a large scale. But It could be used a database to train a neural network to infer the hyperspectral content of an image from the RGB information captured by a low-cost camera.

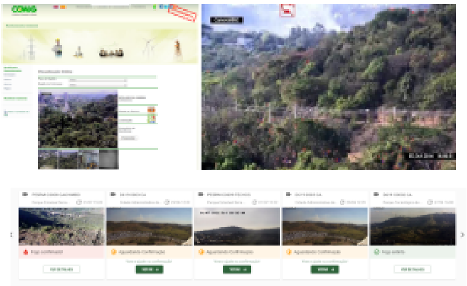

Figure 8 - The intranet website in corporate Cemig´s network.

Figure 9 – Experimental images already obtained in hard situations of detection. i) sunset and fire detection in the same frame, ii) smoke and fire detection at night.

Figure 10 – Experimental images already obtained in false-alarm detection: i) spider out of focus in front of camera identified as smoke, ii) the vegetation in movement in the orange flowers color, and iii) fog view in landscape.

Conclusion

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