RoViSP 2023

The 12th International Conference on Robotics, Vision, Signal Processing and Power Applications

rovisp.eng.usm.my

UNIVERSITI SAINS MALAYSIA

Springer

Special group discount

28 - 29 August 2023

PARKROYAL Penang Resort, Penang
Malaysia

Call for papers

International Conference on Robotics, Vision, Signal Processing and Power Applications (RoViSP) has been routinely organized by School of Electrical & Electronic Engineering, Universiti Sains Malaysia (USM) since 1994 (known as Robotics, Vision & Parallel Processing for Industrial Automation, ROVPIA). The conference has been a place for researchers, scientists, engineers, academicians, students and industrial professional to present and exchange research findings and activities.

Important Dates

Full Paper Submission Deadline:
16th June 2023

Notice of Acceptance (from):
22nd May 2023

Early Bird Registration & Payment Deadline:
10th July 2023

Normal Registration, Payment & Camera-Ready Deadline:
11th August 2023

Conference Days:
28th to 29th August 2023

Please refer to the conference website for more detailed information (registration, conference fees, etc.)
rovisp.eng.usm.my

Technical tracks

RoViSP conference 2023 topics:

- Robotics, Control, Mechatronics and Automation
- Vision, Image and Signal Processing
- Telecommunication Systems and Applications
- Electronic Design and Applications
- Electrical Power, Energy and Industrial Applications

Register with your Team

Save on RoViSP 2023 when you submit with your team.
We offer a group discount of 15% off the early bird registration fee for 3 papers. These discounts cannot be combined with any other discounted rate. To claim these discounts and for more information please contact rovisp@usm.my .
Join us at RoViSP 2023 and be a part of an amazing experience while keeping your budget intact. See you there!

Prospective authors are invited to submit paper in English of 4-6 pages in length including figures, tables, and references.All accepted and presented papers will be included in the conference proceeding published by Lecture Notes in Electrical Engineering (LNEE)-Springer (Indexed by Ei and Scopus)

Contact

Dr. Nor Azlin Ghazali
Tel: +604-5995786 Fax: +604-5996909 Email: rovisp@usm.my

Near Infrared Remote Sensing Of Vegetation Encroachment At Power Transmission Right-Of-Way

Lim Pei Yu[1], David Bong[1], Ting Kung Chuang[2], Florence Francis Lothai[2], Annie Joseph[1], and Tengku Mohd Afendi[1]

[1] Faculty of Engineering, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Malaysia.
[2] Faculty of Computing and Software Engineering, i-CATS University College, 93350 Kuching, Malaysia.

Abstract. The event of electricity outage could cause huge financial losses for the industry and inconvenience to the consumers. Vegetation encroachment at the power transmission right-of-way is one of the main causes. Transmission line fault could occur when a tree falls into the vicinity of power transmission line. Conventional inspection method such as ground inspection is the simplest approach to counter vegetation encroachment. However, technical personnel is required to travel on site to perform the inspection manually. This process is often time consuming and prone to human error. Airborne Light Detection and Ranging (LiDAR) system and satellite imagery are remote sensing approaches to inspect the power transmission right-of-way. These approaches could reduce reliance on physical site inspection and remove human error. However, large dataset needs to be processed and specialist equipment is needed for this method which also increases the overall cost. In this research, a simple yet cost effective method is used to detect vegetation encroachment by using near aerial infrared (NIR) image processing approach. The process is divided into two parts. First, detect the inconspicuous power transmission line by utilizing Radon Transform (RT) in vertical derivative image and detect the peaks of the Radon Transform. Next, detect the vegetation encroachment in the clearance zone by using green normalized difference vegetation index (GNDVI) algorithm to differentiate between trees and glassy plains. Preliminary experiment results show a satisfactory performance in detecting vegetation encroachment at the power transmission right-of-way.

Keywords: Vegetation Encroachment, Power Transmission Right-of-way, Near Infrared (NIR).

1 Introduction

Highly elevated structures are used in the transmission of high voltage electrical energy generated from the generation plant to the consumer area. The clearance for overhead line with aluminium or copper conductors must be maintained as it is predisposed to flashover. This causes unnecessary power interruptions for the consumer and revenue losses to the utility companies. The consequence of a blackout can be catastrophic when it affects a large businesses area that relies on electricity for its operations [1].

Transmission network should be monitored to guard against any failure of continuous electricity supply. The preservation of electrical distribution networks should be examined regularly as the highest failure is due to tree encroachment [2][3]. Better surveillance information can be provided by using online or remote monitoring as any fault could be located precisely and the process of power supply recovery could be facilitated. This can help to decrease the interruption time. Trees could be trimmed, and specified clearance of grasslands and bushes at the power transmission right-of-way should be determined in order to keep the vegetation from affecting the conductors.

Since the high voltage transmission lines are cascade connected, vegetation encroachment at any part of the right-of-way will potentially affect the entire cascading network [4]. Therefore, for commercial and legal reasons, electric utility companies have to regularly inspect their power transmission lines. One of the conventional methods involves site surveys or ground inspection, where a team is responsible for visual inspection of power transmission right-of-way by foot patrols or using vehicles [5]. Any vegetation that encroaches into the high voltage righ-of-way are identified and trimmed after the visual inspection. Unfortunately, this approach is costly because a high number of technical personnel are needed. It is also time consuming because it requires long hours to travel to the actual site. Moreover, it is prone to judgmental errors during the visual inspection.

Another method is by using airborne Light Detection And Ranging (LiDAR) scanning system [1]. LiDAR is an active remote sensing technique. This technique can find the distant target range or further information by measuring the scattered light property. Vegetation encroachment of power lines could be detected by satellite imagery too [6][7]. However, costly specialist equipment is required for this kind of remote sensing.

In this research, a low-cost solution is designed to monitor the vegetation encroachment to the power transmission right-of-way by using near infrared (NIR) imaging technique. A DJI Phantom 3 with Blue-Green-NIR advanced camera drone is used to capture image combination of Blue, Green and NIR channels. Image processing technique is then used to identify vegetation encroachment at the power transmission right-of-way. NIR wavelength between 680nm to 800nm is used in this technique.

2 Methodology

2.1 Region of Interest

The red channel of the advanced NIR camera could record NIR image/video. The camera has the feature to differentiate vegetation from non-vegetation remotely by capturing colour NIR-Green-Blue (NIR-G-B) image of wavelength between 680 to

800nm. It is built with 20mm focal length lens. Fig. 1 shows the process of extracting region-of-interest (ROI) from an NIR-G-B image.

NIR-G-B image is different from conventional RGB image where the red channel is replaced by NIR channel. Fig. 2(a) shows a sample NIR-G-B image where the brownish areas indicate the presence of vegetation such as trees or grass plains.

A vertical mask *w(i,j)* [8] is used for linear feature extraction of the image. The image itself has to be aligned to achieve 90° vertical orientation of the transmission line. In drone mission planning, the direction of flight is planned along the power lines, which could result in the alignment of the power transmission line being imaged as intended. Through convolution process, the output grayscale pixel *G(x,y)* can be obtained as follows:

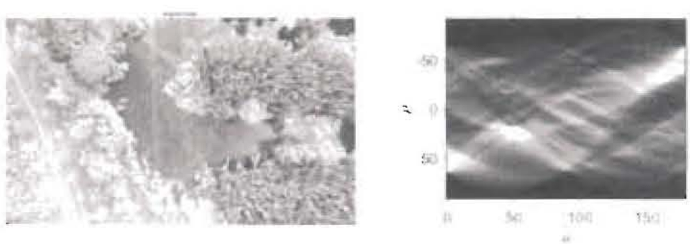
$$G(x,y) = \sum_{i=0}^{n} \sum_{j=0}^{n} f(x+i, y+j) * w(i,j) \quad (1)$$

where *f(x,y)* is the grayscale value of input image and *n* is the total number of pixels. Radon Transform is then applied to the output image. From the Radon Transform, peak values could be obtained which indicate the positions of the lines from the image. Fig. 2(b) shows the result of Radon Transform.

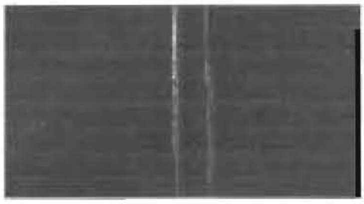
Thresholding is then applied to eliminate image noise. The value is set to zero if it is less than the threshold, and set to one if more than the threshold. Inverse Radon Transform is applied to obtain the line image. Morphological operation and blob analysis are used to trace the boundary of the power transmission line (Fig.).

A region of interest (ROI) is identified after the blob analysis to select the boundaries of the clearance zone where the power transmission line is detected.

Fig. 1. Extraction of ROI from the NIR image



(a) (b)



(c)

Fig. 2. (a) A sample of NIR-G-B image (b) The result of Radon Transform (c) Output image after performing blob analysis

2.2 Green Normalized Difference Vegetation Index (GNDVI)

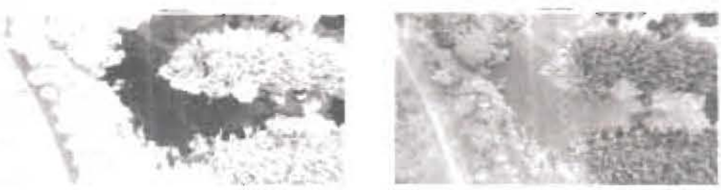
Fig. 3 shows the Green Normalized Difference Vegetation Index (GNDVI) algorithm to extract and process the NIR and green channels of an image for the purpose of quantifying vegetation. Fig. 4 shows the NIR and green channels of a sample image.

GNDVI quantifies vegetation by using

$$GNDVI = \frac{NIR-G}{NIR+G} \tag{2}$$

Values that range from 0 to 0.1 resemble sterile areas of rock, sand, or snow. Values in between 0.2 to 0.4 indicates a low positive value that signify shrub and grassland, while high values that are in between 0.5 to 0.9 or close to 1 signify temperate and tropical rainforests [9]. Therefore, the value of GNDVI can be used to classify trees and grass plains. This is important to avoid false positive detection of grass plains as potential threat.

Fig. 3. The GNDVI algorithm

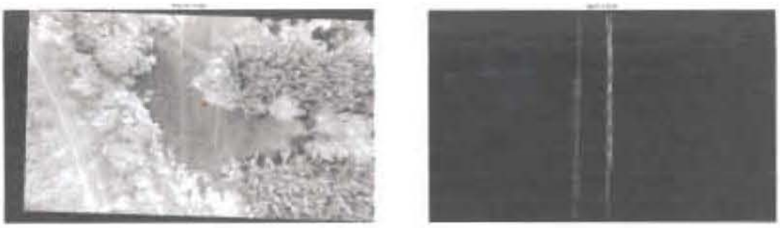


(a) (b)

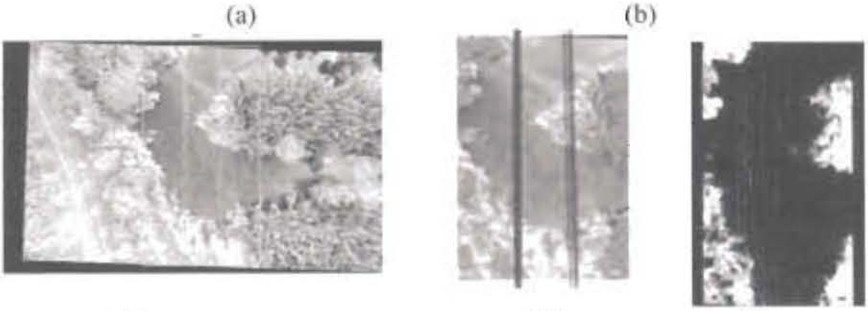
Fig. 4. (a) NIR channel (b) Green channel

3 Results and Discussion

Fig. 5(a) shows the aligned image of power transmission lines by using the algorithm from Fig. 1. Image ROI is then determined (red box in Fig. 5(c)). Clearance of the power transmission right-of-way is determined from the image ROI. Fig. 5(d) shows the final result with the blue lines indicate the detected power transmission line and the red segmented areas represent the vegetation encroachment which located inside the clearance zone



(a) (b)



(b) (d) (e)

Fig. 5. (a) Aligned image (b) Boundaries of the power transmission line (c) Image ROI (d) Final image (e) Overlapped image.

The overlapped image of ground truth with GNDVI output image is as shown in Fig. 5(e). The green segmented areas in the image represent vegetation encroachment which is not detected (False Negative). The purple segmented areas indicate detected vegetation encroachment which is not present in the ground truth image (False Positive). The white segmented areas represent True Positive and black segmented areas represent True Negative. From the preliminary experiment, the accuracy of the proposed algorithm for a single location is about 91%.

4 Conclusion

This research proposed detection of vegetation encroachment at power transmission right-of-way by using low cost NIR image. Inconspicuous power transmission line is detected by using Radon Transform (RT) in vertical derivative image and the vegetation encroachment is detected by using GNDVI. Preliminary experiment showed satisfactory result in detecting vegetation encroachment and differentiating types of vegetation. For future work, multisensorial UAV systems could be used, which combine NIR-G-B camera and spectrometry with laser scanning.

Acknowledgement

Kementerian Pengajian Tinggi Malaysia, Fundamental Research Grant Scheme (FRGS), FRGS/1/2020/TK0/UNIMAS/02/14.

References

1. J. Ahmad, A.S. Malik, L. Xia, N. Ashikin (2013), Vegetation encroachment monitoring for transmission lines right-of-ways: A survey, Electric Power Systems Research, Vol. 95, pp. 339-352.
2. D. Louit, R. Pascual, and D. Banjevic (2009) "Electrical power and energy systems optimal interval for major maintenance actions in electricity distribution networks," Int. J. Electr. Power Energy Syst., Vol. 31, No. 7–8, pp. 396–401.
3. A. Sittithumwat, F. Soudi, and K. Tomsovic (2004), "Optimal allocation of distribution maintenance resources with limited information," Electrical Power System Research, Vol. 68, No. 3, pp. 208–220.
4. C. Zheng and D. Sun (2006), "Recent applications of image texture for evaluation of food qualities — a review," Trends in Food Science & Technology, Vol. 17, No. 3, pp. 113–128, 2006.
5. L. F. Luque-Vega, B. Castillo-Toledo, A. Loukianov and L. E. Gonzalez-Jimenez (2014), "Power line inspection via an unmanned aerial system based on the quadrotor helicopter," MELECON 2014 - 2014 17th IEEE Mediterranean Electrotechnical Conference, Beirut, Lebanon, pp. 393-397.
6. M. Gazzea, M. Pacevicius, D. O. Dammann, A. Sapronova, T. M. Lunde and R. Arghandeh (2022), "Automated Power Lines Vegetation Monitoring Using High-Resolution Satellite Imagery," IEEE Transactions on Power Delivery, Vol. 37, no. 1, pp. 308-316.
7. F. M. E. Haroun, S. N. M. Deros and N. M. Din (2021), "Detection and Monitoring of Power Line Corridor From Satellite Imagery Using RetinaNet and K-Mean Clustering," IEEE Access, vol. 9, pp. 116720-116730.
8. T. S. Chan and R. Yip (1996), "Line detection algorithm," in Proc. Int. Conf. Pattern Recog., Vienna, Austria, pp. 126–130
9. E. P. Baltsavias (1999), "A comparison between photogrammetry and laser scanning," ISPRS Journal of Photogrammetry and Remote Sensing, Vol. 54, No. 2-3, pp. 83–94.