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Research on an Intelligent Lane Guidance System

Yuan-yuan Fan[1,a*], Teng Teng[2], Jingwen Huang[2], Zhenglin Sheng[2], Dong Zhao[1], Mingyu Yin[1] and Yingjun Sang[2]

[1]Faculty of Mathematics and Physics, Huaiyin Institute of Technology, Huaian 223003, China
[2]Faculty of Automation, Huaiyin Institute of Technology, Huaian, 223003, China
fyuanyuan123@163.com
**Corresponding author*

Abstract: *Aiming at the problem of congestion and blockage caused by the increasing number of cars in urban roads, in order to alleviate the congestion and blockage of urban main roads, the number of vehicles in each lane was calculated based on geomagnetic sensor and infrared counter. At the same time, considering the influence of the number of lanes on the capacity of the road, according to the actual situation of the road needs to establish the variable lane research program in line with the actual section, and put forward the intelligent lane control system suitable for the urban main road. By analyzing the data collected by sensors, the lane adaptive control can be realized. According to the special situation of emergency rescue, the emergency mode is put forward to save rescue time. Real-time lane information on the screen can help you plan your route in advance and reduce travel time.*

Keywords: *Smart lanes, vehicle count, sensors, traffic jams*

1. Introduction

As early as many years ago, scholars at home and abroad began to study ways to reduce traffic jams on roads, and then introduced tidal lanes mainly for the morning and evening rush hours in cities. However, tidal lanes have numerous disadvantages. Drivers cannot correctly identify lane lines or do not know how to use tidal lanes. Many drivers would rather be stuck in traffic than take the tidal lane. Later, the "zipper car" was innovated, that is, the water horse was used as the railing to realize lane change. At this time, the above situation has been improved, the driver can achieve lane recognition according to the water horse. However, there are still many disadvantages [1]. First, the cost of zipper cars is high. Second, zipper cars need to occupy other lanes and run at a slower speed, so they still cause traffic jams.

Traffic congestion is caused by rush hours or bad weather at key intersections in key urban areas. When traffic is congested on urban roads, the lane in one direction is often very congested, while there is no car in the opposite lane [2]. Thus, it becomes very important to improve the utilization rate of lanes. Among them, drivers cannot predict the number of vehicles in the lane ahead, so they cannot choose the optimal route, leading to more congestion. Some road construction and traffic restriction fail to inform drivers of the information in time, resulting in waste of time and fuel [3]. In the event of an emergency, the rescue vehicles could not reach the scene in time in such a congested lane, which could easily cause huge losses.

In this paper, by setting a flexible two-way lane between the forward lane and the reverse lane, we can change the two-way flexible lane into a more congested lane in one direction when the traffic is congested. Increase the utilization rate of lanes and reduce road congestion [4, 5]. When the bidirectional flexible driving lane is used as the forward driving lane or the reverse driving lane, the LED guiding light band at the beginning of the lane is on, and the LED guiding light band at the end is not on, which plays a guiding role for pedestrians. Lane change information, lane state, lane traffic flow, traffic light information, construction road, traffic limit time, etc. are displayed in real time through the screen installed in the inverted U-shaped hanger. It is beneficial for drivers to plan the road in advance and avoid congestion and waste of resources.

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2. Design scheme

The overall design mainly uses two kinds of sensors, one is a geomagnetic sensor, and the other is an infrared counter. Geomagnetic sensor is the use of the earth's magnetic field in the ferromagnetic object through the change to detect, wireless installation only need to play a 55mm diameter 150mm deep hole in the road surface, small damage to the road surface, maintenance detection point is not easy to be damaged. Install it at the beginning of the solid lane guide line of each lane. In order to accurately count the number of waiting cars and traffic flow on the driveway. The system installed infrared counter and geomagnetic sensor in different places to meet the accurate monitoring of traffic flow. At the same time, it has no reaction to non-ferromagnetic objects, so it can effectively reduce the false count. The above geomagnetic and infrared counter are combined to achieve more accurate counting. The infrared counter is installed on the inverted U-shaped hanger, as shown in Figure 3. Using the reflection principle of the infrared counter, the infrared counter emits infrared light downward, and the infrared ray is blocked when the vehicle passes through the hanger to realize counting [6, 7].

Working principle: When the system starts, the lane mode automatically enters the intelligent mode. The MT8901AT-SS geomagnetic sensor uses the magnetic field to detect ferromagnetic objects, and can accurately count the magnetic field around the car when it passes by. Tty020-ca6 model infrared counter uses the infrared emission and reflection principle, through the infrared emission head installed on the inverted U-shaped suspension to emit infrared and installed on the ground to receive the head, when the car passes by blocking the emission light to complete the counting function. Summarize the number of vehicles in each lane and compare the number of waiting cars in each lane with the efficiency of passing. In case of lane congestion, the smart mode can automatically realize the function of variable lane. Improving traffic efficiency and sharing data with other lanes through wireless communication allows drivers to plan the optimal route in advance. It's more humanized from the driver's point of view. The lower screen uses the scrolling mode to switch information. The rolling information includes lane limit time, lane current waiting number, lane change reminder, construction information reminder, and traffic light time reminder. IRM-8601M2 infrared remote control as a manual mode of short-range communication. When a traffic accident occurs, traffic police need to direct traffic on the spot. The system has a remote control module, which can control the intelligent lane guidance system through the network.

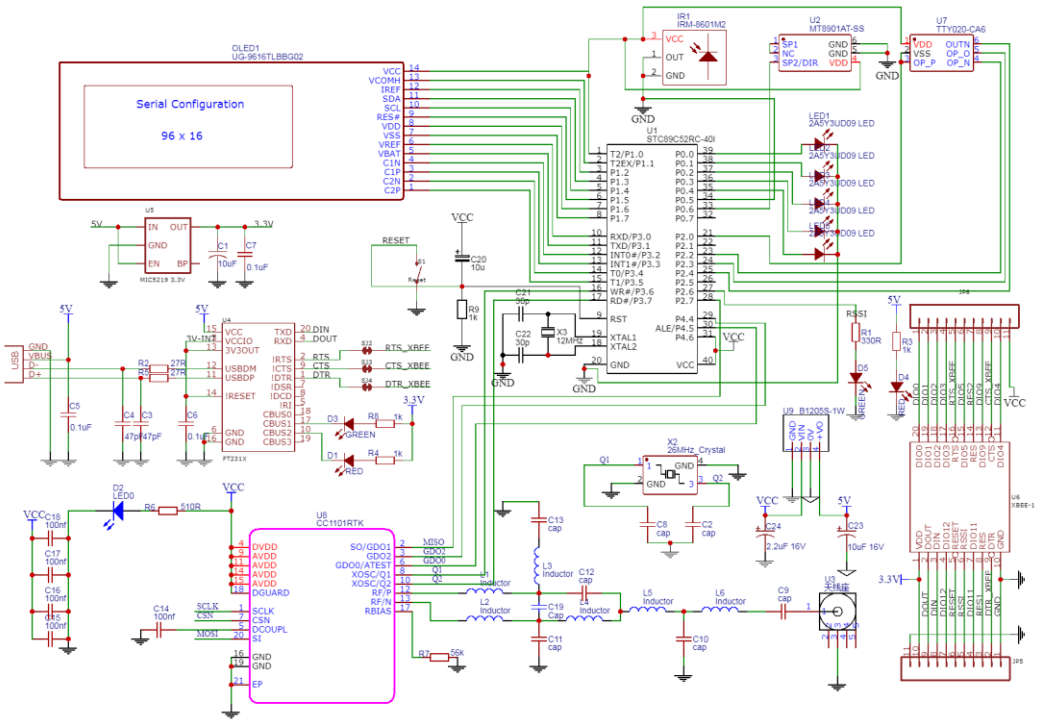

Figure 1: Circuit design scheme

The system also provides an emergency mode, in the event of an emergency rescue accident, the variable lane is closed and no other vehicles are allowed to enter. Improve the efficiency of emergency rescue. Because the volume is small, easy to install, will not destroy the ground and other advantages.

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The infrared counter adopts TTY020-CA6 model transmitting and receiving combination, the system identifies whether the infrared is blocked, so as to produce high and low level to count the function. The system control processor is STC89C52RC MCU chip. The FT231X ZigBee module serves as the communication module. Model CC1101RTK is used to control the system. The screen display module is installed on the inverted U-shaped hanger and uses UG-9616TLBBG02 screen as the display screen. Infrared remote control as short range communication using model IRM-8601M2 infrared remote control. The LED guiding light belt adopts the energy-saving 2A5Y3UD09 LED light belt. As shown in Figure 1, the schematic diagram of circuit connection connects each module for communication.

3. Smart Lane Analysis

3.1 Lane Scheme Design

There are three working modes for the smart lane. The application scenario of the smart mode is under normal road conditions, as shown in Figure 2, state 1 and State 2. Manual mode is under the condition of road construction or traffic police directing traffic on the spot; The emergency mode is used for emergency rescue service and realizes remote control of lane status through network communication module, as shown in State 3 in Figure 2. All lane change information in the picture, construction reminder ahead, traffic restriction period and real-time vehicle number in the lane will be displayed on the screen. Lane change information will also use THE LED guiding light band as an auxiliary reminder. As shown in Figure 2, the LED guiding light band is installed at the beginning of each lane. Thus the driver can improve the right choice of lane. Avoid driving into other lanes resulting in random lane change, so as to reduce the occurrence of collision accidents and ensure the accuracy of each lane measurement data.

The master controller communicates with the terminal program through wireless network to remotely control the state of bidirectional flexible driving lanes. As shown in Figure 3, the display screen is installed above the road surface through the inverted U-shaped hanger. The screen can display the traffic status of each lane, the number of vehicles in each lane, the limit time of each lane, construction reminder and accident reminder functions. Display through main controller signal connection, main controller module through wireless network connected to the magnetic sensor and infrared counter, using magnetic sensor and infrared counter to all lanes of vehicles and the combination of waiting vehicles to count, and count data through the screen to display the real-time sharing, provide reliable data for the owner of the other lanes, Thus, driving routes can be planned in advance to reduce congestion [8, 9].

The infrared counter comprises a signal transmitting end and a signal receiving end, the signal transmitting end is installed on the bottom of the inverted U-shaped hanger above each lane, and the signal receiving end is installed on the road surface of the lane and the corresponding position of the signal transmitting end. The geomagnetic sensor is installed at the end and starting point of the solid guide line along the carriageway. When the receiving end of the geomagnetic sensor and infrared counter is installed, a small hole is opened in the road surface and installed in the small hole. As shown in Figure 2:

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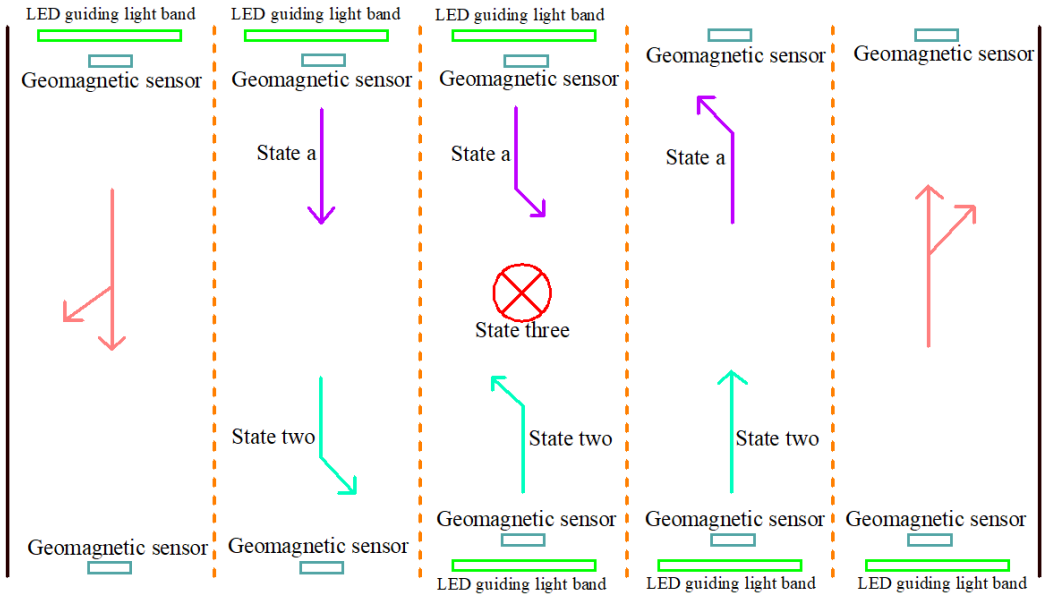

Figure 2: Schematic diagram of smart lane

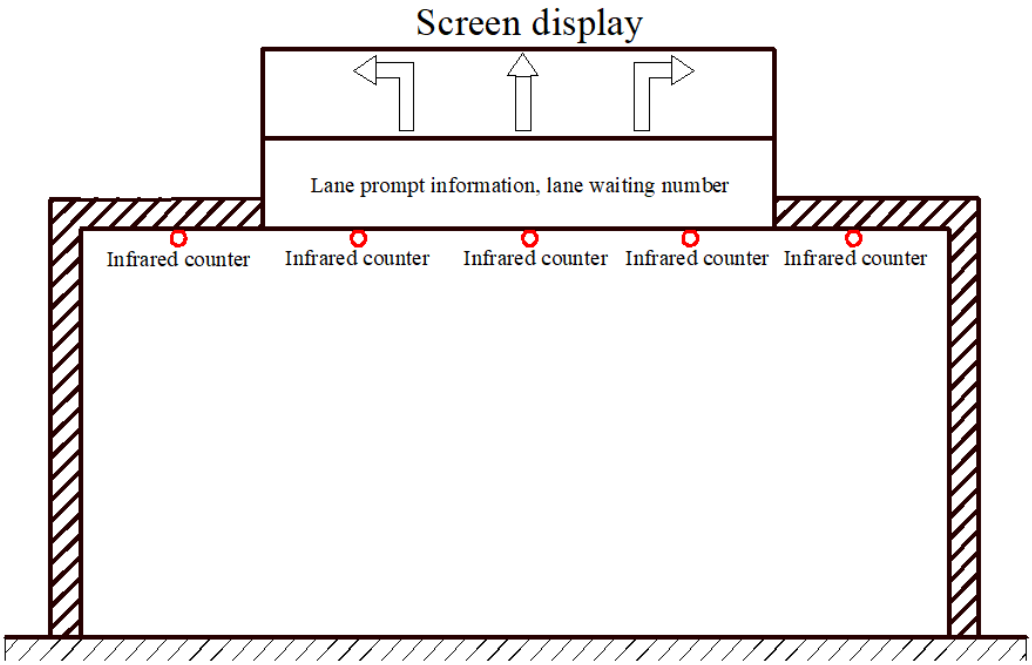

Figure 3: Inverted U-shaped hanger diagram

3.2 Lane Vehicle Analysis

An intelligent vehicle counting method of lane guidance system, as shown in figure 4, each lane to install four sensors were installed in the driveway infrared counter 1 beta, and installed in the driveway starting the infrared counter 4 gamma, and installation at the end of the driveway direction guide lines and starting point location of no. 2 magnetic sensor eta and 3 alpha magnetic sensor. No. 1 infrared counter is responsible for detecting vehicles leaving the lane. When a vehicle passes no. 1 infrared counter, the controller records β1, β2... βn. No. 4 infrared counter is responsible for detecting vehicles entering the lane, when there is a vehicle through the no. 4 infrared counter, the controller records γ1, γ2...γn. The controller obtains the total number of vehicles in the current lane through formula (1), which is as follows:

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$$\gamma_n - \beta_n = \theta_n \tag{1}$$

No. 2 geomagnetic sensor and No. 3 geomagnetic sensor are combined with no. 1 infrared counter respectively to count the vehicles that need to wait after entering the driveway; No. 1 infrared counter and no. 2 geomagnetic sensor are combined to judge when the number of waiting buses is small. The controller records vehicles passing through geomagnetic sensor the no. 2 as η1, η2... ηn. The controller obtains the current number of waiting cars in the lane through Formula (2), which is as follows:

$$\eta_n - \beta_n = \lambda_n \tag{2}$$

No. 1 infrared counter and No. 3 geomagnetic sensor are combined to judge the number of waiting buses. When the number of waiting vehicles is large, sensor 2 is covered by waiting vehicles and cannot count accurately. The no. 3 geomagnetic sensor is used to judge the waiting vehicles. The controller records the vehicles passing through the no. 3 geomagnetic sensor as α1, α2...αn. The controller obtains the current number of waiting cars in the lane through formula (3), which is as follows:

$$\alpha_n - \beta_n = \lambda_n \tag{3}$$

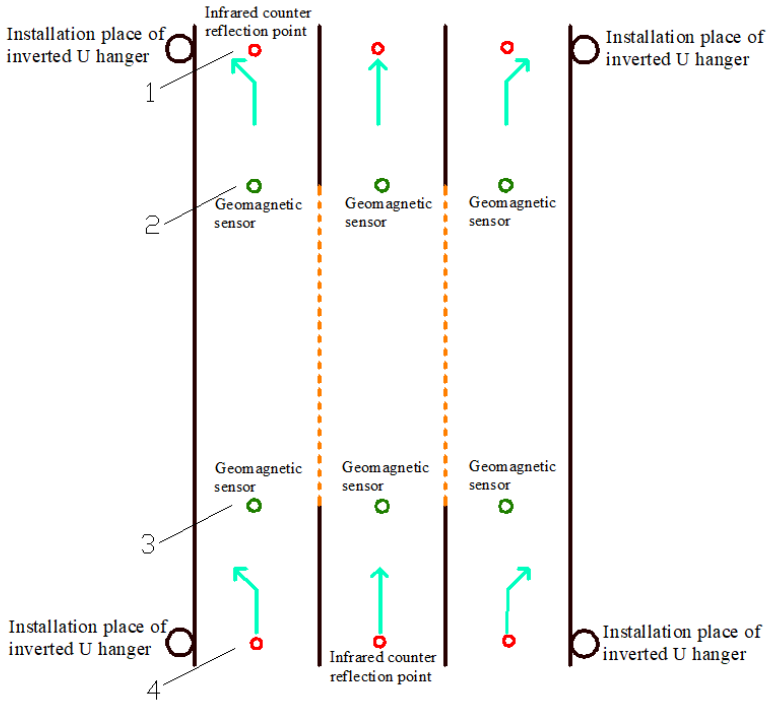

Figure 4: Vehicle count and installation

4. Conclusion

Through the above design scheme, this paper realizes an intelligent lane guidance system, which can be combined with the existing technology to achieve intelligent lanes, greatly increasing the utilization rate of lanes, greatly reducing the risk of traffic jam and improving travel efficiency. The user-friendly design of the screen greatly reduces the risk of drivers being fined for taking the wrong road. This system can be used for the road with few lanes and it is not easy to expand lanes, which is more suitable for the future road demand. By switching mode to provide emergency lanes, provide a lot of precious time for rescue services and ease road congestion. LED light guide belt can provide guidance to drivers and pedestrians at the same time more intuitive and improve safety. Lane and all kinds of information are displayed through the screen, more intelligent, convenient and humanized.

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