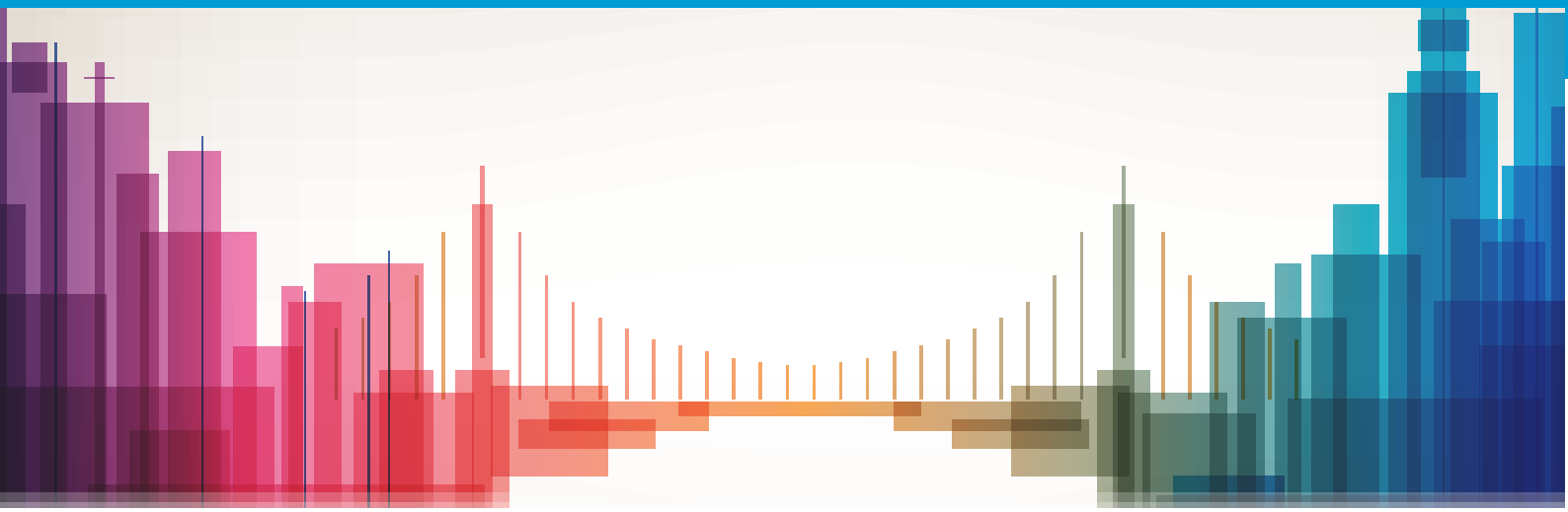
Shenzhen's autonomous public transportation

Case study of the U4SSC Guide to autonomous cities and AI: The next frontier of urban transformation



Convention on Biological Diversity

United Nations ECLAC

Food and Agriculture Organization of the United Nations

UNIDO

ITU

UNDP

United Nations Economic Commission for Africa

UNECE

UNESCO United Nations Educational, Scientific and Cultural Organization

UN environment programme

UNEP FINANCE INITIATIVE

United Nations Framework Convention on Climate Change

unitar United Nations Institute for Training and Research

UN-HABITAT FOR A BETTER URBAN FUTURE

United Nations Department of Economic and Social Affairs

UN 4 PARTNERSHIPS

UNU EGOV

UN Tourism

UN WOMEN

WORLD METEOROLOGICAL ORGANIZATION


12-15
7.12-15
1-6
19-16
终点站
Terminus

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Foreword

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Disclaimer

The opinions expressed in this publication are those of the authors and do not necessarily represent the views of their respective organizations or U4SSC members. In line with the U4SSC principles, this report does not promote the adoption and use of Smart City technology. It advocates for policies encouraging responsible use of information and communications technologies (ICTs) that contribute to the economic, environmental and social sustainability as well as the advancement of the 2030 Agenda for Sustainable Development and the Pact for the Future and its Global Digital Compact.

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Contents

Abbreviations and acronyms

Abbreviation	Full Form
AI	Artificial intelligence
ICTs	Information and communication technologies
OD	Origin-Destination
U4SSC	United for Smart Sustainable Cities

Executive Summary

Shenzhen, as one of the earliest cities in China to open up to the world, has consistently been a pioneer and a leading city in the fields of technology and innovation, and is advancing its public transportation system through AI integration. With a high population flow and reliance on public transit, Shenzhen has implemented a sophisticated AI strategy to improve transportation efficiency. The city has adopted an innovative system developed by Intellifusion and the Shenzhen Bus Group, utilizing “head, shoulder, and neck” recognition algorithms for accurate passenger flow analysis, while respecting privacy. This system optimizes bus routes, enhances vehicle dispatch, and reduces operational costs. The system also integrates bus and metro networks to streamline routes and minimize redundancy. Shenzhen's intelligent transportation system sets a benchmark for smart urban transit solutions, contributing to the city's sustainable development goals.

1 Introduction

Shenzhen, not only a Special Economic Zone in China but also a global leader in innovation, is rapidly emerging as a frontrunner in urban technology development. As a critical hub connecting cities worldwide, Shenzhen has achieved significant success and accumulated extensive experience, particularly in effectively utilizing AI technology to improve public traffic. With its open economic policies, strong technological capabilities, and innovative atmosphere, Shenzhen has become a key force in driving global urban technology advancement.

2 Background and context

Shenzhen is a city with a high population flow, making it highly dependent on public transportation, especially bus and metro. In the public transportation system, passenger OD (origin-destination), which refers to the volume of travel, involves collecting data on passengers' starting and ending points to understand their travel patterns. These data are crucial for accurately planning and meeting passengers' travel needs. Simply put, it involves collecting data on passenger boarding and alighting at bus stops and analysing the passenger flow. However, the challenge of how to collect passenger OD data has been a longstanding issue in the industry. This problem has led to difficulties in accurately understanding citizens' travel needs, providing appropriate transportation capacity, and helping bus companies improve quality and efficiency at the lowest cost.

3 AI strategy (approach) in the city

In the AI implementation strategy released by the General Office of the Shenzhen Municipal Government, it was outlined that Shenzhen will accelerate the development of advanced computing infrastructure, connecting national resources to establish a core node for Shenzhen's AI strategy. The plan includes advancing the construction of an open intelligent computing centre in Shenzhen, creating a source innovation centre for domestic AI ecosystems, and equipping it with domestic computing power, algorithms, operator libraries, databases, toolchains, model libraries, and other tools. The goal is to develop two major industry models and empower 50 companies to create typical application scenarios. Additionally, the strategy encourages enterprises, universities, and research institutions to jointly establish AI collaborative laboratories to develop a series of “AI + industry” solutions.

4 Autonomous System adopted by the city

The urban bus transportation project implemented by Intellifusion and Shenzhen Bus Group integrates AI, big data, and cloud computing technologies. The solution innovatively employs

shoulder and neck recognition instead of facial recognition algorithms, fully respecting personal data and privacy. This allows for accurate identification and analysis of passengers' boarding and alighting data at different stops, providing scientific decision-making support for bus route planning, stop placements, and scheduling. This approach helps to build a human-centred, multidimensional transportation system, effectively improving the operational efficiency of Shenzhen Bus Group, supporting its digital and intelligent transformation, while also enhancing the travel efficiency and happiness of city residents and contributing to the development of green transportation.

5 Implementation of the autonomous system

Using an innovative passenger flow analysis system based on "head, shoulder, and neck" recognition algorithms, passenger travel trajectories are simulated and mapped to enhance route and transportation planning across six aspects of public transportation.

Intelligent Express Lines: The system automatically identifies and optimizes express line routes through algorithms, ensuring the most efficient service.

Smart Interval Lines: The application of smart interval lines involves automatically recommending turn-back points, thereby increasing passenger capacity and vehicle turnover rates.

Mixed Vehicle Configuration: The system provides mixed vehicle configuration options for passengers, recommending appropriate vehicle types based on simulation assessments, reducing overall resource consumption.

Route Cancellation Simulation: The system offers precise quantitative evaluations for route cancellations, helping to assess and determine the most effective routes to discontinue.

Self-Service Route Diversion: The system analyses passenger flow blind spots and simulates the impact of route adjustments, allowing for optimized changes that better distribute passenger flow.

Dual-Network Integration System: It analyses the distribution of bus passenger flow around subway stations, integrating bus and subway networks to streamline and eliminate inefficient bus routes that significantly overlap with subway routes.

6 Results and outcomes

By analysing bus OD data, Intellifusion has helped Shenzhen Bus Group achieve digitalization and intelligence in OD statistics, resulting in a 20 per cent improvement in bus dispatch efficiency and a 30 per cent reduction in operational costs. With this system, dispatchers can monitor the number of passengers in real-time, identify times and areas with high occupancy rates, and promptly deploy additional vehicles to manage passenger flow, alleviate pressure on vehicles and stations,

and reduce passenger waiting times. Currently, 10 express bus routes have been implemented, successfully saving 21 per cent of travel time for 70 per cent of passengers, effectively contributing to the city's goals of sustainable development and carbon neutrality.

7 Assessment of the autonomous system

Shenzhen's intelligent transportation system has developed an innovative recognition algorithm that simulates passenger travel trajectories, achieving comprehensive optimization of route and transportation planning. The system is capable of accurately analysing passenger flow based on work and residential locations, allowing it to determine passengers' connection needs. This intelligent analysis not only makes the setup of express and interval lines more scientific but also enhances the efficiency and resource utilization of the transportation system through functions such as mixed vehicle configuration and route cancellation simulation. Particularly in planning high-frequency micro-circulation routes, this system can quickly disperse passengers, providing more convenient travel options for residents and significantly improving the overall quality of public transportation services. However, this system also faces some potential issues. For example, although the system can optimize bus routes through data analysis, in practice, route adjustments may be less accurate due to delays in data updates or algorithm errors. Additionally, over-reliance on algorithms may overlook the actual experiences of residents, leading to dissatisfaction among some passengers.

To address these issues, it is necessary to further improve the accuracy and update frequency of data collection to ensure the precision of system analysis. At the same time, a citizen feedback mechanism should be introduced to gradually refine the transportation system based on the real needs of residents. Through these measures, Shenzhen's intelligent transportation system will better serve its residents and achieve sustainable urban transportation development.

8 Conclusion

Shenzhen's intelligent transportation system utilizes innovative recognition algorithms to simulate passenger travel trajectories, achieving comprehensive optimization of route and transportation planning. The system is capable of accurately analysing passenger flow based on work and residential locations, allowing for the scientific setup of express and interval lines. Additionally, it enhances the efficiency of the transportation system through functions like mixed vehicle configuration and route cancellation simulation. Particularly in the planning of high-frequency micro-circulation routes, the system provides residents with more convenient travel options. By leveraging these innovative algorithms to improve transportation efficiency, the system offers a cutting-edge solution for the development of smart urban transportation.

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