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Traffic control at crossroad that cut railroad based on friendly environment

Case : Crossroads at Prof. M. Yamin road with Gaharu road in Medan

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Abstract. The frequent congestion causes accumulation of vehicles at the intersection of roads cutting off railroads, reducing the functionality of highway services, the loss of vehicle functions as a means of transportation, waste of fuel energy, and CO2 increase in intersections. The occurrence of congestion caused by the absence of integration of traffic light controls by opening and closing the railway barrier, therefore need to be done integrated control especially during and after a while train crossing the highway. The case raised in this study is the crossroads Prof. H.M. Jalan Yamin with Gaharu road in Medan. Researchers tried to solve the problem by designing and creating a tool that would coordinate and regulate traffic lights with railroad doors, thus reducing congestion for 23 minutes, reducing fuel by as much as 60,340 liters per day, thereby reducing CO2 exhaust gases in the area. This tool uses microcontroller as its control center. This design is done with a miniature simulation, meaning it is not done in the actual situation, but the field conditions can be represented in the simulation in the form of miniature.

1. Introduction

Traffic Light plays a very important role in maintaining the smoothness of traffic, especially at crossroads that are prone to congestion. Sometimes even though there is traffic light on the road, there are still frequent congestions. One example, this occurs at a crossroads close to the railway track crossing. Each train passes on a road close to the intersection of the road, than there will be a traffic jam on the intersection of four. This traffic jam also lasts for several minutes after the train crossed the road, due to the large number of vehicles that have accumulated at the intersection because of the lack of coordination between the traffic light control at the intersection with the open lid railway open. The example case is at Gaharu Street and Prof. Muhamad Yamin Street intersection in Medan, as in Figure 1. Traffic congestion often occurs at the intersection of Prof. H.M. Yamin Street with Gaharu Street in Medan, especially when the train passes or leaves the railway station which is ± 300 meters from the railway passageway, and worsens due to frequent train passing at the track, while the Traffic light at the intersection Gaharu Street and Prof. M. Yamin Street runs as usual so as to lead to the accumulation of vehicles in front of the railway door.

The accumulation of vehicles from 3 directions towards one direction of the railway track causing the occurrence of congestion causing losses, including: the reduced function of road services, the loss of function of the vehicle as a means of transportation, wasted fuel energy wasted, and increased levels of CO , CO2 at the crossroad areas.

In congestion, about 20% of machine work time is spent in 0 km / h (stop). Stopping with engine turned on is the same as disposing fuel, because motor vehicles are losing their

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function as a means of transportation. As it is known that motor vehicles dispose harmful substances that can cause negative impacts, both on human health and the environment [5]. Air pollution resulting from motor vehicles that emit harmful gases greatly contributed to the occurrence of air pollution and one consequence is the presence of global warming [2]. The exhaust gas emissions are the residual result of a fuel burning process inside the engine. Composition of exhaust emissions in the form of water (H2O), toxic carbon monoxide (CO), carbon dioxide (CO2), which is a greenhouse gas, sulfur (SOx), nitrogen oxide (NOx) compounds, hydrocarbon (HC) and particulate compounds Dust including lead (PB). In this case its only limited to gases in the form of CO, and CO2.

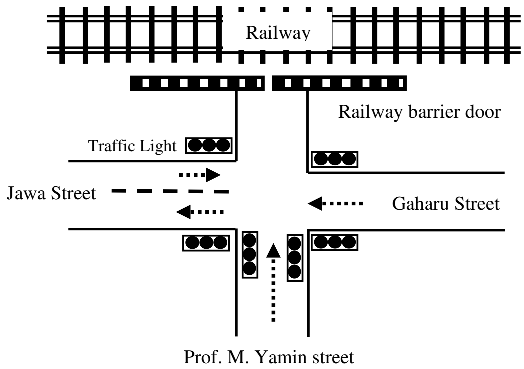

Figure 1. Map of crossroad Gaharu Street with Prof. M. Yamin Street

When the train passes on the track, the railway track is closed, and while traffic light lights up as usual, there is a buildup of motor vehicles in front of the railway track to traffic light. The duration of the congestion at the intersection of four depends on the length of the train carriage Lokomotip brought and the speed of the train. On the track, the train always runs at a slow pace because it cuts off the highway and close to the railway station, this will cause a lot of motor vehicle to be in a stop position, resulting in wasteful energy consumption, increased vehicle exhaust gas, and rise the temperature in the area that lasts during a jam. To parse this bottleneck it takes about 2-3 minutes because even when the traffic light turns green, there is still congestion in front of it.

Coordination of open-lid control of railway latches with traffic light is required so that the congestion quickly decomposes so that it can reduce the motor vehicle exhaust pollutants in the area which will automatically save the vehicle fuel as well, for that needed a controler device that indicates traffic light system with open lid railway doors, which in this case designed a microcontroller-based control tool in the form of miniature simulations that works to take over the work of traffic light automatically when the train will or is crossing the door of the train track.

2. Research Methodology

This research was conducted by taking the case of congestion that occurred in the intersection of Prof. M. Yamin streets with Gaharu streets in Medan which occurs whenever train crosses, observation time and data retrieval is done at 8.30 am. until 05.00 pm at the area in front of the railway track, the time when heavy traffic occurs. The data taken is the number of trains crossing the road on a regular basis, the number of occurrences on the road, the time length to close the railway barrier door of the train track on a regular cross, the time length to close the railway barrier door of the train trajectory at the time, the number of vehicles located in the area in front railway tracks, and length of congestion breaking down as the railway railway barrier door opened.

The data obtained is used as material for designing a controller that can synchronize the open lid of the railway barrier door with the traffic light system at the intersection, so that when the train passes the road the controller will take control of the taffic light and return it after the railway barrier door the track is open 30 seconds, so in that way can reduce the duration of the congestion on the railway barrier door area.

The reduction in the duration of the congestion on the railway track area will provide benefits such as improving the function of the road service, maximizing the function of the vehicle as a means of transportation, reducing fuel consumption, reducing the exhaust gas of CO and CO2 in the area. The design of the control device is done in the Telecommunication Laboratory of the Faculty of Engineering, Nommensen HKBP University, this controller uses a microcontroller equipped with supporting components to form a system that can be applied or implemented to control equipment with many control parameters. Or it can be said that this microcontroller can replace the function of a computer for a particular application. The microcontroller used is Atmel AT89C2051 which has memory system, timer, serial port and 32 bit I / O so it is possible to form a system consisting of single chip only, thereby reducing the design space [1,3]. This microcontroller serves as a data processing center that receives input from railway arrives sensors and outputs to ligth traffic and to the railway barrier door controller. Overall, the circuit block diagram is designed as in Figure 2.

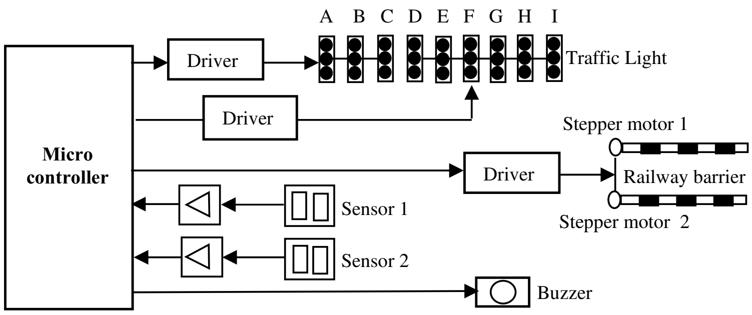

Figure 2. Block diagram controller

3. Results and Discussion

Based on observations and data we get from train officers who work as Officers that open the lid of the railway barrier door when the train cross on the railway barrier door of the railway track road Prof. M. Yamin is that in a day the train that crosses the line between 8.30 am to 05.00 pm is 16 times and the railroad that cross the road averages 7 times as can be seen in Table 1.

The railway barrier door attendant will close the railway barrier door as the train is about 500 meters away from the railway entrance door, and the average railway latch's time is 2 minutes, and when the train is switcher the crossing door is closed during 3 minutes,while the average time needed to break down the traffic jam that occurred in front of the door crossing to return to normal is 1 minute.

Table 1. Length of time close crossing barrier door of railway

Direction of train (round trip)	Frequency (times)	Length of time close the barrier (minute)	Length of time decomposes (minute)	Total of time (minute)
Medan-Binjai	12	12 x 2 = 24	12 x 1 = 12	36
Medan-Belawan	4	4 x 2 = 8	4 x 1 = 4	12
Switcher (everage)	7	7 x 3 = 21	7 x 1 = 7	28
Total	23	53	23	76

Based on the observation, the number of motor vehicles accumulated in front of the railway barrier door to the traffic light average of 50 vehicles four wheels and 100 vehicles of two and three wheeled vehicles. The amount of exhaust volume depends on the amount of fuel combustion cylinder space, if it is assumed that the exhaust volume of four-wheeled vehicles is equal to 4 times the volume of exhaust gases of two or three wheeled vehicles then we can assume that the number of 4 wheel vehicles accumulated as much as 50 + (100 / 4) equal to 75 cars of four wheels. In one day (8.30 am to 05.00 pm) there were 23 closures of the railway crossbar with the total number of vehicles 75 multiply by 23 equal to 1.725 four-wheeled vehicles with a total time of congestion for 76 minutes. The four-wheeled vehicle that stops (in a stuck situation, the live engine) has a rpm (revolution per minute) smaller than 500 rpm. The engine rotation of the vehicle in a state of stopping (traffic jams) is below 500 rpm (revolution per minute), according to research conducted by Sastra Negara et al. That the exhaust gas generated by four-wheeled vehicles in rotations below 500 rpm fueled 88 octane premium is 5.5% (CO), and 11.626% (CO2). The number of vehicle exhaust gases at each railway door closing is 247 (CO), and 532 (CO2) which lasts for an average of 3.3 minutes. Based on the Pacific Consultant International (PCI) equation, the fuel spent by four-wheeled vehicles in standstill is 0.583 ml / sec [8], resulting in the amount of fuel spent during traffic congestion (8.30am. - 17.00 pm.) Is 0.583 ml / sec multiply by 75 vehicles multiply by (76 times 60) seconds equal to 199.386 ml equal to 199,386 liters. Description of the road junction and position of the lamp, stepper motor, sensors and railway gate in the minitaur designed as in Figure 3. If the train passes through sensor 1 or sensor 2, then sensor 1 or sensor 2 will give input to microcontroller, then microcontroller will Activate the stepper motor driver so that the stepper motor will rotate, consequently the latch will be closed following the stepper motion stepper motor as far as 90 degrees. At the same time the microcontroller will also activate the lamp driver so that all lamps at the crossroads are in the red phase. Furthermore, once the train has passed the sensor 2 or sensor 1, it will give the input back to the microcontroller to return to the original state where the stepper motor will rotate in the opposite direction with the first rotation direction as far as 90 degrees, so that the latch will reopen and the condition of the lamp on The crossroads will return to the first phase. These conditions can be seen in Table 2, where the train is assumed to pass through sensor 1 to sensor 2.

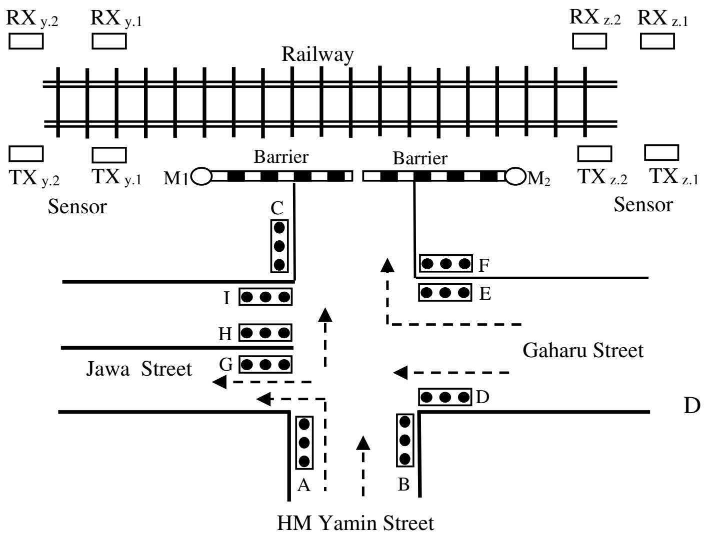

Figure 3. Crossroads, sensor position, stepper motor, and railway barrier door

Table 2. Condition of sensor, stepper motor, and traffic light on system instant before and after the train crosses sensor 1 towards sensor 2

No	State	Sensor 1		Sensor 2		Motor stepper		Traffic Light	
		$Rx_{z.1}$	$Rx_{z.2}$	$Rx_{y.1}$	$Rx_{y.2}$	M_1	M_2	A=B=C	D=E=F=G=H=I
1	Normal (t_1)	OFF	OFF	OFF	OFF	OFF	OFF	Green	Red
2	Normal (t_2)	OFF	OFF	OFF	OFF	OFF	OFF	Yellow	Red
3	Normal (t_3)	OFF	OFF	OFF	OFF	OFF	OFF	Red	Green
4	Normal (t_4)	OFF	OFF	OFF	OFF	OFF	OFF	Red	Yellow
5	Cross train (t_1)	ON	OFF	OFF	OFF	OFF	OFF	X	X
6	Cross train (t_2)	ON	ON	OFF	OFF	ON	ON	Red	Red
7	Cross train (t_3)	ON	ON	ON	OFF	ON	ON	Red	Red
8	Cross train (t_4)	ON	ON	ON	ON	ON	ON	Red	Red
9	Cross train (t_5)	OFF	ON	ON	ON	ON	ON	Red	Red
10	Cross train (t_6)	OFF	OFF	ON	ON	ON	ON	Red	Red
11	Cross train (t_7)	OFF	OFF	OFF	ON	OFF	OFF	Red	Red
12	Normal (t_1)	OFF	OFF	OFF	OFF	OFF	OFF	Green	Red

Table 3. Phases of lamps at the crossroads in normal state

Phase	HM.Yamin Street			Gaharu Street			Jawa Street			Long Phase (second)
	M_1	K_1	H_1	M_2	K_2	H_2	M_3	K_3	H_3	
1	1	0	0	0	0	1	0	0	1	50
2	1	0	0	0	1	0	0	1	0	3
3	0	0	1	1	0	0	1	0	0	50
4	0	1	0	1	0	0	1	0	0	3

The overall toolwork process is illustrated by the system flowchart as in Figure 4.

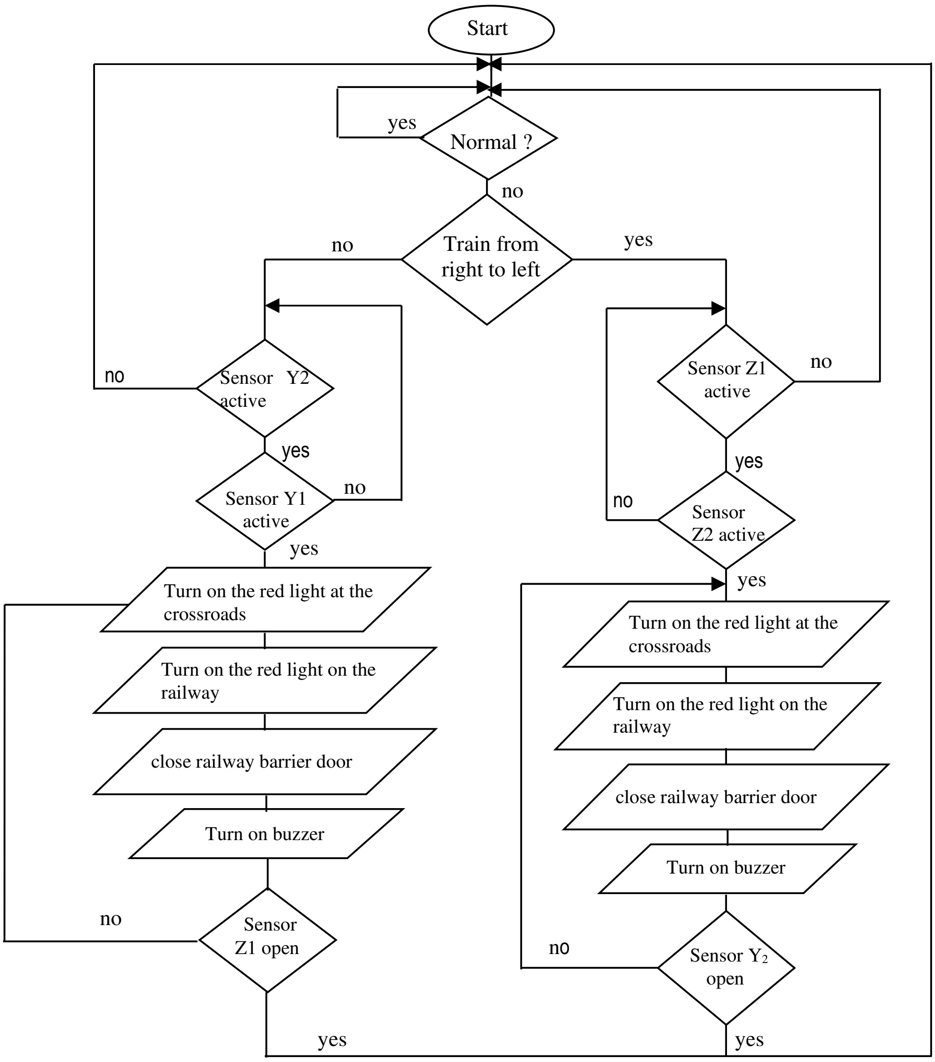

Figure 4. Flow chart Overall System

With the result of designing this control tool, it can be eliminated the time required to unravel the congestion that occurs in the railway door area when the railway barrier door is closed. This is because when the railway barrier door is closed (the train is 500 meters away from the track door) all the traffic light is red at all intersections so that no vehicle accumulates and precedes each other when the railway barrier door opens again, which means 1 minute congestion time to unravel the congestion can be eliminated so that the congestion time is reduced to just 2 minutes by the time a regular train passes and reduced to 3 minutes when the train switcher.

The total reduced congestion time in one day is 23 minutes so the total one-day bottleneck time becomes 53 minutes. Reduced fuel loss in one day is 23 minutes multiply by 60 seconds multiply by 0.583 ml / second multiply by 75 vehicles equal to 60.340 ml equal to 60.340

liters. The exhaust time of CO and CO2 is reduced for 23 minutes with 1,725 vehicles in one day so as to reduce exhaust pollution in the four-point area.

4. Conclusion

1. The design of traffic light control system can reduce congestion on the crossroad of M. Yamin street with Gaharu street for 23 minutes.
2. The design of this traffic light control system can reduce vehicle fuel waste by 60,340 liters per day and can reduce CO2 and CO2 emissions from the car for 23 minutes in one day in the area.
3. The design of this traffic light control system improves the function of road and vehicle functions as a means of transportation in the area.

5. References

[1] Agfianto E P 2002 *Learning AT89C51 / 52/55 Microcontroller (theory and application)* (Yogyakarta; Gajah Mada)
[2] Arifin Z 2009 *Vehicle Pollution Control* (Bandung; Alfabeta)
[3] Danny C, and Kris P 2004 *Basic Guide of MCS51 Family Microcontroller* (Surabaya; Innovative Electronics)
[4] Sastra N, Budiarsa S, Suarna 2012 *The Effect Of Fuel Octane Value And Engine Round On Motor Vehicles To The Characteristic Of Exhaust Emissions. Proc. Ecotrophic* 4(2) 106-111
[5] Kuswara 2006 *Emission Inventory of pollution CO2, NOx, HC and SPM in Bandung Regency J. Teknik Lingkungan* **3 (1)** 215-224.
[6] Government Regulation of the Republic of Indonesia Number 41 1999 *Air Pollution Control*
[7] Rann Y, Fanny R A, Ferina F 2011 *Analysis of the amount of Air Pollution Based on Motor Vehicle exhaust gas level in the Parking Area Gunadarma University Kalimang* (Jakarta: PKM University of Gunadarma)
[8] Yudha W 2009 *Analisis Speed of Vehicles On the Road Section Brigjen Sudiarto (Majapahit) Semarang City and Its Influence on Fuel Consumption* (Semarang : Thesis Magister of Civil Engineering University Dipanegoro)