Detection of Railways Through Axle Detection Patterns Using Inductive Proximity Sensors

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Abstract. Early Warning System (EWS) at level crossing gates is a system used to provide early warning in the formof signals or lights and siren sounds when a train is approaching crossed. This level crossing is prone to accidents. In order to improve railway security and safety, railway facility detectors have an important role in passenger safety nationally. This facility detection system uses an inductive proximity sensor. This vehicle detection system was created to find out what type of equipment haspassed and to determine the axle pattern. This tool is designed using hardware and devices soft. The hardware consists of inductive proximity sensors, LCD, I2C, and Personal Computer. Meanwhile, the software consists of Arduino IDE and Visual Basic Studio. In this tool, the sensor is installed parallel to the trackwith a distance between sensor 1 and sensor 2, namely 60 cm. Based on the tests that have been carried out, this tool can detect the type of passing vehicle which can be determined based on the axle pattern. This sensor can detect well if it is placed at the optimal limit, namely 1 – 4 mm. The output of this type of passing vehicle can be seen on the LCD, while the axle pattern can be seen in the form of a sinusoidal wave via the Visual Basic Studio application. In calculating the average percentage of error on the tool, the percentage result is 0%, which means the tool can work well.

Keywords: Axle Counter, Detector, Inductive proximity sensor, Arduino Uno.

1 Introduction

Early Warning (EWS) at level crossing doors is a system used to provide early warning in the form of signals or lights and siren sounds when a train is about to pass. This level crossing is prone to accidents and has a high number of traffic accidents. This accident occurred due to various factors, starting from the siren at level crossing not sounding, the crossing gate not closing, the speed of the train exceeding the speed limit, and the error of the driver who broke through the gate. In order to improve railway security and safety, railway facility detectors have an important role in passenger safety nationally[1]. Detection of facilities on the railway line requires a high level of accuracy regarding train information. Detecting the presence of trains along railway lines is critical and important, so the use of accurate, reliable and efficient detection technology is very important to avoid potential collisions and ensure that train traffic runs safely[2]. With reliable and efficient rolling stock detection, it is hoped that axles can be identified early, so that preventive action can be taken to reduce the risk of accidents. This research develops a railway rolling stock detection system using inductive proximity sensor technology[3]. By implementing inductive proximity sensor technology, it is hoped

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that axle detection can be carried out in a timely and accurate manner, so that the potential for interference and the risk of accidents can be minimized[4].

2 Method

This method uses hardware and software system design methods. Then use the tool testing method, namely to find out the system that has been created is in accordance with what was designed[5]. This testing method is testing the type of passing vehicle by setting the distance between sensors and testing the detection device based on the pattern. Apart from that, this system uses a tool validation test method to show the extent to which the tool used can function properly[6].

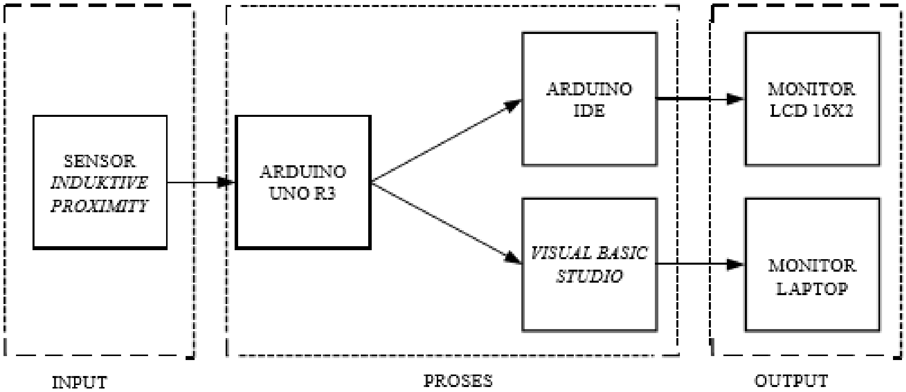

Fig 1. Diagram Block.

This diagram figure 1, starts from taking a voltage source from USB (Universal Serial Bus) serial on the laptop is 5 VDC. Then this voltage used to turn on the Arduino. Then the Arduino output pin (pin 2 and pin 3) of 5 VDC will be stepped up or filled with voltage of 12 VDC which is used to turn on the voltage on inductive proximity sensors. This voltage is stepped up to 12 VDC because the input voltage on this sensor is 10 – 30 VDC. Next, pins 12 and pin 13 are used to turn on the lights LED as an indicator if the sensor has detected an object[7]. On the SDA pin and SCL are connected, namely the I2C Module which is used as a module for reading on LCD 16 x 2. For reading through axle patterns Visual Basic Studio application using USB connected on laptop to transmit the data. A means detection pattern will be formed if the sensor detects the presence of an axle that crosses the rail[8]. Then amount suggestion types of locomotives and passing trains can be detected on the layer 16x2 LCD[9].

3 Results

The results of designing a train detection system using this device hardware and software. Hardware consists of Arduino Uno R3, sensors inductive proximity, 16 x 2 LCD, and I2C, while the software consists of Arduino IDE and Visual Basic Studio. This hardware is assembled and placed in a box measuring 12.5 x 8.5 x 5 cm according to the wiring[10].

3.1 Inductive Proximity Sensor Test Results

The results of the design in one a unified railway rolling stock detection system consisting of sensors and supports, a laptop for Arduino power and displaying the axle detection pattern in the Visual Basic Studio application and a box containing an LCD to display the number of types of rolling stock of locomotives and carriages passing by like in figure 2.

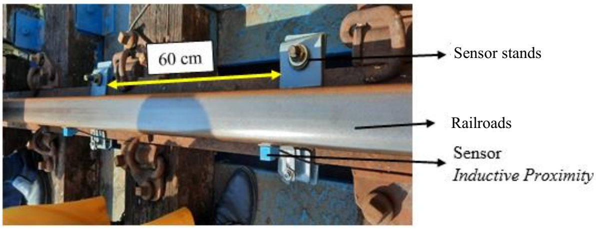

Fig 2. Installation of the System on Rails

This installation is carried out by locking the support to the foot of the rail, then the placement of the sensor on this support can be adjusted to a predetermined distance, namely 4 mm below the train axle. The distance between these two sensors is 60 cm.

3.2 Visual Basic Studio Programming Results

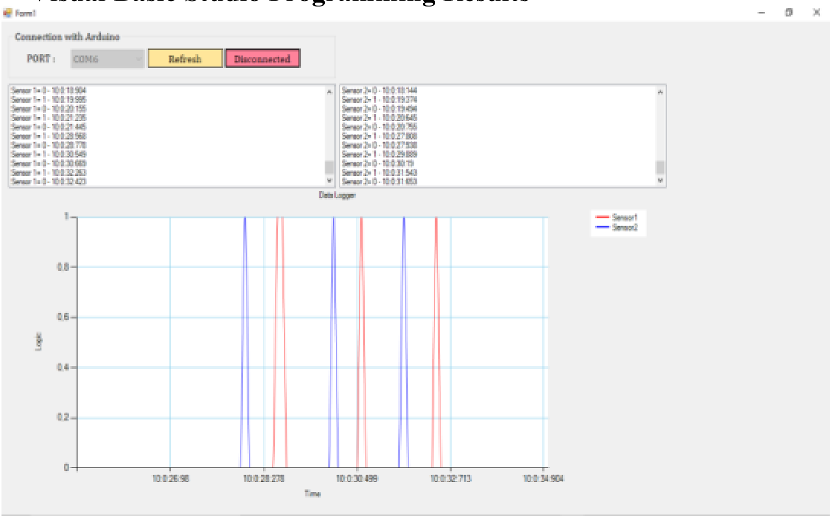

Fig 3. Visual Basic Studio Display when Sensor Detects Objects

The display in figure 3, the Visual Basic Studio application when the sensor detects an object, at that time the detection pattern on the inductive proximity sensor is visible, which is indicated by a sinusoidal wave with a value of 1. Then in the box display above is the input from sensor 1 and sensor 2 in real time. The image above is an example if the sensor is detected by a metal object on sensor 1 and sensor 2.

3.3 Inductive Proximity Sensor Test Results

Table 1. Inductive Proximity Sensor Test Results

NO	DISTANCE OBJECT (MM)	TYPE OBJECT	CONDITION SENSOR 1	CONDITION SENSOR 2
1	0	Metal	*High*	*High*
2	1	Metal	*High*	*High*
3	2	Metal	*High*	*High*
4	3	Metal	*High*	*High*
5	4	Metal	*High*	*High*
6	5	Metal	*Low*	*Low*
7	1	Fabric	*Low*	*Low*
8	1	Plastic	*Low*	*Low*
9	1	Cardboard	*Low*	*Low*
10	1	Wood	*Low*	*Low*

From the table 1 above, it can be concluded that the object is a metal type with an optimal distance of 0 –4 mm can detect objects, whereas objects made of cloth, plastic, cardboard and wood cannot be detected by this sensor. This test means that it complies with the specifications of the sensor used.

3.4 Sensor Placement Distance Test Results

Table 2. Sensor Placement Distance Test Results

No	Distance Sensor 1 and sensor 2 (cm)	Amount Axle Enter	Detection Amount Axle En-ter	Error %	Accuracy%
1	50	2	2	0%	100%
2	60	2	2	0%	100%
3	70	2	2	0%	100%
4	80	2	2	0%	100%
5	90	2	2	0%	100%

The average at table 2, percentage error obtained from testing the distance of this sensor placement is 0%. This is because the tool can detect incoming facilities with a distance between sensors of 50-90 cm.

3.5 Sensor Accuracy Level Test Results

Table 3 Sensor Accuracy Level Test Results

No	Distance Sensor1 and sensor 2 (cm)	Amount Axle Enter	Detection Amount Axle Enter	Error%	Accuracy%
1	1	2	2	0%	100%
2	2	2	2	0%	100%
3	3	2	2	0%	100%
4	4	2	2	0%	100%
5	5	-	-	100%	0%

This table 3 shows that the sensor can detect facilities with an optimal distance of 1 mm to 4 mm to the axle of the facility, for a distance of more than 4 mm the sensor cannot detect the presence of an axle. The sensor cannot detect accurately when it is placed less than or exceeds the optimal limit

3.6 Means Detection Test Results

Table 4. Means Detection Test Results

No	Name Train	Departure Time	Suite	Detected
1	KA Sancaka	09.02	1 locomotive 10 carriages	Not Detected
2	KA Kahuripan	09.14	1 locomotive 10 carriages	Not Detected
3	KA Sritanjung	10.04	1 locomotive 10 carriages	Detected
4	KA ArgoWilis	10.12	1 locomotive 10 carriages	Detected
5	KA Logawa	11.06	1 locomotive 10 carriages	Detected

Table 4 showed the 5 trains that passed at that hour on the downstream route, 2 trains, namely KA Sancaka and KA Kahuripan, were not detected by the system because the sensor placement was not correct. In the 3rd – 5th experiment, the system was able to detect the facility well.

3.7 Non-Means Axle Pattern Test Results

Fig 4. Patterns are not Means

The red wave at figure 4 is the result of high detection from sensor 1, while the blue wave is the result of high detection from sensor 2. Where when the sensor does not detect a device a random pattern will form.

Fig 5. Patterns are not Means

The red wave at figure 5 is the result of high detection from sensor 1, while the blue wave is the result of high detection from sensor 2. Where when the sensor does not detect a device a random pattern will form.

3.8 Means Axle Pattern Test Results

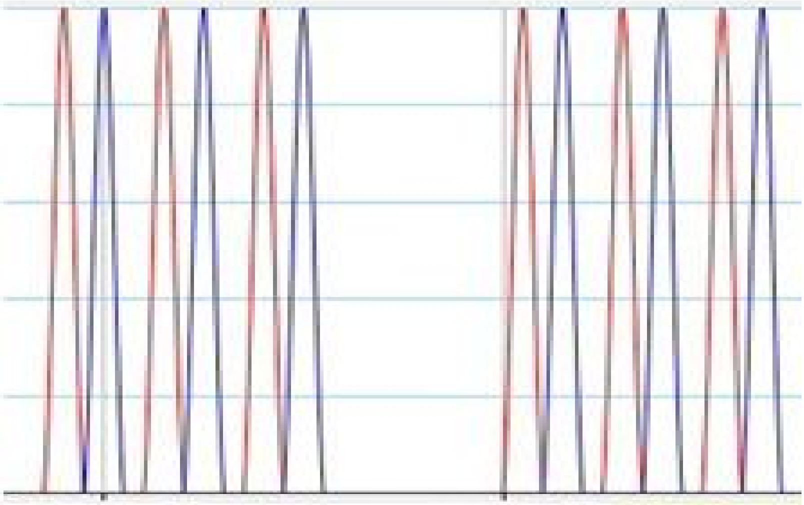

Fig 6. Axle Patterns of a Locomotive

The axle at figure 6 can be counted as 1, if the sensor is 1 orsensor 2 detected high, then from the 12 patterns detected high, it was concluded that 6 axles were detected and showed the axle pattern of the locomotive.

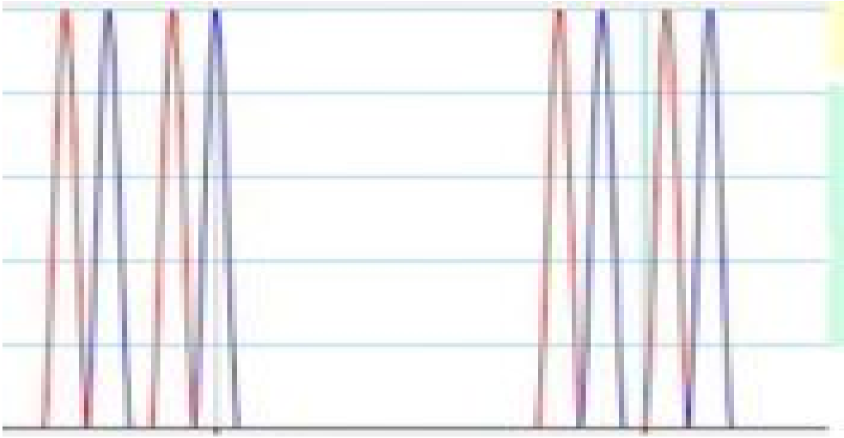

Fig 7. Axle Pattern of Carriage

The axle at figure 7 can be counted as 1, if sensor 1 or sensor2 is detected as high, then from the 8 patterns detected as high, it can be concluded that there are 4 axles detected and this shows the axle pattern of the carriage.

4 Conclusions

Design a railway facility detection system based on axle detection patterns using *inductive proximity* sensors. This system has the capability of being able to detects axle patterns based on the number of axlesand can display the patterns in the *Visual Basic Studio application.* Apart from that, it can detect thenumber of locomotives and carriages passing by which can be seen on the 16 x 2 LCD display. The way this axle detection system works is that itcan determine the type of passing vehicle. The advantage of this system is that it can display the axle pattern in the *Visual Basic Studio* applicationand the number of vehicles passing on the 16 x 2 LCD. The disadvantage of this system is that there is no data logger for the pattern produced in the *Visual Basic Studio application.* The results of the rolling stock detection pattern basedon the axle detection pattern using the *inductive proximity* sensor are in the form of sinusoidal waves. The axle detection pattern display can be displayed in the *Visual Basic Studio application,* while the type of vehicle passing can be displayed on the LCD

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