PUBLIC TRANSPORTATION SMART CARD FOR ANALYSIS OF THE PASSENGER FLOW IN SHENZHEN

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Abstract: Traditional data sources can only statically reflect residents' traveling habits and needs for a short period of time, and cannot achieve the effect of real-time and long-term tracking survey. The use of urban public transportation IC card data can accurately reflect the operation status of bus lines and passenger flow, with the advantages of low cost, short time-consuming, and high accuracy. This paper introduces the IC card usage status and IC card authentication process in a city in China, in order to better analyze the changes in public passenger flow and to understand the characteristics of the bus behavior of the city's public transport passengers.

Keywords: ITS, bus IC card, passenger flow.

СМАРТ-КАРТА ОБЩЕСТВЕННОГО ТРАНСПОРТА ДЛЯ АНАЛИЗА ПАССАЖИРОПОТОКА В ШЭНЬЧЖЭНЕ

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Аннотация: Традиционные источники данных могут только статически отражать привычки и потребности жителей в поездках в течение короткого периода времени и не могут достичь эффекта исследования в реальном времени и долгосрочного отслеживания. Использование данных IC-карт городского общественного транспорта может точно отразить состояние работы автобусных линий и пассажиропоток, обладая такими преимуществами, как низкая стоимость, короткие временные затраты и высокая точность. В данной статье представлен статус использования IC-карт и процесс аутентификации IC-карт в одном из городов Китая, чтобы лучше проанализировать изменения в общественном пассажиропотоке и понять особенности поведения пассажиров городского общественного транспорта в автобусах.

Ключевые слова: ИТС, IC-карта автобуса, пассажиропоток

A smart card (IC, Intelligem Card) is designed to be a device that stores data and in most cases acts as a processing review data. Smart cards are not only portable but also long-lasting and are suitable for various purposes such as identification, authorization approval, and means of payment. As of 2024, there are a total of 918 bus lines in operation in Shenzhen public transportation (Fig 1), and the buses are equipped with front and rear doors, and each bus is equipped with a bus IC card reader, which is installed at the front door of the bus, near the driver's position, and stipulates that the bus passengers pass through the front door when boarding the bus, and pass through the rear door when getting off the bus. In addition to this, card-carrying passengers pay the fare by punching the card on board the bus and do not repeat the card when getting off the bus. When a bus passenger uses a bus IC card to pay for the fare, the accompanying card reader will record the passenger's card consumption information, and the specific consumption data items are shown in Table 1. The card consumption data of a day's operation of a bus vehicle will be reproduced into the company's intelligent management system database, which will provide data support for the bus company to carry out the daily operation and management.
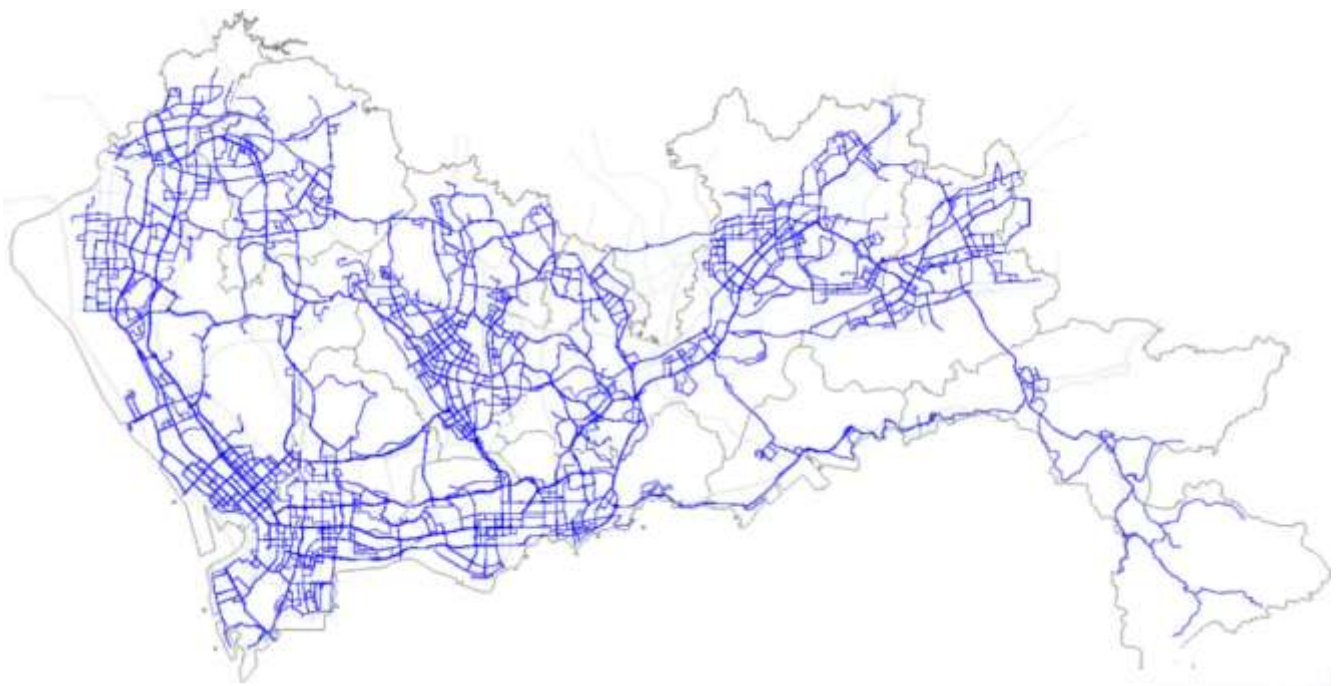

Figure 1 – Shenzhen Bus Route

Table 1 – Card consumption data table

Data item	Comment
CARDNO	Bus card number
CONSUME	The amount or frequency of consumption, bus cards are divided into two categories: monthly pass card and electronic wallet card. Monthly pass card is recorded according to the number of times, and electronic wallet card is recorded according to the amount.
REMAINTIMES	The remaining number of monthly pass cards
BALANCE	E-wallet remaining amount
CONSUMEDATE	Card swiping time, accurate to seconds
CONSUMETYPE	Swipe type
LINENO	Line number
BUSNO	vehicle number

As can be seen from Table 1-1, the card consumption data information includes some basic information about the cardholder's travel, such as the passenger's boarding time, the bus route, and the amount of money spent, etc. However, there is a lack of information about the bus stop where the passenger boards and the bus stop where the passenger gets off. But the lack of bus passengers on the bus station information and get off information, such as bus passengers off the station, get off time. Nevertheless, compared with the traditional data sources, the bus IC card consumption data still has the following three advantages: First, the public transportation operating companies can obtain a rich and large number of passengers' personal travel data information; second, a single bus IC card consumption data corresponds to a single bus IC card, and with the index of the bus IC card number, it can be searched to the cardholder's consecutive one-day, one-week, or even longer travel record information; second, the single bus IC card consumption data corresponds to a single bus IC card. Third, by analyzing the bus IC card registration data, consumption data and recharge data, public transportation operators can locate their customer groups and conduct dynamic analysis and research.

Public transportation IC card data effectively responds to passenger travel information, taking public transportation IC card data information table 2 as an example, and the corresponding field comments in the table are shown in table 3.

Table 2 – City bus IC card data information table

card_num	time	line	bus	LONGITUDE	LATITUDE	stationnam
10001001091580	15.03.2017 7:23	5251	21	108.987433	34.22083	Yuejiazhai Bus Dispatching Station
10001000798532	15.03.2017 7:23	5251	21	108.987251	34.220805	Yuejiazhai Bus Dispatching Station
10001000182716	15.03.2017 7:24	5251	21	108.985253	34.220625	Beichitou 2nd Road Interchange
10001000119280	15.03.2017 7:25	5251	21	108.983638	34.219744	Beichitou 2nd Road Interchange
10001000672059	15.03.2017 7:28	5251	21	108.97766	34.2155	Beichitou 2nd Road, Furong East Road Intersection
10001000179188	15.03.2017 7:28	5251	21	108.97766	34.2155	Beichitou 2nd Road, Furong East Road Intersection

Table 3 – Bus IC card data field description

Name	type	detail
card_num	character	IC card number
time	time	date and time
line	character	Line number
bus	character	Line name
LONGITUDE	number	longitude
LATITUDE	number	latitude
stationnam	character	Station name

IC card authentication process in IC card charging system is divided into three steps:

1) Realize the card number authentication code algorithm process, the process is as follows:
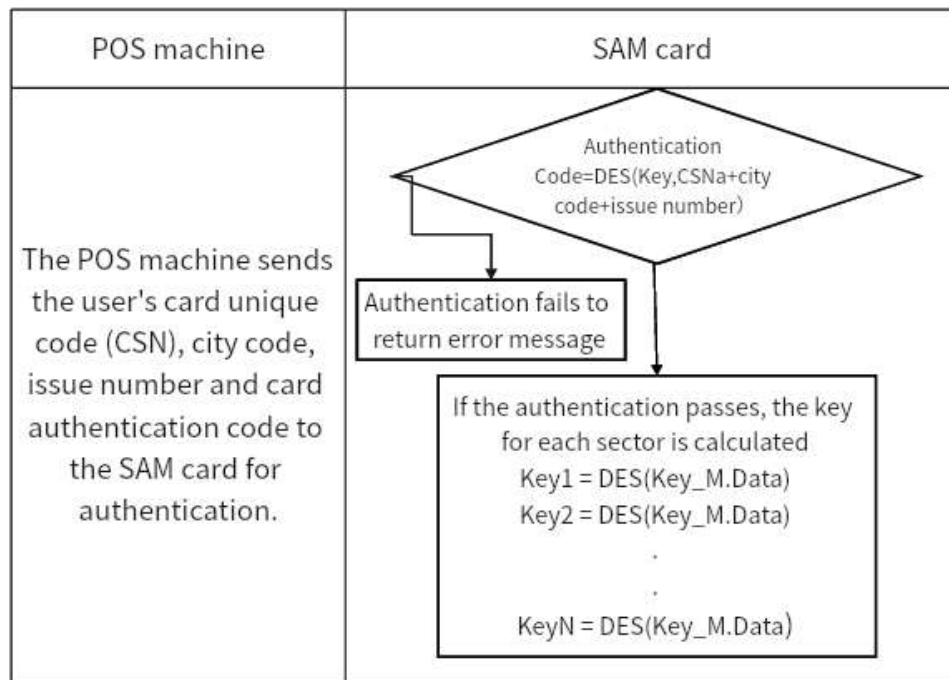
Figure 4 – Block diagrarm for Card No authentication code algonthm graph

Since CNS is a unique code, it is not possible to duplicate the same card .

2) The algorithmic process to realize the card authentication code (Card_MAC), the process is as follows:

Card_MAC = 3DES (Key,Data)

Card_MAC: card authentication code

Key: card authentication code special key (DES encryption key)

Data: encrypted data by the unique code (CSN) + issue number + city code composition

Encrypted data and card authentication key for DES encryption operations obtained 8-byte results, take the result of the high 4 bytes to get Card_MAC

3) Generate the read and write keys for each sector. The process is as follows:

Key_Ax = DES(Key_MA,Data)

Key_Bx = DES(Key_MB,Data)

Key_MA: is the read master key

Key_MB: for writing the master key

The emergence of new data sources in the field of public transportation brings opportunities for related research and also poses challenges for researchers. The data

collection scale of public transportation system grows exponentially, the information collected is enriched, and the public transportation 1C card swipe data exists in the form of offline massive data, based on which the provision of more accurate, comprehensive, and intelligent traffic management and information services has become a hotspot of research and development of the current intelligent transportation system. Providing scalable and visualized public transport applications for massive and diversified public transport 1C card data has become one of the key demands in the construction of the current ITS.

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