Web Based Information System of Carbon Monoxide Pollution

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Abstract. In Indonesia, carbon monoxide is one of which type of gas used as a parameter in the air pollution. Unfortunately, reporting and monitoring air pollution in Indonesia is regulated in government rules and reported once a day. The value of carbon monoxide concentration always change but the published information is out of date. Without real-time information, people cannot avoid the danger of monoxide pollution toxicity effect. This paper purpose the solution by publishes the real-time information from the carbon monoxide sensor data acquisition. This Research uses the rule-based method to calculate carbon monoxide pollution from data acquisition. Results of experiments show that information generated by the system in accordance with the manual calculation results of carbon monoxide pollution. This research contributed to providing information on real-time carbon monoxide measurement to the public, so the danger of carbon monoxide poisoning can be avoided.

Keywords: **Rule-Based; Carbon Monoxide; Air Pollution; Real-Time Measurement System ;**

1 Introduction

Rule-based methods are very easy to implement in a system so that the system can behave intelligently [1], one of its applications to monitor air pollution. because air is one of the determinants of environmental quality that today has become a serious issue. Some of the gases officials used to determinate Air Quality Index in Indonesia are sulfur dioxide (SO2), carbon monoxide (CO), Nitrogen Dioxide (NO2), Ozone (O3), and Particulate (PM10) [2].

Carbon monoxide (CO) is an indicator of air quality. CO is colorless and odorless but at high concentrations, CO becomes a highly toxic gas[3], Carbon monoxide poisoning is common, resulting in more than 50,000 emergency department visits per year in the United States [4]. Carbon monoxide has an affinity for hemoglobin 200-250 times that of oxygen, and the symptoms and signs that follow inhalation of carbon monoxide have been supposed to result from tissue hypoxia. Carbon monoxide combines with hemoglobin to form carboxyhemoglobin, reducing the total capacity of the blood to carry oxygen and shifting the oxygen dissociation curve to the left[5]. The symptoms of carbon monoxide poisoning are nonspecific. Mild exposures result in a headache, myalgia, dizziness, or neuropsychological impairment. Severe exposures to carbon monoxide result in confusion, loss of consciousness, or death [6].

Air pollution resulting from fossil fuel combustion has become an important problem, especially for countries with an increasing energy demand and inherent fuel consumption[3]. Real-time Monitoring of Carbon monoxide concentration is important because it is particularly dangerous as it cannot be detected by man's natural sense organs[7]. In Indonesia air quality index reporting to the public is not done in real-time, AQI reporting to the public is only done once a day and is valid 24 hours from 15.00 WIB [2], The real-time data acquisitions has become a major issue [8][9][10][11], especially in air pollution monitoring [12][13] The value of carbon monoxide concentration always change but the published information is out of date. Without real-time information, people cannot avoid the danger of monoxide pollution toxicity effect.

Computer network-based automation can improve work effectiveness in measurement in processing. Computer-based systems are more precise and faster in execution so it is suitable for measurements that require high response speeds [14]. The real-time information can be used as a reference to handling and reducing carbon emission for developing low carbon society.

2 Related Work

Over the past few years, many research of air pollution has mainly focused on forecasting the concentrations of air quality [15][16][17][18][19] and air quality measurement [20][21][22][23][24].

The forecasting of air quality became popular, many methods have been purposed for forecasting air quality such as hidden Markov model[15], first-order and one-variable grey model [16], developed support vector machine [17], fuzzy time series model [18][19][25], Solar Radiation[26], and Fuzzy-AHP[27].

Compared with forecasting, determination of air pollution has recently become an important issue due to

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its significance, and several new methodologies have been developed for the determination of air quality, such as Fuzzy-AHP[27], artificial neural networks[28], and real-time measurement[29].

Based on the literature on the determination of air quality mentioned above, real-time measurement became an important issue since air pollution parameters difficult detected by a human body. Real-time measurement of carbon monoxide sensor adopts to combine with the rule-based method. The rule-based method is a very easy method to create system act intelegently[30]. Combination of rule-based served the information of real-time carbon monoxide measurement to the public.

3 Methodology

3.1 Real-time Data Acquisition

The purpose of real-time data acquisition in this paper using carbon monoxide sensors to capture the carbon monoxide concentration. The sensors installed on the node station and send data acquisition to send into web service, after the process of determination of air quality, the result will publish into public as a real-time information of carbon monoxide pollution.
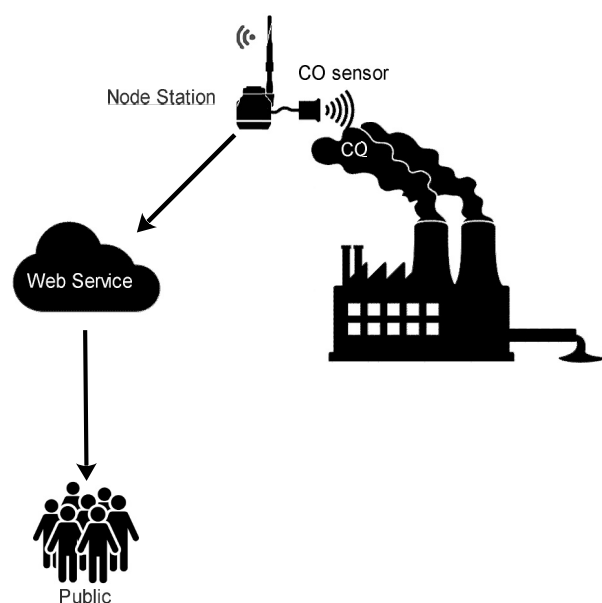

Fig.1 Real time carbon monoxide aquisition

3.2 Indonesian Air Quality Index

In Indonesia the Air Quality Index Calculation Method is based on government rules, this Air Quality Index is adapted to determine the carbon monoxide pollution. About Technical Guidance of Calculation and Reporting and Information of Indonesian Air Quality Index as follows :

$$I = \frac{I_A - I_B}{X_A - X_B}(X_X - X_B) + I_B \qquad (1)$$

With I is the calculated AQI, IA is the upper limit AQI, IB is the lower limit AQI, XA is the upper ambient limit, XB is the lower ambient limit, and XX is the real ambient content of the measurement result. The values of IA, and XB are based on the AQI boundary table as shown in Table 1. Index Number and Category of Indonesian Air Quality Index based on government rules are showed in Table 2.

Table 1. Air Quality Index Limit

Air Quality Index	24 Hour PM10 ug/m3	8 Hour SO2 ug/m3	8 Hour CO ug/m3	1 Hour O3 ug/m3	1 Hour NO2 ug/m3
50	50	80	5	120	
100	150	365	10	253	
200	350	800	17	400	1130
300	420	1600	34	800	2260
400	500	2100	46	1000	3000
500	600	2620	57.5	1200	3750

Table 2. Index Number And Category Of Indonesian Air Quality Index

Category	Range
Good	0-50
Medium	51-100
Unhealthy	101-199
Very Unhealthy	200-299
Dangerous	Over 299

3.3 Modeling of Indonesian Air Quality Index using Rule-Based Method

AQI formulation modeling using the rule-based method, in the determination of IA, IB, XA, and XB based on AQI boundary table as in Table 1.

Step 1: Define XX

Step 2: Determine the IA

IA determine with the rule :

If XX less than 6, then IA is 50

If XX more than 5, and below 11, then IA is 100

If XX more than 10, and below 18, then IA is 200

If XX more than 17, and below 35, then IA is 300

If XX more than 34, and below 47, then IA is 400

If XX more than 46, then IA is 500

Step 3: Determining the IB

IB determine with the rule :

If XX less than 6, then IB is 0

If XX more than 5, and below 11, then IB is 50

If XX more than 10, and below 18, then IB is 100

If XX more than 17, and below 35, then IB is 200

If XX more than 34, and below 47, then IB is 300

If XX more than 46, then IB is 400

Step 4: Define XA

XA determine with the rule :

If XX less than 6, then XA is 5
If XX more than 5, and below 11, then XA is 10
If XX more than 10, and below 18, then XA is 17
If XX more than 17, and below 35, then XA is 34
If XX more than 34, and below 47, then XA is 46
If XX more than 46, then XA is 57.5
Step 5: Define XB
XB determine with the rule :
If XX less than 6, then XB is 0
If XX more than 5, and below 11, then XB is 5
If XX more than 10, and below 18, then XB is 10
If XX more than 17, and below 35, then XB is 17
If XX more than 34, and below 47, then XB is 34
If XX more than 46, then XB is 46
Step 6: Calculate I, the calculation I is done using equation (1)
Step 7: Perform rounding of calculation result I
Step 8: Define the category and color of AQI according to Table 2

4 Result and Discussion

4.1 Implementation

Implementation of the Indonesian AQI Model is applied to web-based applications that display the location of the station, the graph of the acquisition value, and the pollution of carbon monoxide measurement table using the system. It is shown in fig.2.

4.1 Verify the results of implementation Indonesian Air Quality Index monitoring system

Verification is done by testing the conformity of the calculation result with the system and the ambient air quality data of Pontianak city on August 26, 2014. The result of the match test is shown in Table 3

Table 3. Verify The Results Of Implementation Indonesian Air Quality Index Monitoring System

No	Acquisition Time	CO (ug/m3)	AQI Pontianak City August 26, 2014		AQI Calculation Using System		Match
			AQI	Cat	AQI	Cat	
1	00:00:00	3.87	39	GOOD	39	GOOD	Yes
2	00:30:00	3.98	40	GOOD	40	GOOD	Yes
3	01:00:00	4.05	41	GOOD	41	GOOD	Yes
4	01:30:00	4.12	41	GOOD	41	GOOD	Yes
5	02:00:00	3.88	39	GOOD	39	GOOD	Yes
6	02:30:00	3.69	37	GOOD	37	GOOD	Yes
7	03:00:00	3.41	34	GOOD	34	GOOD	Yes
8	03:30:00	3.53	35	GOOD	35	GOOD	Yes
9	04:00:00	2.42	24	GOOD	24	GOOD	Yes
10	04:30:00	2.41	24	GOOD	24	GOOD	Yes
11	05:00:00	2.45	25	GOOD	25	GOOD	Yes
12	05:30:00	2.22	22	GOOD	22	GOOD	Yes
13	06:00:00	1.35	14	GOOD	14	GOOD	Yes
14	06:30:00	1.57	16	GOOD	16	GOOD	Yes

No	Acquisition Time	CO (ug/m3)	AQI Pontianak City August 26, 2014		AQI Calculation Using System		Match
			AQI	Cat	AQI	Cat	
15	07:00:00	1.46	15	GOOD	15	GOOD	Yes
...	...	...	...	...	...	...	...
43	21:00:00	2.19	22	GOOD	22	GOOD	Yes
44	21:30:00	3.37	34	GOOD	34	GOOD	Yes
45	22:00:00	1.57	16	GOOD	16	GOOD	Yes
46	22:30:00	2.14	21	GOOD	21	GOOD	Yes
47	23:00:00	1.6	16	GOOD	16	GOOD	Yes
48	23:30:00	2.41	24	GOOD	24	GOOD	Yes
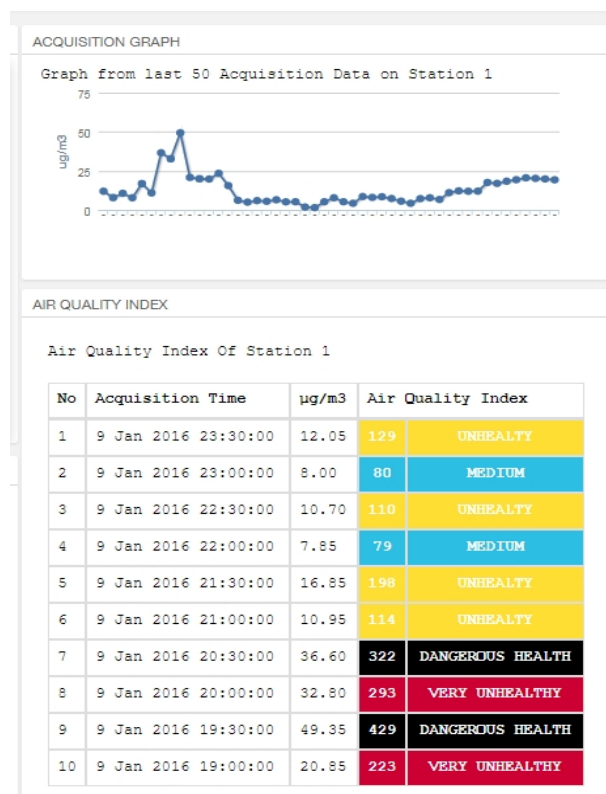
Fig. 2. Real-Time Measurement of Carbon Monoxide Pollution

5 Conclusion

From the results of this research can be concluded that clear rules have to be clear to building system using the rule-based system. This is proven by the calculation of air pollution from carbon monoxide gas using rule-based method has a 100% match rate compared to manual calculation.

The rule-based method can be adopted and combine with the real-time acquisition of carbon monoxide concentration to determinate the carbon monoxide pollution. The information about carbon monoxide pollution can be delivered as real-time public information to avoid the danger of carbon monoxide poisoning. The real-time information can be used as a reference to handling and reducing carbon emission for developing low carbon society

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