Nexus : Journal of Innovative Studies of Engineering Science (JISES)
Volume: 02 Issue: 05 | 2023 ISSN: 2751-7578
http://innosci.org/

Description of the Passengers Flow Ascertainment Device Installed in Public Transport of Tashkent City

Rakhimjonov Muslimjon Ravshanjon ogli
Tashkent state transport university, Uzbekistan, Tashkent

Khikmatov Ravshan Saidiumarovich
Tashkent State Transport University, Candidate of Technical Sciences, Associate Professor, Tashkent, Uzbekistan

Annotation: The movement of passengers and their number are important in the organization of the public transport system. Now we will look at the operation system of one of the most common devices that perform this task on buses.

Key words: passenger, public transport, bus, ARC, MDVR, device control, monitoring.

The urban transport plan is drawn up based on the statistics of the number of passengers using the bus route. The increase in the number of transport vehicles and the mobility of the population requires the optimization of passenger transport, indicating the need to adapt them to constantly changing conditions. [1].

Several measures aimed at determining the number of passengers have been implemented in Uzbekistan. From 2020, students of Tashkent State Transport University are involved in counting the number of passengers and traffic in order to draw up a transport plan for various regional centers every year. Previously, students of the appropriate direction for calculating traffic were also attracted from the Turin Polytechnic University in Tashkent. The students not only counted the passengers boarding the bus in the station cross section, but also calculated the type of vehicles traveling at intersections, their direction of travel, the number of passengers crossing the road.

Resolution of the President of the Republic of Uzbekistan No. PQ-111 of 02.02.2022 on additional measures for further development of public transport system in Tashkent stipulates renewal of public transport by modern, environmentally friendly buses, including electric buses [2]. Based on the resolution, From April 2023, the 12-meter-long Yutong, 18-meter-long King Long buses, an electro bus and buses from local manufacturers began to be added to the Tashkent bus fleet[3].

The buses, which began to be used in Tashkent from April 20, 2023, are equipped with automatic passenger counting devices of the QC007 model belonging to the Magnetic North manufacturer. They are located on the ceiling of each entrance and count the number of incoming and outgoing passengers (figure 1). It consists of the main 3 parts (table 1). This device is an automatic computing device that transmits data in real time. It is also possible to store data from devices in black box mode. Both of these regimes have their own peculiarities (table 2). Data reception depends on how the route or center is equipped with technical means.

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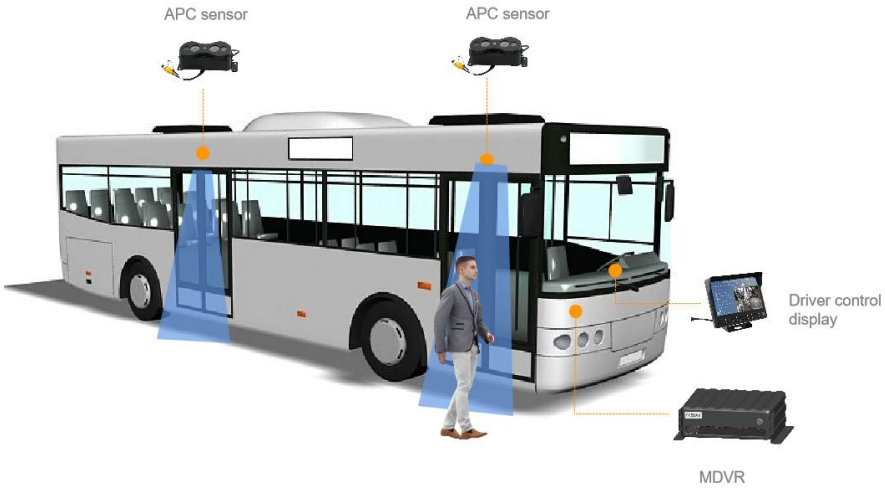

Figure 1. Automatic Passenger Counting (APC) System.

Table 1. Devices of the APC system

1	2	3
		
Automatic Passenger Counting (APC)	Mobile Digital Video Recorder (MDVR)	Device control and information display

Table 2. Data recording modes.

Mode type	Description	Advantages	Disadvantages
Real time mode	The received data is automatically or via GSM/GPRS channels to the dispatcher's center at the request of the dispatcher	Quick connection with the bus. At any time, information about its location and the state of the sensors can be obtained. Provides voice communication with the driver.	The technical equipment is expensive and the need to pay a subscription fee for the services of a mobile operator.
Black box mode	The data is stored in the memory of the on-board device and can only be taken for analysis when the bus arrives at the dispatch center	Low cost of using the system	There is no quick access to data

This device creates the following capabilities:

- comparing and verifying fare collection data with the number of passengers;
- obtaining reliable information about passenger statistics to justify payments to transport companies;
- scheduling maintenance and cleaning depending on the use of the bus;
- optimization of excess passengers on the bus by regions, time intervals and other factors;
- creates opportunities such as quality of Service Control.

It determines the flow of passengers in a normal state, regardless of the level of clothing, load, lighting and other aspects. This device is based on the APC algorithm, which works with an accuracy of more than 95%. It also allows real-time data exchange between the APC terminal and

the server to show the number of passengers. GPS is installed so that dispatch center operators can dispatch buses based on the number of passengers and know where they are moving. For taking data Ethernet and 485 ports are installed. There are automatic notification functions if the number of passengers in the bus cabin exceeds. And the instructions show the following technical characteristics (table 3).

Table 3. APC System technical specifications.

Item	Parameter	Item	Parameter
Image sensor	1/3CMOS	**Gain**	Auto
Video format	PAL (PAL or NTSC optional)	**S/N**	＞48db
Horizontal clarity	700TVL	**Output**	Ethernet, 485,AHD optional
Image output	Synchronize	**Voltage input**	5-24V
Lens spacing	5cm (12cm depends on detecting range)	**Power**	≤1W
Lens parameter	960×576 pixel,	**Operating temperature**	-20～+70℃
White balance	2.8mm (2.1mm/2.8mm/3.6mm /4mm/6mm/8m m optional)	**Relative humidity**	10%～90% (non-condensing)
Shutter	Auto	**Thermal radiation**	Passive thermal radiation
FPS	1/50-1/80000 (sec) 1/60-1/80000 (sec)	**Dimension (mm)**	L*165×W*58×H*56 (include frame)
Video output interface	25fps/sec	**Weight**	≤0.25kg

The system consists of two stereoscopic cameras and high-resolution infrared sensors. They provide high computational accuracy even in the intensity of the input. With the help of sensors on both sides, passengers and objects are detected with the optimal combination of light and other environmental conditions. Infrared sensors scan the cavity with infrared rays and receive information from reflected light. This helps to obtain more accurate information. The sensor analyzes passengers crossing the observation zone, the height, size and direction of objects by measuring the distance. As a result, based on the analysis of different images of the door area, it calculates the passengers entering and leaving the designated line with high accuracy. (figure 1). The door area in the program can be changed depending on the type of bus, the width and structure of the entrance.

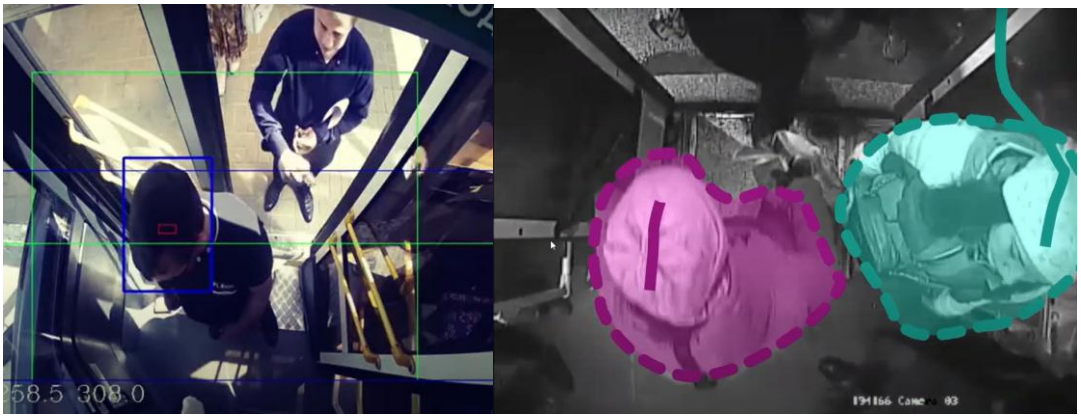

Figure 2. Monitoring and counting of movements in the door area.

The program monitors the direction of passenger movement using artificial intelligence. If the passenger moves outside the designated door area, the passenger will be subtracted from the number of passengers in the cabin as the passenger has left, if the movement is inward, the passenger will be considered to have entered and will be added to the number of passengers in the cabin.

Thus, this method of counting passengers carried by public transport in the city provides objective information about the volume of passenger traffic. This makes it possible to assess the actual pressure of public transport, as well as to carry out an effective prediction of the demand for transport after the accumulation of statistical data.

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