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A Traffic Control System Using Inductive Loop Detector

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ABSTRACT: This paper presents the development of an inductive loop traffic sensor device that can detect the vehicles under heterogeneous and lane less traffic conditions. The existing available loop systems are only suitable for lane based and homogeneous traffic conditions. The developed multiple loop system has a new loop structure that can detect large vehicles like bus, truck etc., as well as small vehicles like bicycle, motorcycle etc., occupying any available space in the road. The proposed system detects, segregates the vehicle type and also counts the number of vehicle even in mixed traffic flow condition.

KEYWORDS: Inductive loop, vehicle detector, intrusive and non-intrusive sensors.

I.INTRODUCTION

In present century the traffic problem in metro cities is a very serious issue since the number of vehicles on road is increasing day by day. The severe traffic spot is near road junctions where all passing by vehicles stop for a few minute. Hence a reliable and efficient traffic flow sensing and managing system is required at the intersections. The existing methods used for traffic management are not so good in terms of cost and performance. So choosing an appropriate traffic flow sensor is a crucial task.

A traffic flow sensor is a device that sense and indicate the presence of vehicles and provide information that help for traffic control applications such as incident detection, vehicle classification, vehicle volume data and signal control. The traffic flow sensors can be categorized into two groups, intrusive and non-intrusive types. The intrusive sensors such as magnetometer, pneumatic tube and inductive loopare placed below the surface of the roadway or on the surface of the roadway whereas, non-intrusive sensors such as laser radar, microwave radar, ultra sonic sensors, infrared sensors and video image processor are installed above the roadway [1]-[2].

Among the sensors mentioned above, the inductive loop detector is the most widely using sensor in modern traffic control systems. The existing inductive loop detectors are only suitable for traffic system that conforms to lane discipline. These sensors will not work properly when there is parallel movement of vehicles within the same loop area and heterogeneous traffic with vehicles of different types occupying the same road area. Also a loop designed to detect large vehicles such as bus and truck cannot detect a small vehicle such as motor bike and bicycle reliably. Thus, the existing loop detectors are applicable only in countries where vehicular traffic conforms to lane-discipline and homogeneous traffic conditions. Thus, there is a need to develop a new detector that can sense the type of vehicle even under heterogeneous and lane-less traffic conditions.

This work proposes a novel inductive loop sensor structure [3] that can sense both large as well as small vehicles and differentiates the large one from the small even under mixed traffic condition.

II. NEW LOOP STRUCTURE

The proposed loop geometry consists of a small inner loop and a relatively large outer loop. The sensor is capable to provide output information such as individual vehicle speed, type, count and length. Thus vehicles that do not conform to lane discipline and flow in a mixed traffic condition can be detected by placing multiples of proposed loops at the junctions in such a way that, the road width must be covered. The sensor coil can be placed below or on the surface of the road.

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There are three different inductive loop structures show in the Fig.1. The small loop designated as Loop 1 intended to detect small vehicles like bicycle, motor bike etc. The large one, indicated as Loop 2 detects large vehicles like bus or car. The third loop structure embedding Loop 1 and Loop 2. The small vehicles such as bicycles goes over the large loop cause no considerable change in the loop inductance, this may lead to a miss detection. Whereas the new Loop 3 give a relative change in inductance similar to Loop 2 when a large vehicles pass over it and give a relative change in inductance similar to Loop 1 when small vehicles pass over it.

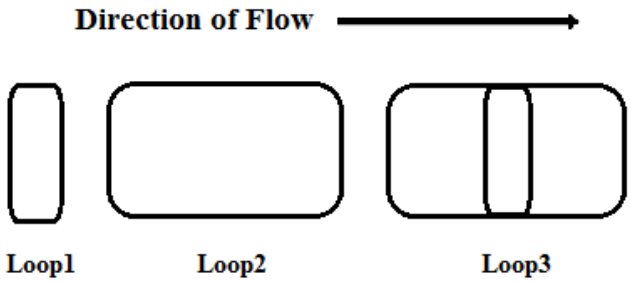

Fig.1: Loop1 small vehicle detector, Loop2 large vehicle detector and Loop 3 new loop detector.

III. MEASUREMENT SYSTEM

Inductive-loop [4]detector senses disturbances to the electromagnetic field over a coil in the presence of a metal detector. Fig.2 shows the simple block diagram of proposed system which can describe the working of the system.

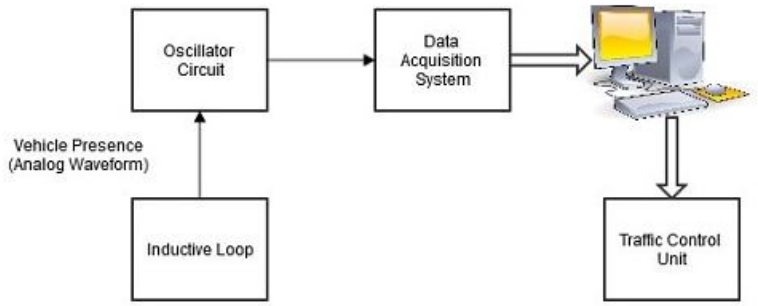

Fig.2: Block Diagram

The electronics unit transmits energy into the wire loops at some specific frequency, depending on the model. The inductive loop system behaves as a tuned electrical circuit in which the loop wire and lead in cable are the inductive elements. When a conductive object enters the area over the wire loop or stopped within the loop the magnetic field generated by alternating electrical current in the signal detector circuit induces weak electrical current in the conductive object. According to Lenz's law the current induced in the metal surface generate its own magnetic field that works in opposition to the magnetic field generated by the sensor coil, which decreases the inductance. This will also leads to the change in the resonant frequency of the sensor circuit and sends a pulse to the controller indicating the presence of a vehicle. Measurement of amplitude for varying loop inductance gives corresponding vehicle count and type.

IV. CIRCUIT DESIGN

Fig.3 shows the electrical equivalent circuit for sensing vehicles that do not follow lane discipline. There are two sensor coils with structure similar to that of 'Loop 3'. L1 and L2 are the inductance of individual loops. Loop inductance along with the capacitors C1, C2 and C3 forms resonant circuit. The circuit is excited by applying an AC power supply having amplitude Vs.

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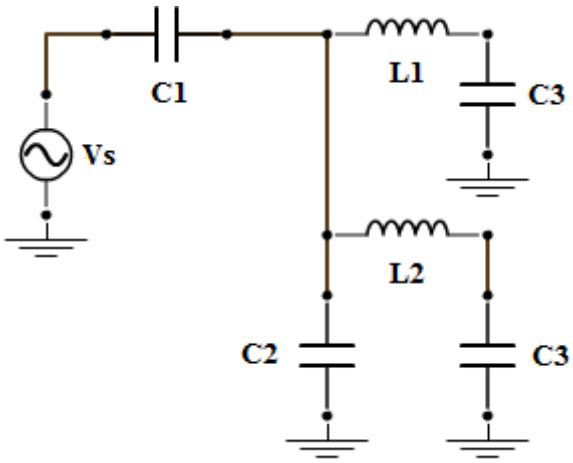

Fig.3: Equivalent Circuit

Suppose a bus is passing over the loops, inductance of both the loops will change. Change in inductance produces corresponding output voltages V1 and V2 across capacitor C3. The output voltages then given to the data acquisition system. Data acquired by DAS is considered for indicating the presence of bus. Suppose three scooters are passing over the multiple loops, inductance of the loops will change hence output voltages. This output voltage will be different from the previous case (in the case of bus). Thus a reliable vehicle classification is possible using these data.

V. EXPERIMENT AND RESULT

Prototype of the detector system is built and tested for the feasibility. A detector system with three loops and each having 5 number of turns been developed. L1=L2=L3= 100µH. C1= C2=0.05µF and C3= 0.07µF is selected. The AC source voltage realized using 10V amplitude. The resonance frequency of the system is measured. It is around 65 kHz. The output voltages acquired using a Data Acquisition System. PIC18F4550 controller is used to manage the further controlling process by making use of the gathered information and an appropriate algorithm. An LCD is interfaced to the controller for displaying detected vehicle type and its count.

The different types of vehicles are made to pass over the prototype detector system and the corresponding output voltage is recorded for each type of vehicles. For different sized vehicles unique range of voltage is obtained. These experimentally obtained values are used for vehicle classification process. Data base is made for bus, car and bicycle. PIC controller is programed according to this data base. Table.1 gives actual and experimentally obtained results.

Table.1: Result from field test

Vehicle Type	Count	True Count
Bicycle	9	10
Car	10	10
Bus	10	10

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Table.1 gives true count and experimentally obtained vehicle count. From the test it has been seen that large sized vehicle can be detected with 100% accuracy. There is a small error in counting small sized vehicles. Compared to the existing methods, this proposed system is more convenient for detecting small vehicles under mixed traffic condition. So the small error in counting bicycle can be neglected.

VI.CONCLUSION

This paper presented a possible solution to the existing loop sensing technique using a vehicle detection system based on a new multiple loop inductive sensor technique. The system is very useful for any cities that follow lane-less and heterogeneous traffic flow. It can also be installed in cities where the road traffic is homogeneous and lane disciplined.

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