ANN Design Model to Recognize The Direction of Multi-Robot AGV

by Eki 16

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Aan Eko Setiawan
Department of Electrical Engineering
Telkom University
Bandung, Indonesia
aaneko@student.telkomuniversity.ac.id

Angga Rusdinar
Department of Electrical Engineering
Telkom University
Bandung, Indonesia
angga22002@yahoo.com

Rina Mardiati
Department of Electrical Engineering
UIN Sunan Gunung Djati Bandung
Bandung, Indonesia
r_mardiati@uinsgd.ac.id

Eki Ahmad Zaki Hamidi
Department of Electrical Engineering
UIN Sunan Gunung Djati Bandung
Bandung, Indonesia
ekiahmadzaki@uinsgd.ac.id

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***Abstract*—Automatic Guided Vehicle (AVG) Robot is a kind of mobile robot. This robot serves to transport goods from one place to a certain place. One type of robot that is currently being developed and researched is the multi robot. This robot is more focused in terms of communication between robots, so that the robots will not collide with each other. In its implementation, multi-robots differentiate from each other by communicating using camera sensors, so that image processing will be carried out. In this study, an Artificial Neural Network (ANN) model will be implemented which can differentiate between two robots. There are six input which are R1L, R1SR, R1SL, R2Ls, R2SR and R2 SL. The number of data sets entered is 300 data which is divided into 225 train data and 75 test data. The activation used are RelU and Softmax. The optimizer used is the Adam optimizer with a learning rate of 0.003, epoch used 50 with a batch size of 25. The result shows that the accuracy of the ANN model was 96%.**

Keywords*—Robot, AGV, ANN, Sensor.

I. INTRODUCTION

Robot AGV is a type of mobile robot. This robot runs based on a predetermined path. This AGV robot was made with the aim of developing industrial technology, especially in Indonesia [8]. This robot serves to transport goods from one place to a certain place. One type of robot that is currently being developed and researched is the multi-robot type. This type of robot is more focused in terms of communication between robots. The purpose of this communication is so that the robots do not collide with each other [1][5][4].

Research on AGV and multi robots have also been carried out in studies namely a discussion of robot control and position detection [2][3][9][10][12]. In research [10], the AGV robot moves by detecting landmarks that are placed on the roof. Then the robot camera will detect the landmark to determine the position of the robot's movement direction. Whereas in research [2] and [5] communication between multi AGV robots has been made. Communication is done by sending sensor data from the distance detection between the robots. When the sensor detects another sensor, the motor speed will decrease [6][7].

The difference with the research that will be carried out is by using an inverted camera sensor system that can direction and type of robot, will use the image processing method by using an ANN model approach. The robot will be designed with a differentiator on the chassis to make it easier to distinguish one robot from another [11]. ANN designs will be created using an online software called google collaboration with data sets stored on google drive. Based on the following background, it is necessary to make a study with the title "ANN Design Model to recognize the direction of the multi-robot AGV".

II. ANN MODEL FOR ROBOT POSITION CLASSIFICATION

A. Artificial Neural Network

Artificial Neural Network Artificial (ANN) is an information processing technique or approach that is inspired by the workings of the biological nervous system, especially in human brain cells in processing information. The key element of this technique is the structure of the information processing system which is unique and varied for each application. Neural Network consists of many information processing elements (neurons) connected and working together to solve a particular problem, which is generally a classification or prediction problem [5].

How the Neural Network works can be analogous to how humans learn by using examples or what is called supervised learning. A Neural Network is configured for specific applications, such as pattern recognition or data classification, and then refined through the learning process. The learning process that occurs in a biological system involves adjusting the synaptic connections that exist between neurons, in the case of the Neural Network the adjustment of synaptic connections between neurons is done by adjusting the weight values that exist for each connectivity from input, neuron and output.

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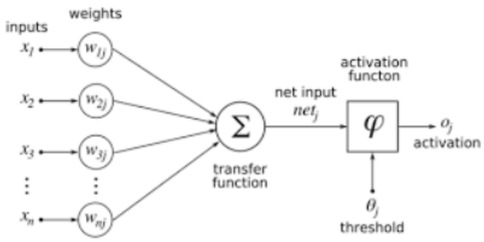

Fig. 1. Artificial Neural Network

Neural Networks process information based on how the human brain works. This Neural Network consists of a large number of elements that are connected to each other and work in parallel to solve a particular problem. On the other hand, conventional computers use a cognitive approach to solving problems; where the way to manage the problem must be known in advance to then be made into several small structured problems. These instructions then become a computer program and then into machine code that can be executed by the computer.

B. Robot detection system model

In this study, the camera was stored on the ceiling to make detection easier. The camera used is a webcam-type camera. The robot used is a prototype AGV robot with an L293D motor driver. Each robot will be given a red and blue marker to distinguish robot 1 from robot 2. Data processing will be carried out on the PC and orders will be sent to the robot using the communication module.

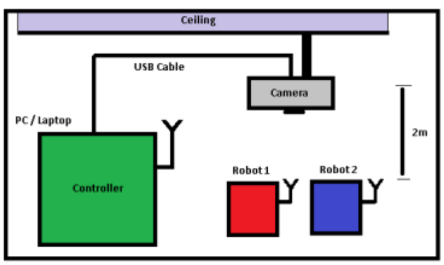

Fig. 2. Design detection system

The camera sensor is mounted on the ceiling. The camera is connected to the controller using a USB cable. While the distance between the camera and the robot is about 2 meters.

C. ANN model system design

In this research, the input for the ANN design is 6 inputs, 3 base layers and 3 outputs. Input consists of R1L, R1SR, R1SL, R2L, R2SR dan R2SL. ANN design for classifying the position of the robot can be seen in Fig. 3.

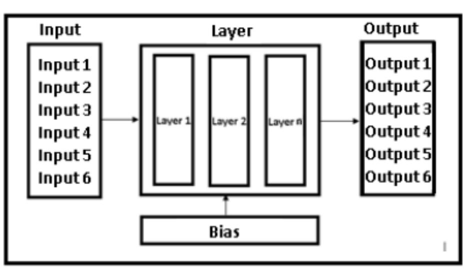

Fig. 3. ANN model system design

D. Data Set and Data Learning

Input as many as 6 with a data set of 300 images. Each input has 50 images. The picture was taken using a smartphone camera. The camera position is fixed as the position when it will be implemented. The robot is placed at a different point in each image. After taking pictures, the next set of data will be uploaded to Google Drive. an example image for the data set can be seen in Fig. 4.

Fig. 4. Example image for the data set

After that the data set will be divided into two. Namely for data sets and learning data. In this study, the testing data were taken 25% of the data set. The total amount of data is 300, 225 are used for train data and 75 are used as test data. Fig. 5 is the source code used for train data and test data. The display of the distribution of train data and tests is shown in Fig. 6.

```
# perform a training and testing split, using 75% of the data for
# training and 25% for evaluation
(trainX, testX, trainY, testY) =
train_test_split(np.array(data),  np.array(labels), test_size=0.25)
print(trainX.shape)
print(testX.shape)
```

Fig. 5. Data train and data test code

```
# perform a training and testing split, using 75% of the data for
# training and 25% for evaluation
(trainX, testX, trainY, testY) = train_test_split(np.array(data),
                                                  np.array(labels),
                                                  test_size=0.25)
print(trainX.shape)
print(testX.shape)

(225, 224, 224, 3)
(75, 224, 224, 3)
```

Fig. 6. Data train and data tests

The picture above explains that line 1 is the data train line. Where the data train is 225 with an image size of 224 x 224. The number 3 means the input colour image or RGB. The second line is the test data line. The number of test data is 75 with an image size of 224 x 224. Number 3 means colour or RGB image input.

E. Simulation and Result

At this stage, an ANN design is made with 3 base layers. With the optimizer used Adam. Adam is a popular algorithm in the deep learning field because it achieves good results quickly. The empirical results show that Adam performs well in practice and does better than other stochastic optimization methods. Learningrate used 1e-3 with Earlystopping patien is 5.

Earlystopping functions to stop the iteration when the value of val_loss does not change or there is no decrease. EarlyStopping is used so that when the best accuracy results are obtained, the iteration will automatically stop. The source code for the ANN and optimizer design is as follow at Fig. 7.

```
# train the model using the Adam optimizer
print("[INFO] training network...")
opt = Adam(lr=1e-3, decay=1e-3 / 50)
model.compile(loss="categorical_crossentropy", optimizer=opt,
  metrics=["accuracy"])
H = model.fit(trainX, trainY, validation_data=(testX, testY),
              epochs=50, batch_size=25 , callbacks=[es, checkpoint])
```

Fig. 7. Code ANN and optimizer

The epoch used is 50 with a batch size of 25. This means that iterations will be carried out 50 times with learning per iteration carried out every 25 data. After the train data is complete, it will go into the next iteration up to 50 times. However, here it is limited by early stopping so that when the learning rate has reached the maximum value, the iteration will be stopped. In this study, iterations were carried out up to 16 times with a learning rate of 96%. Fig. 8 is a display of the iteration results and val accuracy.

```
Epoch 00009: val_accuracy improved from 0.93333 to 0.960
Epoch 10/50
9/9 [==============================] - 39s 4s/step - los

Epoch 00010: val_accuracy did not improve from 0.96000
Epoch 11/50
9/9 [==============================] - 39s 4s/step - los

Epoch 00011: val_accuracy did not improve from 0.96000
Epoch 12/50
9/9 [==============================] - 39s 4s/step - los

Epoch 00012: val_accuracy did not improve from 0.96000
Epoch 13/50
9/9 [==============================] - 39s 4s/step - los

Epoch 00013: val_accuracy did not improve from 0.96000
Epoch 14/50
9/9 [==============================] - 39s 4s/step - los

Epoch 00014: val_accuracy did not improve from 0.96000
Epoch 15/50
9/9 [==============================] - 39s 4s/step - los

Epoch 00015: val_accuracy did not improve from 0.96000
```

Fig. 8. Val accuracy

Comparison of accuracy between train data and test data can be seen in Fig. 9. The blue line is the train data while the orange color is the test data.

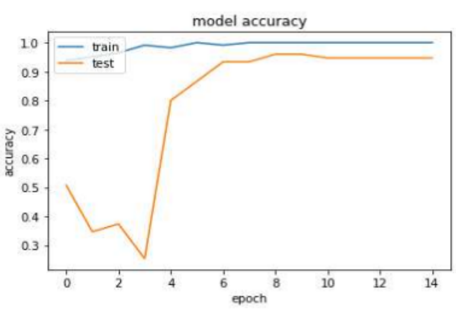

Fig. 9. Model accuracy

In the graph, the accuracy can be seen in the results of the iteration data test 1 to 6 where a wide fit occurs, while in the 6th to 15th iterations it still has fittings but is not too big. This occurs due to several factors such as insufficient data sets, the number of layers or the selection of activation. Fig. 10 is the result of a comparison of the loss values between the train data and the test data.

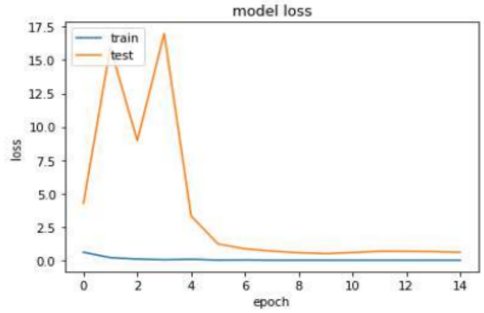

Fig. 10. Model loss

In the loss graph, it can be seen in the results of the iteration test data 1 to 6 there is a large loss, while in the 6th to 15th iterations there is still loss but the loss is already small. The smaller the loss value means the better the design. Fig.11 describes the results of the learning rate for each input and the average of the overall learning rate.

[INFO] evaluating network...

	precision	recall	f1-score	support
R1Lurus	1.00	1.00	1.00	15
R1SerongKanan	0.91	1.00	0.95	10
R1SerongKiri	1.00	0.83	0.91	12
R2Lurus	1.00	1.00	1.00	11
R2SerongKanan	0.87	1.00	0.93	13
R2SerongKiri	1.00	0.93	0.96	14
accuracy			0.96	75
macro avg	0.96	0.96	0.96	75
weighted avg	0.96	0.96	0.96	75

Fig 11. Accuracy rate for each input

III. CONCLUSION

In this study, a simulation was carried out to obtain an ANN model to determine the position direction of the AGV multi robot. Inputs that are used as input are 6 pieces, namely R1L, R1SR, R1SL, R2L, R2SR dan R2SL. The number of data sets entered is 300 data, divided into 225 train data and 75 test data. The number of layers used is base 3 layers and 13 layers' convolution with the activation used are RelU and Softmax. The optimizer used was the Adam optimizer with a learning rate of 0.003. epoch used 50 with a batch size of 25. The accuracy of the ANN model made is 96%. development suggestions that can add new data sets on outdoor conditioning or light changes. so, when the robot can recognize indoor, outdoor areas or changes in ambient light.

REFERENCES

[1] Marpaung, Robisman; Rusdinar, Angga; Dewanta, Favian. Metode Komunikasi Multi Line Follower Robot Pada Kasus Obstacles Avoidance.

[2] Marković, Ivan; Chaumette, François; Petrović, Ivan. Moving Object Detection, Tracking and Following Using an Omnidirectional Camera On A Mobile Robot. In: *2014 IEEE International Conference On Robotics and Automation (Icra)*. IEEE, 2014. P. 5630-5635.

[3] Eriyadi, Mindit. Desain Dan Implementasi Model Komunikasi Data Pada Sistem Robotsoccer. *Kurvatek*, 2016, 1.1: 8.

[4] Melita, Rahmi Agus; Bhaskoro, Susetyo Bagas; Subekti, Ruminto. Pengendalian Kamera Berdasarkan Deteksi Posisi Manusia Bergerak Jatuh Berbasis Multi Sensor Accelerometer Dan Gyroscope. *Elkomika: Jurnal Teknik Energi Elektrik, Teknik Telekomunikasi, & Teknik Elektronika*, 2018, 6.2: 259.

[5] Baek, Iljoo, Et Al. Real-Time Detection, Tracking, And Classification of Moving and Stationary Objects Using Multiple Fisheye Images. In: *2018 IEEE Intelligent Vehicles Symposium (Iv)*. IEEE, 2018. P. 447-452.

[6] Dewan, Ayush, Et Al. Motion-Based Detection and Tracking In 3d Lidar Scans. In: *2016 IEEE International Conference On Robotics and Automation (Icra)*. IEEE, 2016. P. 4508-4513.

[7] Opipah, Sarah, Et Al. Prototype Design of Smart Home System Base On Lora. In: *2020 6th International Conference On Wireless and Telematics (Icwt)*. IEEE, 2020. P. 1-5.

[8] Zaki, Alwan Abdul, Et Al. Modeling Wall Tracer Robot Motion Based On Fuzzy Logic Control. In: *2020 6th International Conference On Wireless and Telematics (Icwt)*. IEEE, 2020. P. 1-6.

[9] Pratiwi, Artdhita Fajar; Riyanto, Sugeng Dwi. Sistem Penentuan Lokasi Dan Penyimpanan Barang Menggunakan Labview Dan Sensor Ultrasonik. *Jurnal Teknologi Dan Sistem Komputer*, 2017, 5.2: 75-82.

[10] Rusdinar, Angga, Et Al. Implementation of Real-Time Positioning System Using Extended Kalman Filter And Artificial Landmark On Ceiling. *Journal of Mechanical Science and Technology*, 2012, 26.3: 949-958.

[11] Aristo, Ahmad Farhan; Suprapto, Bhakti Yudho. *Sistem Deteksi Multi-Robot Dan Api Menggunakan Image Processing Berbasis Algoritma Yolo*. 2020. Phd Thesis. Sriwijaya University.

[12] Mardiati, Rina. Studi Tentang Pemodelan Arus Lalu Lintas. *Jurnal Istek*, 2014, 8.2.

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