Jurnal Mantik, 7 (4) (2024), ISSN 2685-4236 (Online)

IOCSCIENCE

Published by:Institute of Computer Science (IOCS)

Jurnal Mantik

Journal homepage: www.iocscience.org/ejournal/index.php/mantik

Analysis neutral network for smoke detection predictions

Sapriadi
Farmasi, Institut Kesehatan Helvetia, Medan, Indonesia

ARTICLE INFO

Article history:

Received Dec 5, 2023
Revised Jan 11, 2024
Accepted Jan 24, 2024

Keywords:

Accuracy;
Fire;
Neural Network;
Prediction;
Smoke.

ABSTRACT

The applications of neural networks is smoke detection, which is the task of identifying whether an image contains smoke or not. Smoke detection is important for industrial safety, fire prevention, and environmental monitoring. However, smoke detection is challenging because smoke can have different shapes, textures, colors, and intensities depending on the source, environment, and lighting conditions, Smoke detection is important for protecting lives, properties, and the environment from the damages caused by fire. Smoke detection can also be used for monitoring and controlling industrial processes, such as combustion, welding, or smelting. Thermal smoke sensors use a thermistor or a thermocouple to measure the temperature change caused by smoke. Gas smoke sensors use a semiconductor or an electrochemical cell to measure the concentration of gas molecules produced by smoke. Neural networks can also predict the spread and evolution of forest fires, as well as help decision makers plan mitigation methods and extinguishing tactics.

Corresponding Author:

Sapriadi,
Farmasi,
Institut Kesehatan Helvetia
Jl. Kapten Sumarsono No.107, Kp. Lalang, Kec. Sunggal, Sumatera Utara 20124,Indonesia.
Email: sapriadi@helvetia.ac.id

1. INTRODUCTION

Neural networks are a type of artificial intelligence that can learn from data and perform tasks such as classification, regression, and generation. Neural networks are composed of layers of neurons that process inputs and produce outputs. Each neuron has a set of weights and a bias that determine how it responds to the inputs. The weights and biases are updated during the training process using a learning algorithm such as gradient descent. (Izhari, 2020)

Neural networks can be used for various applications, such as image recognition, natural language processing, speech synthesis, and more. Neural networks can also be designed with different architectures, such as feedforward, recurrent, convolutional, and generative adversarial networks. Each architecture has its own advantages and disadvantages depending on the task and the data. Neural networks can recognize objects, faces, scenes, and emotions in images. For example, a neural network can identify whether an image contains a cat or a dog, or whether a person is happy or sad. Some neural networks can also generate captions for images, describing what they see in natural language (Mayatopani, 2021).

Neural networks can understand and generate natural language, such as text and speech. For example, a neural network can translate text from one language to another, or synthesize speech from text. Some neural networks can also perform tasks such as sentiment analysis, question answering, and summarization. Neural networks can produce realistic and expressive speech from text or other inputs. For example, a neural network can convert text to speech, or mimic the voice of a specific person. Some neural networks can also generate speech from non-verbal inputs, such as music or images. Neural networks can create new and realistic data from existing data, such as images, text, or audio. For example, a neural network can generate new images of faces, animals, or landscapes, or new text or audio samples. Some neural networks can also modify or enhance existing data, such as adding color to black and white images, or improving the quality of low-resolution images. (Abidin, 2022)

One of the applications of neural networks is smoke detection, which is the task of identifying whether an image contains smoke or not. Smoke detection is important for industrial safety, fire prevention, and environmental monitoring. However, smoke detection is challenging because smoke can have different shapes, textures, colors, and intensities depending on the source, environment, and lighting conditions.

The aim of conducting research on smoke detection is to find out the working principles, components, types and working methods of fire detection devices which can provide early warning to building or workplace owners if a fire occurs. Smoke detection also aims to increase public awareness and preparedness in facing the dangers of fire, as well as to reduce the negative impacts of fire, such as casualties, material loss and environmental pollution. Smoke detection is very important to carry out research because it can provide benefits for various parties related to fire problems. Some of the benefits of smoke detection research are: For building or workplace owners: Smoke detection research can help them choose a detection tool that suits their conditions and needs, as well as provide information about how to install, maintain and operate the tool correctly and safely. For the public: Smoke detection research can increase public awareness about the dangers of fire and how to avoid them or handle emergency situations if they occur. Smoke detection research can also provide information about how to detect smoke or fire around them using simple tools that are easy to obtain. For the government: Smoke detection research can provide data and analysis about the frequency, location, causes, impacts and solutions of fire cases that occur in a region or country. Smoke detection research can also provide recommendations regarding quality standards, legal regulations, prevention programs, public education, technical assistance, and cross-sector cooperation in the field of personal protection from fire hazards.

2. RESEARCH METHOD

Research methodology is the process of planning and conducting a systematic investigation to answer a research question or solve a problem. Research methodology can vary depending on the field, topic, and purpose of the research. However, some common steps are:

- Define the research problem and formulate the research question or hypothesis.
- Review the existing literature and identify the knowledge gap and the research significance.
- Choose the appropriate research design and methods to collect and analyze the data.

- Implement the research plan and collect the data from the sources.
- Analyze the data using statistical or qualitative techniques and interpret the results.
- Report the findings and conclusions and discuss the implications and limitations of the research.

Table 1. Dataset Smoke Detection

	UTC	Temperature [C]	Humidity [%]	TVOC [ppb]	eCO2 [ppm]	Raw H2	Raw Ethanol	Pressure [hPa]	PM1.0	...	PM2.5	Fire Alarm
0	1654733331	20	57.36	0	400	12306	18520	939.735	0	...	0	0
1	1654733332	20.015	56.67	0	400	12345	18651	939.744	0	...	1	0
2	1654733333	20.029	55.96	0	400	12374	18764	939.738	0	...	2	0
3	1654733334	20.044	55.28	0	400	12390	18849	939.736	0	...	3	0
4	1654733335	20.059	54.69	0	400	12403	18921	939.744	0	...	4	0

Smoke detection is the process of identifying the presence of smoke in the environment, which can be an indication of fire or other hazards. Smoke detection is important for protecting lives, properties, and the environment from the damages caused by fire. Smoke detection can also be used for monitoring and controlling industrial processes, such as combustion, welding, or smelting. There are different types of devices that can perform smoke detection, such as smoke detectors, smoke alarms, and smoke sensors. These devices can use different methods to sense smoke, such as optical, ionization, thermal, or gas. Each method has its own advantages and disadvantages, depending on the characteristics of the smoke and the environment.

Smoke detectors are devices that can detect smoke and send a signal to a fire alarm system or produce a local alarm. Smoke detectors are usually installed on the ceiling or the wall of a building, where they can cover a large area and detect smoke at an early stage. Smoke detectors can use optical or ionization methods to sense smoke. Optical smoke detectors use a light source and a sensor to measure the scattering or absorption of light by smoke particles. Ionization smoke detectors use a radioactive material and an electric current to measure the ionization of air molecules by smoke particles. Smoke alarms are devices that can detect smoke and produce a loud and audible sound to alert the occupants of a building. Smoke alarms are usually battery-powered and can be placed in any room or location where there is a risk of fire. Smoke alarms can also use optical or ionization methods to sense smoke, or they can use both methods in combination to reduce false alarms.

Smoke sensors are devices that can detect smoke and provide a digital or analog output to a computer or a controller. Smoke sensors are usually small and low-cost and can be integrated with other devices or systems, such as cameras, robots, or drones. Smoke sensors can use thermal or gas methods to sense smoke. Thermal smoke sensors use a thermistor or a thermocouple to measure the temperature change caused by smoke. Gas smoke sensors use a semiconductor or an electrochemical cell to measure the concentration of gas molecules produced by smoke. Smoke detection is a challenging and active research topic, as smoke can have different shapes, colors, textures, and intensities depending on the source, environment, and lighting conditions.

3. RESULTS AND DISCUSSIONS

Smoke detection is important for protecting lives, properties, and the environment from the damages caused by fire. Smoke detection can also be used for monitoring and controlling industrial processes, such as combustion, welding, or smelting.
Some of the benefits of smoke detection are:

- It can provide early warning and alert the occupants of a building or the authorities of a potential fire, allowing them to take appropriate actions, such as evacuating, calling the fire brigade, or activating the fire suppression system.
- It can reduce the risk of injury, death, or property loss caused by fire, as well as the environmental impact of fire, such as air pollution, greenhouse gas emissions, or deforestation.
- It can improve the efficiency and safety of industrial processes, such as optimizing the fuel consumption, reducing the waste production, or preventing the equipment damage.

Neural networks can detect smoke in images or videos captured by cameras or sensors deployed in the environment, such as forests, grasslands, or urban areas, and provide data and information for environmental research and analysis. Neural networks can also measure and estimate the impact of smoke on the environment, such as air quality, climate change, or biodiversity.

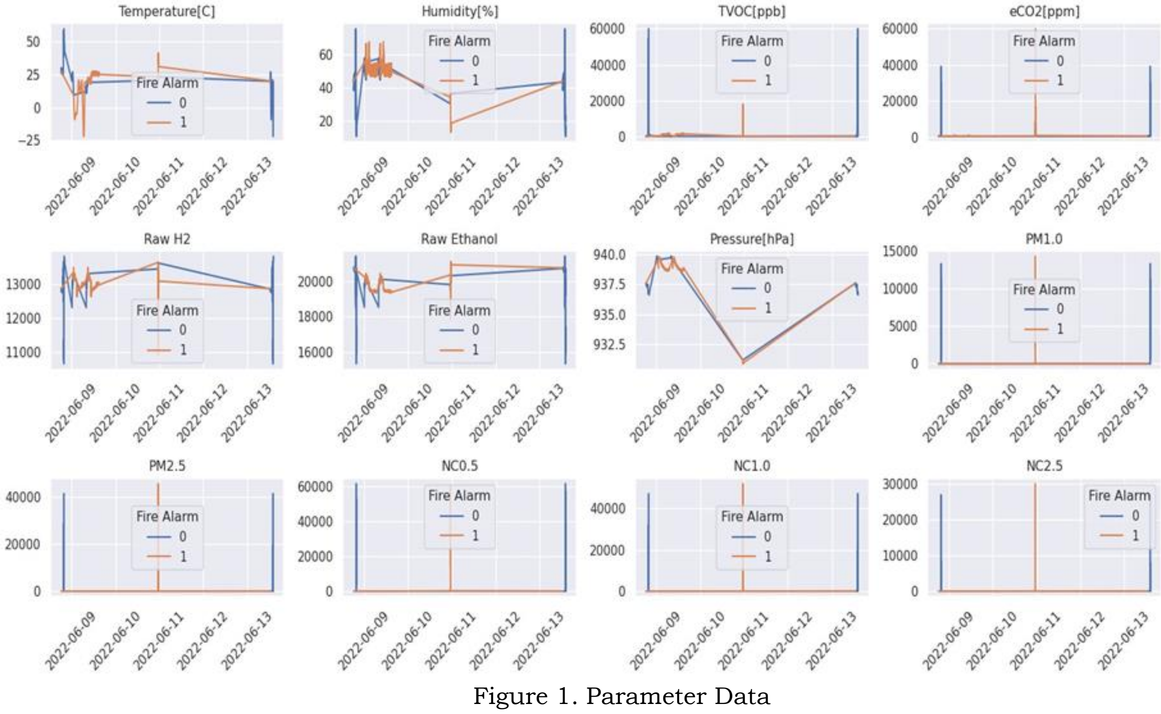


Figure 1. Parameter Data

It can be seen that time does not affect the other parameters. Both positive and negative results are at different points of time. Time will not be taken into account for future prediction.

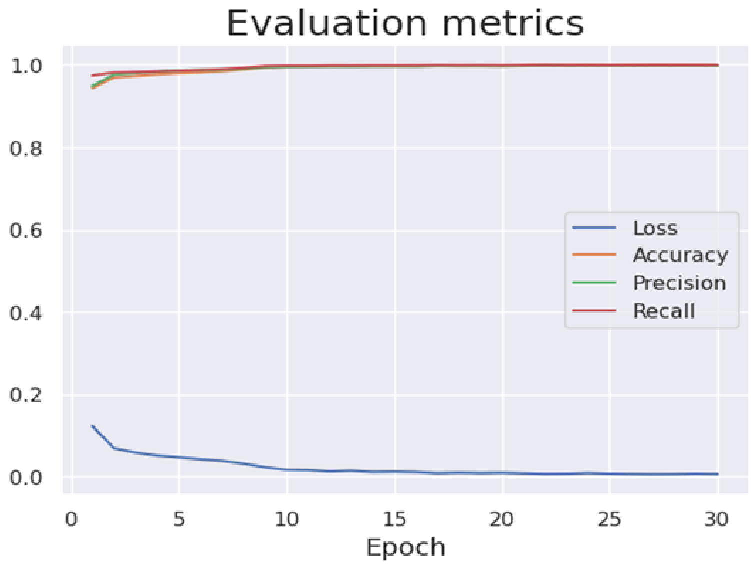
The table below this will be shown the results of data analysis from epochs 1 to 30. Comparison results Among target networks (0 and 1). More clear information could be seen in the table under this:

Table 2. Results of data analysis from epochs 1 to 30

Epoch	Times	loss	Accuracy	precision	recall

Epoch 1/30	4s 24ms/step	0.1228	0.9434	0.9484	0.9739
Epoch 2/30	3s 2ms/step	0.0691	0.9692	0.9761	0.9809
Epoch 3/30	3s 2ms/step	0.0585	0.9727	0.98	0.982
Epoch 4/30	3s 2ms/step	0.0512	0.9764	0.9835	0.9836
Epoch 5/30	3s 2ms/step	0.0471	0.9794	0.9857	0.9856
Epoch 6/30	3s 2ms/step	0.0426	0.9814	0.9867	0.9873
Epoch 7/30	3s 2ms/step	0.0386	0.9839	0.9881	0.9895
Epoch 8/30	3s 2ms/step	0.0317	0.9882	0.9909	0.9926
Epoch 9/30	3s 2ms/step	0.023	0.9933	0.9938	0.9969
Epoch 10/30	3s 2ms/step	0.0167	0.9947	0.9949	0.9976
Epoch 11/30	3s 2ms/step	0.0161	0.995	0.9955	0.9975
Epoch 12/30	3s 2ms/step	0.0128	0.996	0.9964	0.998
Epoch 13/30	3s 2ms/step	0.0145	0.9959	0.9961	0.9981
Epoch 14/30	3s 2ms/step	0.0115	0.9964	0.9967	0.9983
Epoch 15/30	3s 2ms/step	0.0122	0.9966	0.9969	0.9983
...	...	...	...	...	...
Epoch 30/30	0s 16ms/step	0.0061	0.9981	0.9984	0.999

The following are evaluation metrics of the epoch values produced in testing Smoke Prediction with neural network:



Figures 2. Evaluation Metrics

4. CONCLUSION

Neural networks can detect smoke in remote sensing images or aerial videos captured by satellites, drones or airplanes, and provide early warning and alertness to forest fires. Neural networks can also predict the spread and evolution of forest fires, as well as help decision makers plan mitigation methods and extinguishing tactics. A forest fire smoke detection model neural networks and support vector machines proposed a method to distinguish between clouds and smoke in remote sensing images, and achieved 99.90% accuracy. Neural networks can detect smoke in images or videos captured by cameras or sensors installed in industrial locations, such as factories, power plants, or mines, and provide real-time feedback and alarms for potential fires or explosions. Neural networks can also monitor and control industrial processes involving burning, welding, or melting, and optimize fuel consumption, waste production, or equipment breakdown. Neural networks can detect smoke in images or videos captured by cameras or sensors used in environments, such as forests, grasslands, or urban areas, and provide data and information for environmental research and analysis. Neural networks can also measure and estimate the impact of smoke on the environment, such as air quality, climate change or biodiversity. This research has many limitations so it needs to be developed again in the future, so I suggest further research using the transfer learning method to utilize pre-trained models, such as VGG16, InceptionV3, or Xception, to increase the accuracy of smoke detection. Transfer learning is a technique that allows you to use a model that has been trained on other data with skills that match the new data. Then use the learning without forgetting (LwF) method to train your model with a new task without losing previous classification capabilities. LwF is a technique that allows you to maintain the classification ability of your model while being trained on new data, so that there is no performance degradation due to overfitting or underfitting. Next, use the 3D convolutional neural networks (3D CNN) method to detect smoke in recorded videos. 3D CNN is a type of neural network that can process three-dimensional data in parallel, making it faster and more efficient than 2D CNN. 3D CNN can also handle data with complex and heterogeneous structures, such as video footage from drones or satellites. Hopefully this research and suggestions will provide benefits for further research.

REFERENCES

F. Izhari, M. Zarlis, and S. Sutarman. (2020). Analysis of backpropagation neural neural network algorithm on student ability based cognitive aspects. doi: 10.1088/1757-899X/725/1/012103.

H. Mayatopani, R. I. Borman, W. T. Atmojo, and A. Arisantoso. (2021). Classification of Vehicle Types Using Backpropagation Neural Networks with Metric and Ecentricity Parameters. J. Ris. Inform., vol. 4, no. 1, pp. 65–70, doi: 10.34288/jri.v4i1.293.

Herdiansah, R. I. Borman, D. Nurnaningsih, A. A. J. Sinlae, and R. R. Al Hakim. (2022). Klasifikasi Citra Daun Herbal Dengan Menggunakan Backpropagation Neural Networks Berdasarkan Ekstraksi Ciri Bentuk. JURIKOM (Jurnal Ris. Komputer), vol. 9, no. 2, pp. 388–395. doi: 10.30865/jurikom.v9i1.3846.

Izhari, F., & Dhany, H. W. (2020). Comparison of Air Quality Data Accuration Using Decision Tree And Neural Network Method. Jurnal Ipteks Terapan, 14(2), 123-127

Jinkyu Ryu and Dongkurl Kwak. (2022). A Study on a Complex Flame and Smoke Detection Method Using Computer Vision Detection and Convolutional Neural Network. Graduate School of Disaster Prevention, Kangwon National University, Samcheok 25913, Korea.

K. Saputra S and M. I. Perangin-Angin. (2020). Klasifikasi Tanaman Obat Berdasarkan Ekstraksi Fitur Morfologi Daun Menggunakan Jaringan Syaraf Tiruan. J. Inform., vol. 5, no. 2, pp. 169–174, 2018, doi: 10.31311/ji.v5i2.3770.

Kamal Ali Abu Al-Reesh, Muhammad Nidal Al-Safadi, Waleed Sami Al-tanani and Samy S. Abu-Naser. (2023). Predictive Modeling of Smoke Potential Using Neural Networks and Environmental Data. International Journal of Engineering and Information Systems (IJEAIS)

Putra, P. H., Zarlis, M., & Mawengkang, H. (2020). Analysis of the effect number input and hidden layer variations on the addition kohonen algorithm to backpropagation method. In IOP Conference Series: Materials Science and Engineering (Vol. 725, No. 1, p. 012096). IOP Publishing.

R. I. Borman, I. Ahmad, and Y. Rahmanto. (2022). Klasifikasi Citra Tanaman Perdu Liar Berkhasiat Obat Menggunakan Jaringan Syaraf Tiruan Radial Basis Function. Bull. Informatics Data Sci., vol. 1, no. 1, pp. 6–13.

S. Devella, Y. Yohannes, and F. N. Rahmawati. (2020). Implementasi Random Forest Untuk Klasifikasi Motif Songket Palembang Berdasarkan SIFT," JATISI (Jurnal Tek. Inform. dan Sist. Informasi), vol. 7, no. 2, pp. 310–320.

S. Srivastava. (2018). Weka: A Tool for Data preprocessing, Classification, Ensemble, Clustering and Association Rule Mining. Int. J. Comput. Appl., vol. 88, no. 10, pp. 26–29.

Saru, S. and Subashree, S., (2019). Analysis and prediction of diabetes using machine learning. International journal of emerging technology and innovative engineering, Volume no 5, Issue no 4

Sarwar, M.A., Kamal, N., Hamid, W. and Shah, M.A. (2018). Prediction of diabetes using machine learning algorithms in healthcare. In 2018 24th international conference on automation and computing (ICAC) IEEE, Page no 1-6

Saydirasulov Norkobil Saydirasulovich, Mukhriddin Mukhiddinov, Oybek Djuraev, Akmalbek Abdusalomov, and Young-Im Cho. (2023). An Improved Wildfire Smoke Detection Based on YOLOv8 and UAV Images. Department of Computer Engineering, Gachon University, Seongnam 13120, Republic of Korea.

Shuhong Cheng. Jiyong Ma. (2019). Smoke detection and trend prediction method based on Deeplabv3+ and generative adversarial network. Journal of Electronic Imaging.

Veerappampalayam Easwaramoorthy Sathishkumar, Jaehyuk Cho, Malliga Subramanian and Obuli Sai Naren. (2023). Forest fre and smoke detection using deep learning-based learning without forgetting. Fire Ecology.

Vergni, Lorenzo., Todisco, Francesca. (2023). A Random Forest Machine Learning Approach for the Identification and Quantification of Erosive Events. Department of Agricultural, Food and Environmental Science, University of Perugia, 06124 Perugia, Italy.

Wilkinson, C., Ferris, F.L., Klein, R.E., Lee, P.P., Agardh, C.D., Davis, M., Dills, D., Kampik, A., Pararajasegaram, R., Verdaguer, J.T., et al. (2003). Proposed international clinical diabetic retinopathy and diabetic macular edema disease severity scales. Ophthalmology, 110, 1677–1682.

Wu, H., Yang, S., Huang, Z., He, J. and Wang, X. (2018). Type 2 diabetes mellitus prediction model based on data mining. Informatics in Medicine Unlocked, 10, pp.100-107.

Yihong Zhang, Qin Lin, Changshuai Qin, Hang Ge. (2022). Forest Fire Smoke Detection Method Based on MoAm-YOLOv4 Algorithm. Journal of Computer and Communications.

Z. Abidin, R. I. Borman, F. B. Ananda, P. Prasetyawan, F. Rossi, and Y. Jusman. (2022). Classification of Indonesian Traditional Snacks Based on Image Using Convolutional Neural Network (CNN) Algorithm. in International Conference on Electronic and Electrical Engineering and Intelligent System (ICE3IS). pp. 18–23.

Z. Azmi. (2021). Artificial Neural Network Model For Wind Mill. Int. J. Eng. Sci. InformationTechnology, vol. 1, no. 3, pp. 40–48.

Z. Sabouri, Y. Maleh, and N. Gherabi, (2022). Benchmarking Classification Algorithms for Measuring the Performance on Maintainable Applications. in Advances in Information, Communication and Cybersecurity, Cham, pp. 173–179. doi: 10.1007/978-3-030-91738-8_17

Zidian Xie, Olga Nikolayeva, MS, Jiebo Luo and Dongmei Li. (2019). Building Risk Prediction Models for Type 2 Diabetes Using Machine Learning Techniques. National Centre for Biotechnology information, Volume no 50, Page no 100-105

Zou, Q., Qu, K., Luo, Y., Yin, D., Ju, Y. and Tang, H. (2018). Predicting diabetes mellitus with machine learning techniques. Frontiers in genetics, Volume no 9, page no 115.