Automated turn pike using PLC and SCADA

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Automated turn pike using PLC and SCADA

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Abstract. We propose a smart turnpike based on Programmable Logic Controller (PLC) and Supervisory Control and Data Acquisition Systems (SCADA) in this paper. In this work, the basic idea is to measure the weight of the vehicles and classify them according to its weight to the respective lanes. It is difficult for the turnpike people to monitor the whole process all the time. So, this PLC based diversion system can be implemented in turnpikes to reduce the difficulties. This method will work based on weight sensors (piezo-resistive) whose output will be fed to a PLC, which will control the vehicle diversion. Using SCADA software, the whole process can be monitored from a remote area. The algorithm developed in this successfully installed in real time system.

1. Introduction

A public road way, in which a token will be collected for passage of vehicles through it, is known as a turnpike. It becomes one of the main methods to recoup the cost of implementing the roads and one of the main incomes for the Government. In the Indian turnpike system, there are many limitations and drawbacks [1-6]. First of all, there is only less number of turnpikes available. Due to this the number of vehicles coming to a single turnpike lane is very high and also the fee collection time per vehicle increases. This high waiting time causes a very huge economic loss to the nation. Because of insufficient security available, accidents are increasing to sudden lane changes. There also comes a chance for fight between turnpike officials and the drivers regarding the waiting time. In this situation comes the need for automated turnpike system, thereby reducing the waiting time of the vehicles and economic loss to the nation.

In India, the presently existing turnpikes are manually controlled and semi-automatic ones. Manually controlled: It's fully controlled manually by the workers there. In this system, the vehicles can go to any lane according to the driver's wish and due to this some of the lanes get over-crowded with too many vehicles that also light weight and heavy vehicles together, creating a chance of accidents. Thus the waiting time of vehicles increases.

The difficulties due to this system are: (a) fuel wastage (b) time wastage and (c) chance of accidents. Semi-automatic: In the semi-automatic ones, the closing and opening of the turnpike gates are solar powered. Here also, the drivers have to decide which lane to go, and all types of vehicles get mixed up in the same lane and chances of accidents increases. The main objective of this paper is to develop a fully automatic turnpike, where (a) the weight of the vehicles are sensed by the weight sensors, and diverged to different lanes accordingly using PLC, (b) controlling the whole process from a remote area using SCADA. By using this method, we will be able to reduce (a) the accidents, (b) waiting time and (c) fuel wastage to great extent.

2. Proposed system

The proposed system is fully automatic turnpike where the vehicles are diverged to different lanes according to their weight. Here, (a) the IR sensor detects that there is a vehicle in front of the lane, (b) the piezo-resistive load cell detects the approximate weight of the vehicles, and decides whether it is light weight vehicle or heavy vehicle, and give this output to PLC, (c) PLC decides the lane to which the particular vehicle should move to, by giving the gate control and the lane indication of the respective lane, (d) the whole process is monitored from a remote area using SCADA.

3. Hardware and software

The hardware used for this project is PLC, IR sensors, piezo-resistive load cell, lights and gates. The software used is TWIDOSOFT (PLC software TWDLCAA24DRF), INTOUCH(SCADA).

(a) Programmable Logic Controller (PLC)

Figure 1. TWDLCAA24DRF PLC

A programmable logic controller (PLC) is a digital computer which is used in a variety of processing plants to do control functions. It replaces the sequential relay circuits for machine control. The PLC works by scanning its inputs and according to the conditions programmed, turning on/off its

outputs. The programme can be uploaded to the PLC using its software to get the required results. The PLC used here is TWDLCAA24DRF.

Features:-

- Compact base controller
- 230V AC power supply
- 14 input pins of 24V DC each
- 10 relay outputs of 2A each

(b) INFRARED SENSOR (IR)

Figure 2. IR sensor

An IR sensor is an electronic device that emits the infrared radiation continuously, which can be used to detect the objects and also measure the heat of an object. In this module the IR transmitter and the IR receiver are located on the same module.

(c) PIEZO-ELECTRIC LOAD CELL

Figure 3. Piezo-electric load cell

Piezo- electric load cell is a type of weight sensing device which works on the principle of piezo-electric effect. When a load is placed on the sensor, the piezo-electric crystals inside get deformed and a strain is produced, and a voltage output is produced proportional to weight of the object.

(d) SCADA (INTOUCH)

InTouch software is an open and extensible SCADA solution that enables you to quickly create standardized, reusable visualization applications and then deploy them across entire enterprise without having to leave your office. InTouch software helping you:

- Maximize Situational Awareness
- Make Better Decisions
- Lower the Cost

- Reduce Risk and Stay Secure
- Securely Access your System from Any Smart device, Any Time, Anywhere.

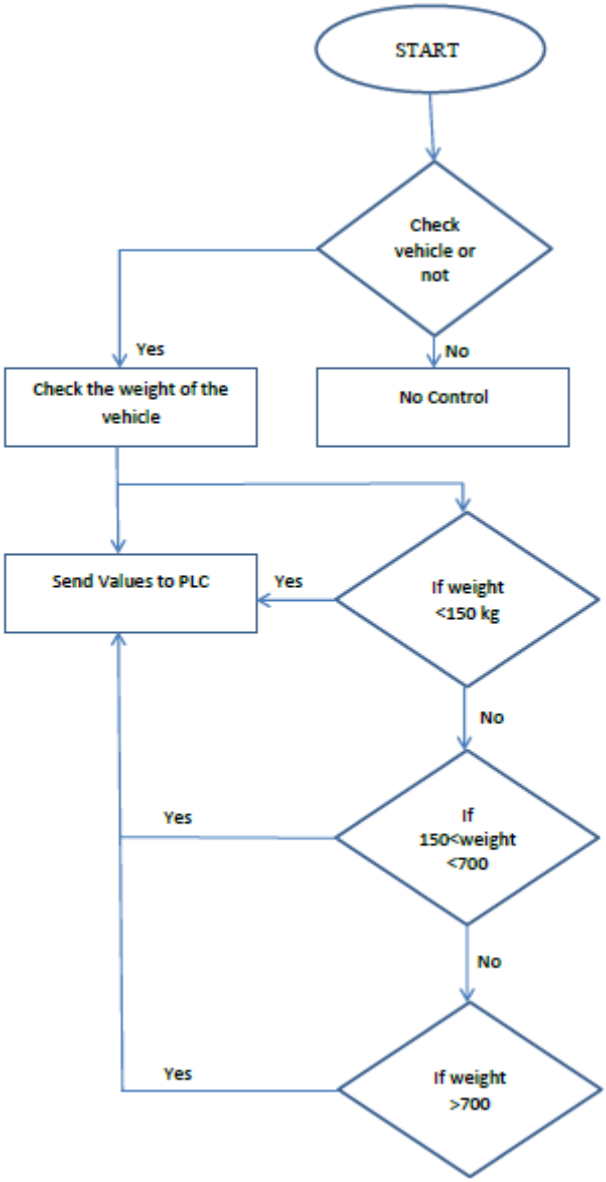

Figure 4. Flow chart for vehicle diversion

The flow chart shown in figure 4 represents the algorithm developed for vehicle diversion.

(a) Checks whether the coming object is vehicle or not.
(b) If detected as a vehicle, the weight of the vehicle is sensed and results sent to PLC.
(c) If the weight is below 150kg, categorize it as two and three wheelers and vehicle diverged to Lane 1.
(d) If the weight is in between 150kg and 700kg, categorize it as four wheelers and diverged to lane 2.

(e) If the weight is above 700kg, categorized as heavy vehicle and diverged to lane 3.

4. Results and discussions

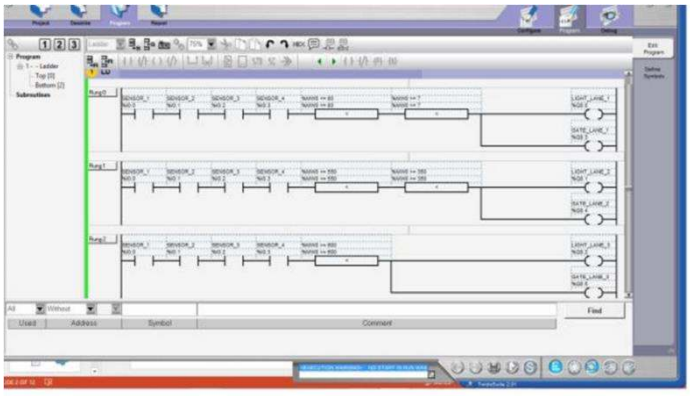

Figure 5. PLC program for vehicle diversion

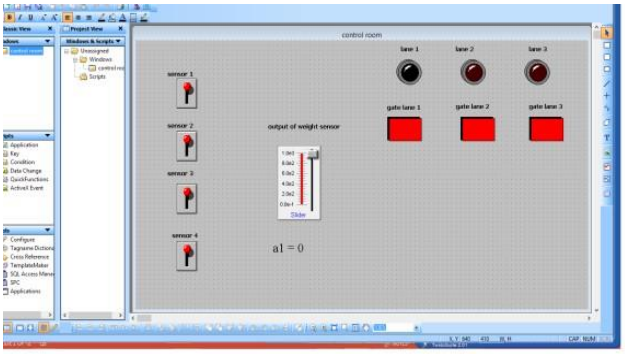

Figure 6. SCADA design for vehicle diversion

The figure 5 and figure 6 represents the program and SCADA design for vehicle diversion and it performs the following operation:

(a) Checks whether the coming object is vehicle or not.
(b) If detected as a vehicle, the weight of the vehicle is sensed and results sent to PLC.
(c) If the weight is below 150kg, categorize it as two and three wheelers and vehicle diverged to lane 1.
(d) If the weight is in between 150kg and 700kg, categorize it as four wheelers and diverged to lane 2.
(e) If the weight is above 700kg, categorized as heavy vehicle and diverged to lane 3.

5. Conclusion

In the Indian Turnpike system, there are many limitations and drawbacks. First of all, there are only less number of Turnpikes available. Due to this the number of vehicles coming to a single Turnpike lane is very high and also the fee collection time per vehicle increases. This high waiting time causes a very huge economic loss to the nation. Because of insufficient security available, accidents are

increasing to sudden lane changes. There also comes a chance for fight between Turnpike officials and the drivers regarding the waiting time. In this situation comes the need for Automated Turnpike system, thereby reducing the waiting time of the vehicles and economic loss to the nation. The proposed system is fully automatic turnpike where the vehicles are diverged to different lanes according to their weight. Here, (a) the IR sensor detects that there is a vehicle in front of the lane, (b) the piezo-resistive load cell detects the approximate weight of the vehicles, and decides whether it is light weight vehicle or heavy vehicle, and give this output to PLC, (c) PLC decides the lane to which the particular vehicle should move to, by giving the gate control and the lane indication of the respective lane, (d) the whole process is monitored from a remote area using SCADA.

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