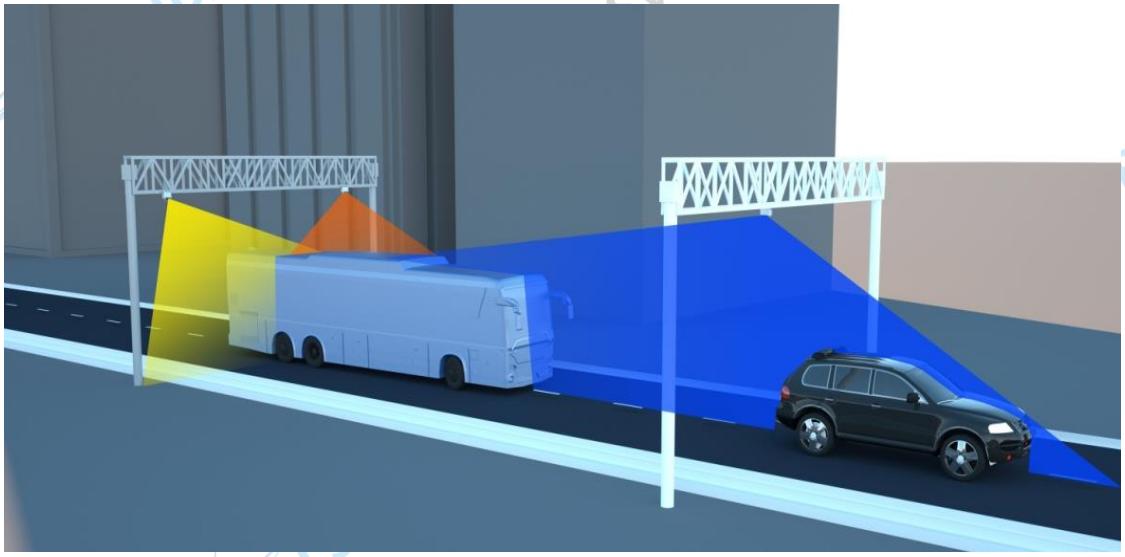
LiDAR Vehicle Contour Detection System Proposal



1. System Description

Leishen LIDAR Vehicle contour detection system is a set of LiDAR and Algorithm to fulfill the smart traffic application,aiming at fully automatic, non-contact to detect the dimension (length, width, height) of the cargo,trucks,lorries running on the highway,as well as the vehicles inspection at Vehicle Administration Bureau.The state of the art system is adopting high speed LiDAR to capture the contour of vehicle quickly without stop or slow down requirement to the vehicle.The contour information includes height, width,length, tire wheelbase and other related parameters.The accuracy and anti-interference capability are significantly higher than the other non-contact detection technology (such as LiDAR,microwave, visual, etc.). LiDAR could work day and night , which could not only improve the implementation efficiency, but also reduce the staff's workload.

2 System Configuration And Working Theory

Leishen LiDAR Vehicle Contour Detection system is based on the world's leading LiDAR detection technology, which could have a high speed dynamic scanning of the passing vehicles. By obtaining the detection data of the reflected distance of object surface points and converting it into three-dimensional space coordinates, it could establish a real time model of the vehicle and calculate the length, width and height of the vehicle on real time basis.

The LiDAR ranging principle adopted in the system is based on Time of Flight detection method. The laser emitter sends out laser pulses, and the internal timer starts to calculate the Time (t_1). When the laser wave has contact with the meeting object, partial energy will return, and when the laser receiver receives the returned laser wave, the internal timer (t_2) stops, and the distance value is calculated according to the following formula:

$$\text{Distance} = (\text{speed of light times}) \times (t\ 2 - t\ 1) / 2$$

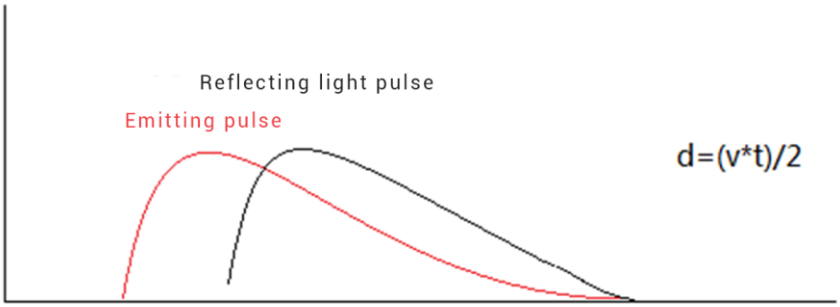


Diagram 1 Laser LiDAR Detection Schematic Diagram

The system mainly consists of LiDAR, central processing unit (CPU) and camera(option) etc.,LiDAR, with it detection advantage at night, could help to trigger camera to capture the vehicles' information when system includes camera, The whole system is easy to install.

Architecture

Figure 2 System Topology Diagram

3、Overall Scheme

The system takes the advantage of LiDAR to obtain the contour information of the vehicle on real time, automatically and high accuracy.Camera will identify the vehicle license. With the fusion of LiDAR and Camera, traffic system will be more smart.

3.1 Detection on Single Lane

Leishen LiDAR vehicle contour detection system could be applied to the entrance of toll station or the over-limit station. Three LiDARs are furnished to detect the external 3D dimensions of the vehicles running on the lane and LiDAR output the accurate information,including the length, width, height, wheelbase, tire dimension as well as vehicle contour model etc.

System structure layout as the following figure shown:

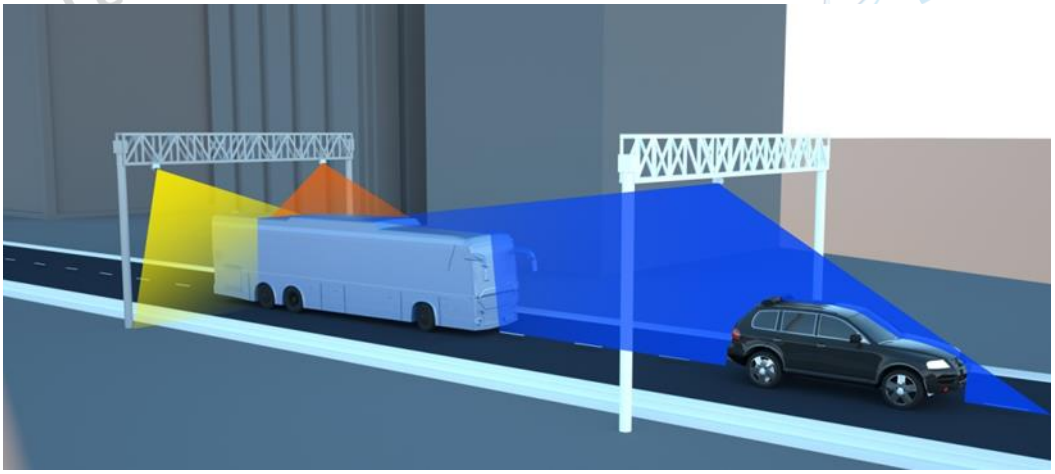
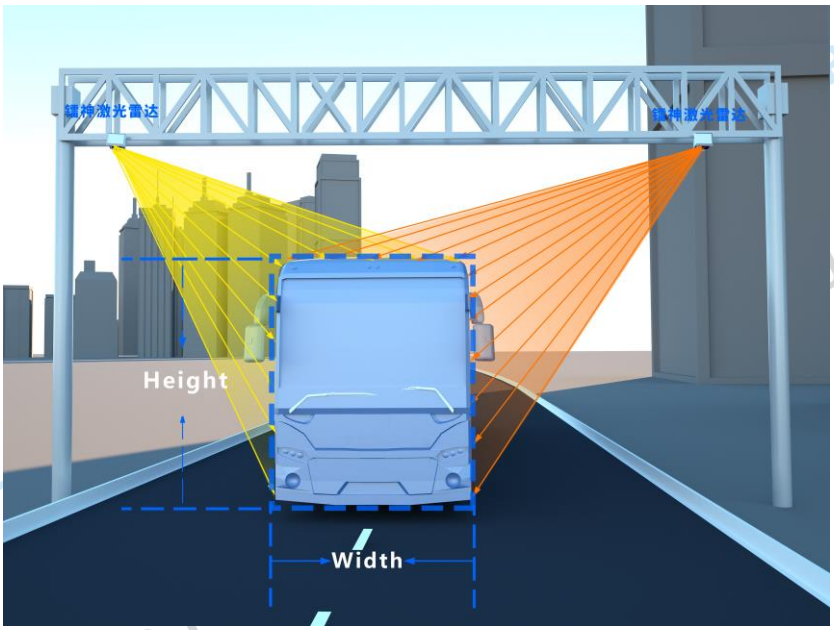


Figure 3 LiDAR Layout On Single Lane Diagram

Two Lidars are arranged separately at two ends of the first gantry, scanning the running vehicle to get the width and height. Another Lidar is mounted in the middle of the second gantry to get the length.

Among which, the height of two gantries should be more than 6.5m. The distance between the two gantries should be set according to the actual situation. The vehicle length upper limit is decided the distance between the two gantries.



Picture 4 Width And Height Detection Diagram

As shown in figure 4,the Lidars in the first gantry scan the both sides of vehicle at vertical direction.As the vehicles continuously move forward, a series of sides data of the vehicle will be obtained.After the vehicle has completely passed the detection area, the system will obtain the whole width and height data and the wheel information as well.

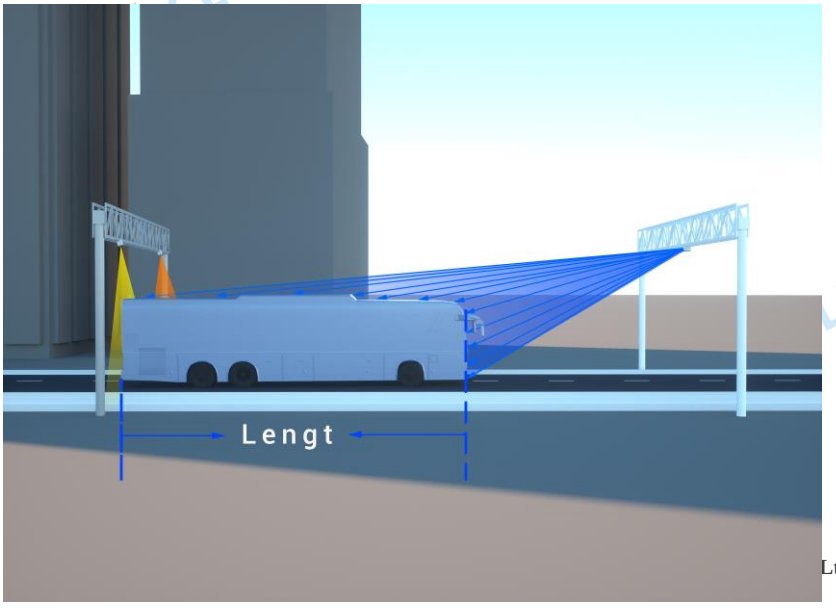


Figure 5. Diagram Of Vehicle Length Detection

As shown in figure 5, the Lidar on the second gantry scan the vehicle at horizontal direction. When the vehicle moves to the scanning zone, the Lidar continuously records the vehicle's moving position information. When the Lidar on the first gantry detects that the vehicle is moving away, the vehicle length is calculated in combination with the vehicle head information obtained by the Lidar on the second gantry and the distance between the two gantries.

3.2、 Detection On Multi-Lane

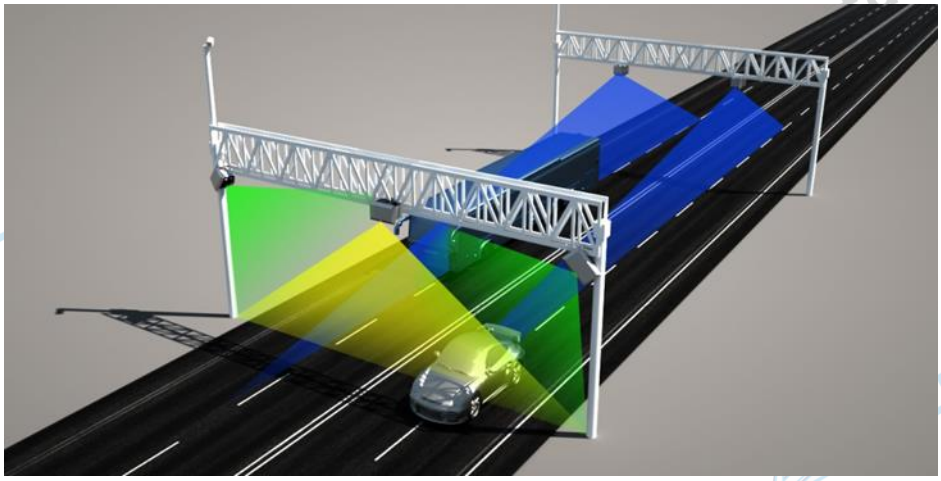


FIG. 6 LAYOUT OF TWO-LANE LiDAR

Figure 6 shows the layout diagram of the two-lane LiDAR. A total of five LiDARs are required for the two lanes: the first gantry is equipped with three units, which are used to detect the width and height of the vehicle; The second gantry is equipped with 2 sets, which are respectively used to detect the length of vehicles in each lane. The calculation principle is consistent with that of the single lane.

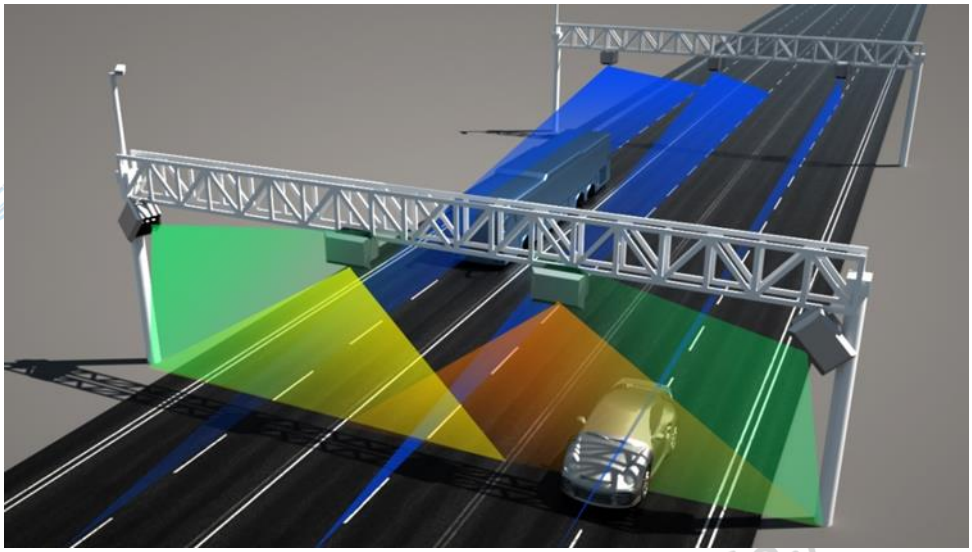


Figure 7 Layout Of Multi-Lane LiDAR

Figure 7 shows the layout sketch of the three-lane LiDAR. A total of seven LiDAR units are required for the three-lane LiDAR: The first gantry is equipped with four units, which are used to detect the width and height of the vehicle. The second gantry is equipped with three sets, which are used to detect the length of vehicles in each lane. The calculation principle is consistent with the single lane.

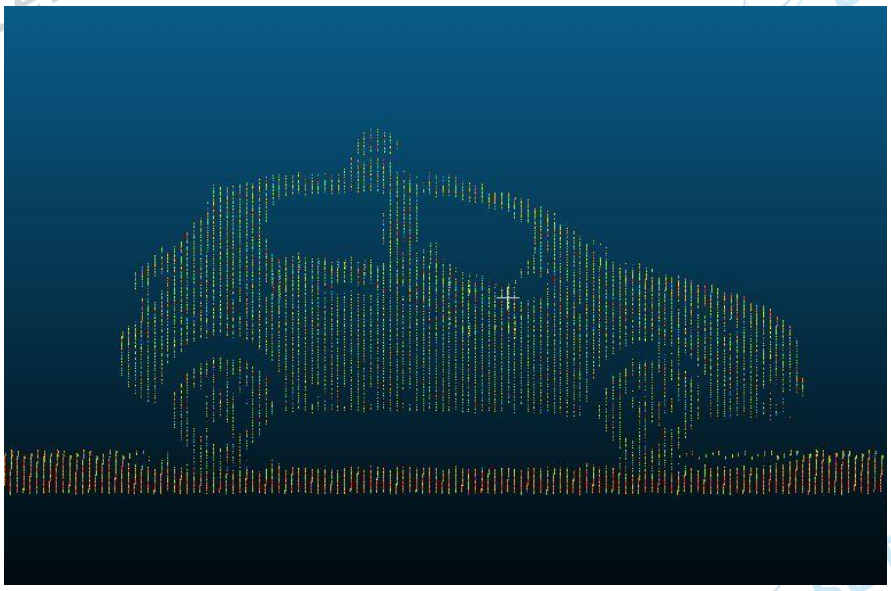


Figure 8 Vehicle Contour Actual Point Cloud

Figure 9 Software Working Panel

4. System Function

- The current detection system only requires to park the vehicle in the designated area. The system could automatically judge whether the vehicle is parked correctly, and could detect the length, width, height, breast-board fence height, wheelbase, pin wheelbase and other parameters of the vehicle automatically. The detection duration is short, not exceeding 1 second.
- Senior managers can get access to system by password, and record the

detection data of the vehicles as standard data to upload to the database.

- The system test makes comparison and appraisal between the data obtained by detection and the standardized database data and uploads the appraisal results and detection data to the database for printing and downloading purpose.

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- The system could automatically eliminate the components such as reflect mirrors which will not be considered in the contour detection of the vehicle without manual adjustment.
- The system utilizes multi line LiDAR detection and is not affected by weather and ray of light.
- The system has its own 3D imaging function to display the 3D contour of the model established on real time basis.
- The system could have, at the same time, interlink with cameras to capture, identify the license plate number of the vehicle and upload to the database.
- It can automatically keep proper distance for the vehicles accurately and effectively to prevent tailing;
- It can record the time when the vehicle passes the detection area;
- It can detect the speed when the vehicle passes the detection area, and can detect the status of the vehicles moving forward and going backward;
- It has the function of self-monitoring, automatic power shut-down and restart, and automatic memory recovery after a crash;
- It has self-checking function to detect the hardware status of the equipment;
- It has the function of automatically storing vehicle information and uploading data;
- It has the function of triggering camera capture.

5. System Characteristics

- Real time and accurate detection of the length, width and height of

vehicles passing through the lane, with quick time and minor possibility of error;

- The equipment is not affected by the external light, with good detection effect during night and stable performance under the foggy, rainy and snowy circumstances;
- The equipment is having fixed installations on the gantry or vertical pole, and the user can locate it flexibly according to the actual road conditions;
- The system is easy for installation and maintenance, not requiring the closing of the traffic, which only requires to install upright or simple gantry, which can be installed both at indoor or outdoor environment and the system is of simple construction which will not create any damage to the road surface, and of low maintenance cost;
- The system supports RS232 / 422 serial communication, TCP / IP network communication, and users could choose flexibly as per their requirements;

- The system supports real-time data transmission and provides dynamic library interface function;
- The system has the self-monitoring function, which could have automatic power off and restart, and automatic recovery after a crash, with the total time of previous task recovery ≤ 1 minute;
- The system has the ability of automatic recovery of previous incoming calls and resumption of data transmission at the previous breakpoint;
- The system upgradation is convenient and can add and integrate multiple senors according to the requirements of the users;
- The system supports the functions of saving and reading of the

configured files and restoring original factory settings;

- The system provides the matched parameters configuration software, which supports batch configuration of parameters and is of easy operation.

6. System Parameters

- Detection method: non-contact non-stop detection
- Detection speed: 0 ~ 120km / h
- Detection time: < 1s
- Ratio of passing vehicles being detected: 100%
- Protection grade: IP68
- Scanning frequency:40~ 80Hz
- Working temperature: - 40 ℃ ~ 85 ℃
- Storage temperature: - 40 ℃ ~ 105 ℃
- Scanning distance: 100M
- Number of scanning lines: 1 line / 4 lines / 8 lines for selection
- Installation height: 6m ~ 10m
- Overall detection range deviation and detection error of the system are as follows:

detected parameters	Detected range	Detected deviation
total length of vehicle	1-30m	±3cm
Total width of vehicle	1-5m	±3cm
Total height of vehicle	1-5m	±3cm
Breast board height	1-5m	±3cm

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Wheelbase		±3cm
Pin wheelbase		±3cm

7. Major Technical Parameter Of Equipment

7.1 LiDAR

HS series high-speed scanning Lidar has excellent detection accuracy and anti-interference performance, with a detection range of up to 100 meters, measuring accuracy up to ±2cm, and a scanning frequency up to 40/80Hz, capable of real-time perception of high-speed moving objects and accurate capture of vehicle contour information.

Model No.		HS1	HS4	HS8
Scan lane		1 lane	4 lane	8 lane
Ranging method		Time of Flight ranging method（TOF）		
laser wavelength		905nm		
laser class		Class Ⅰ（human eye safe）		
Detection range		100m		
Detection precision		±2cm		
Detection point velocity		106000 points/s	426000 points/s	426000 points/second
Scan frequency		80Hz、100Hz、120Hz、160Hz、200Hz(optional)		
Field angle	horizontal	120°		
	vertical	0°	-4°~ 0°	-6.66°~ 2.66°
Angular resolution	horizontal	80Hz: 0.09° 100Hz: 0.11° 120Hz: 0.13° 160Hz: 0.18° 200Hz: 0.22°		80Hz: 0.18° 100Hz: 0.25° 120Hz: 0.27° 160Hz: 0.36° 200Hz: 0.45°
	vertical	1.33°		
Power supply range		9V~36VDC		
work temp		-40℃ ~85℃		
communication interface		Gigabit internet portal, PPS		
shock		500m/sec², maintaining for 11ms		
vibration		5Hz-2000Hz，3G rms		
IP Class		IP67		
Dimension （ L•W•H ）		155 * 107.5 * 90mm		

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weight	Approx. 1600g

7.2 Central Processing Unit

The central processing unit is a industrial level computer.The system is developed based on Intel Bay Trail platform, with board built-in high-speed memory, effectively endure vibration and shock. By adopting the rear-mounted zero-distance fan-less cooling scheme, combined with widely voltage power supply, the equipment could meet the requirements of various harsh industrial application scenarios and is integrated with Intel dual network security terminal data acquisition, monitoring and control at high efficiency and precision.

8. List Of Equipment

No	main equipment item	Unit	Qty	manufacturer	remark
1	LiDAR	set	3	Leishen Intelligence	Incl. protection cover, internet cable and power cord
2	LiDAR installation gantry	set	3		
3	camera	set	1		optional
4	Central processing unit	set	1		
5	Power line and cable	m	50		
6	Signal line	m	50		
7	Equipment installation and commissioning	pc	1		

Note: This bill of quantities is for a typical configuration of 1 lane and for general reference only. It does not include gantry , civil construction and pipeline laying. The specific amount of civil construction shall be subject to the actual site investigation.