The Automatic Design of Light Intensity Led Lights Signal Based on Weather with K-NN Algorithm

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Abstract. The signal lamp is an important component in the railway signaling system. The most important component of the signal lamp is LED (led emitting diode). Because the signal lamp is continuo turned on and in a bright situation even in different weather conditions, so from that situation comes a reduction in the lamp life, and the waste of electrically tariff cost. This research uses K-NN algorithm method used for weather data classification from readings of each sensor. The current weather will be classified automatically, and from the result of the classification are used for setting the light intensity of the trains led signal lamp. The K-NN algorithm will be made in the Arduino. IDE programming language which will be inserted into the Arduino mega 2560 pro mini microcontroller, and the sensor to be used are the rain sensor, the light sensor or LDR, and the DHT22 sensor. The result from this research has been done on 27–30 June 2022. The K-NN algorithm has succeeded in classifying the weather data from readings of each sensor. From the results of the classification, the system has also succeeded in automatically adjusting the light intensity of the trains LED signal lamp, and also succeeded in saving electrically energy which also has an impact on saving the cost of PLN tariff Rp 8.027,22 to Rp 7.651,92 With difference of Rp 375.26 One month tariff in one train LED signal lamp.

Keywords: automation · K-NN Algorithm · Lamp LED Signal

1 Introduction

In terms of railway, signal has function to give information from PPKA (Train dispatcher) to train driver of railway. Nowadays, filament technology in railway signals is no longer used. It is replaced by new technology namely LED (Light Emitting Diode) and it is effectively applied to give important and specific signal in railway namely starting signal, home signal, shunting signal, block signal and many others. LED (Light Emitting Diode) [1] is made up from semiconductor material. The semiconductor material in LED lamp has function for electricity conductor, therefore it has expire duration of usage.

Beside the effect of age [2], when it is turned on, and it is on for long time, there is negative effect namely a huge number of energy consumption. When this LED lamp is on

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with maximum level of brightness, whether it is on in the condition of bright weather or in the condition of dark weather, the electricity consumption sustains same and unavoidably it leads into wasteful use of electricity. The domino effect of extravagant/wasteful consumption on electricity is high cost on electricity needs, and financially it drives into a loss potential. The cost for electricity never deescalates, on the contrary, it escalates and gives negative strike on industry and housing [3].

From the aforementioned background above, the writer plans of making an automatic system for controlling the intensity of light lamp LED of railway signal. This signal is projected to automatically control and adjust the change of light intensity so that the lamp LED will no longer turn on in the maximum light condition. This control will be taken from the under the circumstances by using algorithm learning machine K-NN (near neighbor) [4]. This promoted LED lamp for signal when the weather is bright, this LED Lamp will adjust into light maximum level. Conversely, when the weather is dark, this lamp will reduce its' light.

2 Research Methods

2.1 K-NN Algorithm

Algorithm of K-NN (Classification of Nearest Neighbor) is part of learning machine or on another terms, it is also called as artificial intelligence. Supervised Learning Technique is a technique which is applied in learning machine and it can accept previous information by giving certain labels. The results of query instance furthermore are classified by the nearest distance from the category which exists in the Supervised learning Algorithm. When the K-NN functions to classify, it does not need the trial process, but it accomplishes it automatically based on its memory. The classification type will be used in this Algorithm is K-NN or classification of nearest neighbor as the prediction score of new sampling test [5]. Figure 1, explains of how the working process of K-NN to classify the data based on the nearest neighbor.

2.2 Block of Prototype Diagram

In the Fig. 2 explains how the operating process of light intensity automatic tool of LED lamp for signal of railway works. Block of diagram will be divided into two aspects

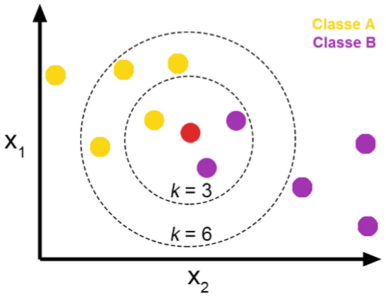

Fig. 1. Working process of K-NN

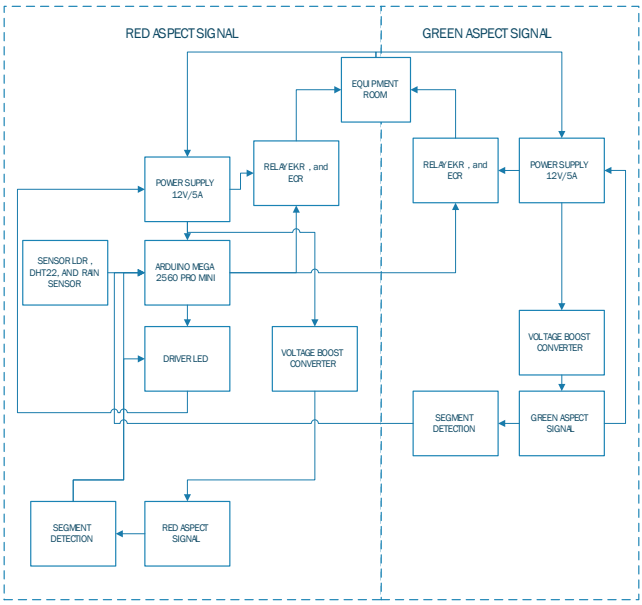

Fig. 2. Block diagram operating process of light intensity automatic tool of LED lamp for signal

of signals; they are red aspect and green aspect of signaling, the lamp will turn on if it is given a logic from the interlocking at the Equipment room. For signal LED lamp of red aspect, it will be turned on as mandatory to show that the condition is safe or clear. The sequence of operating process as follows: block of sensor diagram is the source which heads to Arduino Mega 2567 pro mini [6]. Block of LED driver [7], the setting of light intensity comes from reading the weather condition which refers to the K-NN Algorithm. Block of detecting the segment, it has function to give the light data of signal lamp segment which is sent to the Arduino Mega 2560 Pro mini. The last, block of relay EKR and ECR diagram.

2.3 Flow Chart of Automatic Program on the Light Intensity of Signal Lamp Railway's LED

The process of the LED lamp on the light intensity of signal for railway is demonstrated precisely at the Fig. 3. Algorithm of K-NN will classify the data by comparing sampling data of Arduino when it gets new data through the sensor. The results obtained from the K-NN Algorithm are inserted into 3 sub classes based on their own sensor types. Afterwards, to determine the light intensity of railway' LED lamp, it can be done by switching on them into light mode or into dim. So, the data from each sub class sensor is input into the logic processing of AND on the sub class of determined each sensor. Subsequently, the result of processing the logic will be turned into signal of Pulse Width Modulation (PWM). The score of PWM will arrange the level of brightness or darkness of light intensity of signal on the LED lamp of railway.

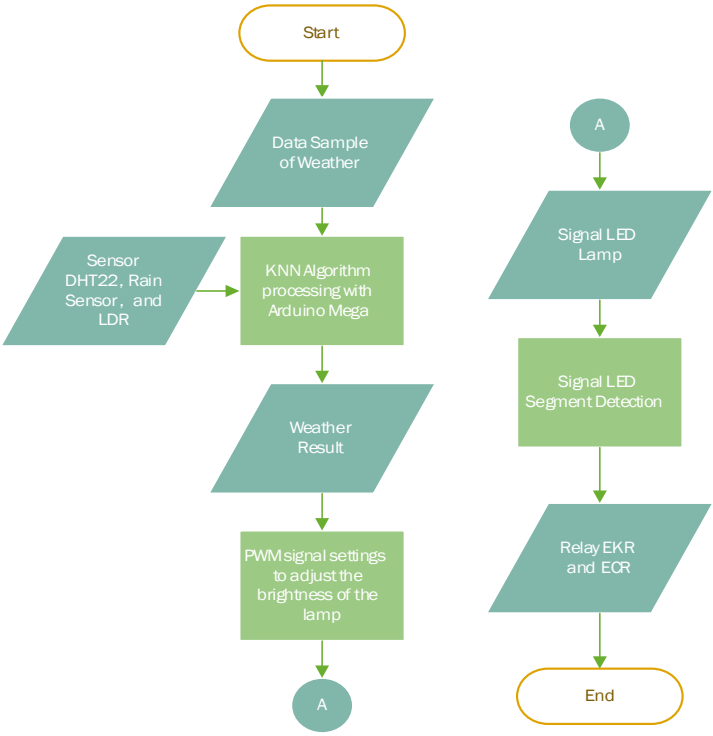

Fig. 3. Flow chart process of the led lamp on the light intensity of signal for railway

Furthermore, the light of LED lamp signal of railway will be detected by a series of segments. The last, there are relay EKR (Elumination Check Relay) and ECR (Elumination Control Relay). Both relays will deliver input into interlocking. Relay ECR will fall when 2 segments on the signal of LED lamp of railway indicates that the electricity is off or outage. The consequence, it will make the screen on the VDU (Visual Display Unit) will blink. Moreover, when one of 3 segments of LED lamp for signal of railway turns off, then the relay EKR will fall and it causes the signal lamp cannot be changed because the appearance on the signal of VDU (Visual Display Unit) will indicates off.

3 Result and Discussion

3.1 Test of Visual Distance

The test of visual distance is utilized to determine the minimum score of PWM which will be used for red aspect signal. The test technique is by starting the highest PMW score namely 255 up to 80. Referring to the guidance of PT. KAI, the test of visible distance is only carried out by direct seeing the object within 400 m from the signal pole [8]. Therefore in the process of test of visible distance, this study involved 10 respondents to see directly within the distance 520 m from the signal pole.

Table 1. Result of test visual distance

No.	PWM Value	Responden Result
1	255	10 people said clearly visible
2	230	10 people said clearly visible
3	200	10 people said clearly visible
4	180	10 people said clearly visible
5	160	10 people said clearly visible
6	140	10 people said clearly visible
7	120	10 people said clearly visible
8	100	10 people said vague visible
9	80	10 people said not clear visible

From the test of visual distance, the results are displayed in the Table 1, and the minimal score for PWM in red aspect signal arrangement is 120.

3.2 Algorithm Test on K-NN

The Algorithm test of K-NN was done on June 27th 2022 until June 30th 2022. The test was done to investigate whether the system can work normally and whether Algorithm of K-NN could classify the data of weather based on the obtained sampling data.The result of test in Table 2 shows that the system and algorithm of K-NN can work and succeed to classify the data of weather on raining and temperature, in line with the data of sampling class which was obtained.

Result of test yielded on the Table 3 shows that the system and K-NN Algorithm can work well and successfully can classify the data of weather, humidity, based on received the data of sampling class. Results of test in the Table 2 demonstrate that system and K-NN algorithm can work well and successfully classify the data of weather and the data of light LUX LDR based the class data sampling.

3.3 Result of Automaticity of Light Intensity on Signal

The signal lamp will be getting dim or dark when the result of class classification on each sensor must meet the requirement that was made by the program. The requirement of setting on the dim light intensity on LED is yielded on Table 3, taken from the opportunity of a weather condition and it is result of weather classification which is being processed by K-NN algorithm. For total of opportunity, there were 81 chances, meanwhile from the calculation 3 which is 4 are class of weather resulted from each sensor and rank 4 is sensor data used (knn_rain, knn_temperature, knn_humidity, and knn_ldr).

Table 2. Result of algorithm test on K-NN rain and temperature

Date	Time	Rain Value	K-NN Rain	Temp Value	K-NN Temp	Humidity Value	K-NN Humidity
27.06.2022	7:10:42	466	2	30.7	1	99.9	3
27.06.2022	7:11:37	460	2	30.4	1	99.9	3
27.06.2022	7:12:07	442	2	30.2	1	99.9	3
27.06.2022	7:12:37	451	2	30	1	99.9	3
27.06.2022	7:13:07	463	2	30	1	99.9	3
28.06.2022	7:47:11	1023	1	33.3	1	61.3	2
28.06.2022	7:47:41	1023	1	33.5	1	60.8	2
28.06.2022	7:48:11	1023	1	33.4	1	60.6	2
29.06.2022	17:44:23	1023	1	24.7	2	60.5	2
29.06.2022	17:44:53	1023	1	24.5	2	61.2	2
29.06.2022	17:45:23	1023	1	24.4	2	76.9	3
29.06.2022	17:45:53	1023	1	24.6	2	77.3	3
29.06.2022	17:46:53	1023	1	24.5	2	77.6	3
30.06.2022	8:07:00	1023	1	41.2	1	77.1	3
30.06.2022	8:07:31	1023	1	41.7	1	77.2	3
30.06.2022	8:08:01	1023	1	41.3	1	45.4	1
30.06.2022	8:08:31	1023	1	40.8	1	45.3	1
30.06.2022	8:09:01	1023	1	40.8	1	45	1

To determine the automatic requirement on light intensity of signal lamp Table 4. Must fit some requirements as follow:

a) K_NN rain may not enter into class 3, because the class 3 is classified into criterion of heavy rain. When it comes (heavy rain), the signal must strongly lights up.
b) K_NN temperature, humidity and LDR may not enter to the class 3 together, because when the environment around is getting dew, that potentially close the visible distance. Therefore the signal at that time must strongly light up.
c) K_NN LDR may not enter into class 1, because the condition around where sun shines bright. Hence signal must be turned on with maximum bright.

3.4 Comparison on Power Tariff

The calculation of power is measured is power which is needed based on service no 7 during 24 h by obtaining the data for each seconds. Data obtained is 1 day and from the data, it needs calculation on electricity of cost during 1 month [9].

Table 3. Result of algorithm test on K-NN LDR

Date	Time	ADC LDR	LUX LDR	KNN LDR
27.06.2022	7:10:42	22	1900	1
27.06.2022	7:11:37	15	2000	1
27.06.2022	7:12:07	22	1900	1
27.06.2022	7:12:37	18	2100	1
27.06.2022	7:13:07	22	2000	1
28.06.2022	7:47:11	20	2500	1
28.06.2022	7:47:41	3	2600	1
28.06.2022	7:48:11	10	2550	1
28.06.2022	7:48:41	6	2550	1
28.06.2022	7:49:11	9	2450	1
28.06.2022	7:49:41	8	2550	1
29.06.2022	17:44:23	495	12.32	3
29.06.2022	17:44:53	520	11	3
29.06.2022	17:45:23	547	9.86	3
29.06.2022	17:45:53	573	9.32	3
29.06.2022	17:46:23	595	8.86	3
29.06.2022	17:46:53	621	8.32	3
30.06.2022	8:07:00	11	2650	1
30.06.2022	8:07:31	5	2700	1
30.06.2022	8:08:01	5	2650	1
30.06.2022	8:08:31	7	2700	1
30.06.2022	8:09:01	3	2700	1

3.5 LED Lamp of Railway Signal Without Using the System of Light Intensity Automacy

From the power of measurement, the result was there was a voltage 1 segment as 41 V and electricity current as 20 mA, because 1 lamp consists of 8 segments. Hence to measure the necessary voltage and current based on Law of kirchhof 1 [10] is 41 V. Then, to count the cost of electricity in a single day, it can use based on expert for formula of power.

$$8 \times 20 = 160\,\text{mA} = 0.16\text{A}$$

Counting the daily cost and within a day can reputable by using formula as follows:

$$P = V \times I$$

$$P = 41 \times 0.16$$

$$P = 6.56\,\text{W}$$

$$P(24\,\text{h}) = 6.56 \times 24 = 157.44\,\text{W}$$

$$P(KWH) = \frac{157.44}{1000}$$

$$P = 0.16\,\text{Kwh}$$

Based on the electricity cost of PLN 2022 [11], For P1 (6.600–200.000 VA) Rp, 1.699,53. The dimming of lamp with voltage is only allowed as 11.30 WIB and in the condition of brightness during 12 h and 30 min:

$$Tariff\ 1\,day = 0.16\,\text{Kwh} \times Rp1.699,53$$

$$Tariff\ 1\,day = Rp267.57$$

$$Tariff\ 30\,days = Rp267.57 \times 30$$

$$\boldsymbol{Tariff\ 30\,days = Rp\ 8.027,22}$$

3.6 LED Lamp of Railway Signal Using the System of Light Intensity Automacy

The dimming voltage lamp to be used is 37 V. The system dimming the signal lights for 11 h 30 min and when the conditions are bright for 12 h 30 min. To ease in calculation the power used, then divided into two. Requirements of automatic light intensity signal shows on the Table 4. First, the condition of power is shining and the other when condition is dim, then add up those results:

a. Power of bright

$$P = 41\,\text{V} \times 0.16\,\text{A}$$

$$P = 6.56\,\text{W}$$

$$P = 82\,\text{W}(12\,\text{h}30\,\text{min})$$

$$P = 0.08\,\text{kwh}$$

Table 4. Requirements of automatic light intensity signal

No	Opportunity Occurred For Dimming							
1	knn_rain:	1	knn_temp:	1	knn_humidity	1	knn_ldr:	3
2	knn_rain	1	knn_temp	1	knn_humidity	2	knn_ldr:	3
3	knn_rain	1	knn_temp	1	knn_humidity	3	knn_ldr:	3
4	knn_rain	1	knn_temp	2	knn_humidity	1	knn_ldr:	3
5	knn_rain	1	knn_temp	2	knn_humidity	2	knn_ldr:	3
6	knn_rain	1	knn_temp	2	knn_humidity	3	knn_ldr:	3
7	knn_rain	1	knn_temp	3	knn_humidity	1	knn_ldr:	3
8	knn_rain	1	knn_temp	3	knn_humidity	2	knn_ldr:	3
9	knn_rain	2	knn_temp	1	knn_humidity	1	knn_ldr:	3
10	knn_rain	2	knn_temp	1	knn_humidity	2	knn_ldr:	3
11	knn_rain	2	knn_temp	2	knn_humidity	1	knn_ldr:	3
12	knn_rain	2	knn_temp	2	knn_humidity	2	knn_ldr:	3
13	knn_rain	1	knn_temp	1	knn_humidity	1	knn_ldr:	2
14	knn_rain	1	knn_temp	1	knn_humidity	2	knn_ldr:	2
15	knn_rain	1	knn_temp	1	knn_humidity	3	knn_ldr:	2
16	knn_rain	1	knn_temp	2	knn_humidity	1	knn_ldr:	2
17	knn_rain	1	knn_temp	2	knn_humidity	2	knn_ldr:	2
18	knn_rain	1	knn_temp	2	knn_humidity	3	knn_ldr:	2
19	knn_rain	1	knn_temp	3	knn_humidity	1	knn_ldr:	2
20	knn_rain	1	knn_temp	3	knn_humidity	2	knn_ldr:	2
21	knn_rain	2	knn_temp	1	knn_humidity	1	knn_ldr:	2
22	knn_rain	2	knn_temp	1	knn_humidity	2	knn_ldr:	2
23	knn_rain	2	knn_temp	1	knn_humidity	3	knn_ldr:	2
24	knn_rain	2	knn_temp	2	knn_humidity	1	knn_ldr:	2
25	knn_rain	2	knn_temp	2	knn_humidity	2	knn_ldr:	2
26	knn_rain	2	knn_temp	2	knn_humidity	3	knn_ldr:	2
27	knn_rain	2	knn_temp	3	knn_humidity	1	knn_ldr:	2
28	knn_rain	2	knn_temp	3	knn_humidity	2	knn_ldr:	2

b. Power of dim

$$P = 37\,\mathrm{V} \times 0.16\,\mathrm{A}$$

$$P = 5.92\,\mathrm{W}$$

$$P = 68.08\,\mathrm{W}(11\,\mathrm{h}30\,\mathrm{min})$$

$$P = 0.07\,\text{kwh}$$

the total power of dim and bright is:

$$P\,total = 0.08 + 0.07$$

$$P\,total = 0.15\,\text{kwh}$$

These below are results of counting the power and usage for tariff cost which is used in line with P1 (6.600 – 200.000 VA) Rp, 1.699,53. So the tariff of cost which is used by utilizing LED for signal railway as follows:

$$Tarif\ 1\,day = 0.15\,\text{Kwh} \times \text{Rp}\,1.699,53$$

$$Tarif\ 1\,day = Rp\,255,06$$

$$\boldsymbol{Tarif}\ 30\,\boldsymbol{days} = \boldsymbol{Rp}\,7.651,92$$

Then the comparison of tariff of PLN cost which will be used for one lamp LED with signal of railway by predicting the cost is 1 month. Between using system and not using it is as follows:

$$\text{Difference} = \text{tariff without system} - \text{tariff using system}$$

$$\text{Difference} = Rp\,8.027,22 - Rp\,7.651,92$$

$$\text{Difference} = Rp\,375.26$$

From the data, automatic system on light intensity LED Lamp for signal railway was successfully saving the electricity and cost of tariff PLN. Viewed from the difference of calculation by using system and not using system the prediction of cost was 30 days or it is equal 1 month for only 1 signal lamp.

4 Conclusion

The making of K-NN Algorithm by calling the function of library K-NN and adding the sampling data for each classified data and inserting into class data to obtain the result of classification by algorithm K-NN. The setting of light intensity of LED lamp for signal railway automatically is based on the result of classification K-NN algorithm based on the weather as it is happening, so from the result of classification and by considering parameter of diming of signal, then the setting of light intensity of lamp can be done automatically. Automaticity of light intensity of LED lamp for signal railway, has succeeded doing energy saving, mainly electricity savings and the saving for the cost tariff PLN which is previously they need budget Rp8.027,22 for tariff cost 1 month and 1 lamp of signal used. Moreover, after using automatic system of light intensity fro tariff 1 month and 1 signal lamp as Rp7.651,92. Therefore, system of automatic light of lamp LED because the signal is not good and it is saving money as worth Rp.375.26 for 1 tarif of month and 1 LED lamp for railway signal.

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