Digital Twin Based School Bus Scheduling Approach

# Introduction

School bus scheduling in SUSTech is still adjusted manually and often faced with lots of problems. It’s quiet common that in a rainy day, a large quantity of students is waiting at the bus stations, while school buses are still too crowded to carry so many students. Another problem is that among after-school time, buses are resting somewhere and waiting to the start time of bus.

The major problem of school bus is that the time schedule doesn’t fit the dynamically changed requirements of passengers. Neither existing time schedule, or adjusting the schedule to another static version would solve the problem. Our way to solve such kind of question is to dynamically arrange peak lines by using an online algorithm, which adjust the schedule of school bus according to the needs of passengers.

We focus on solving the following two problems:

1. In rush hours, the school bus is too crowded and even some passengers cannot get into bus. However, as we have 7 buses in total, only 4 or 5 buses are in use among these hours. The first goal is to solve heavy traffic in course breaks, rainy days, and evening.
2. In early morning, especially weekends, bus is empty at most of time. If there isn’t passenger at all, buses shouldn’t be sent to a complete empty line.

Besides, a digital-twin based simulation platform would be used to preliminary the time arrangement. Send bus first, and then wait for result doesn’t realistic. So, a simulator to the physical service is required.

The basic structure of proposal would be raised in these parts. First part is the background and concept of dynamically arranged schedule. Followed by the data gathering and coupling to be put into simulator, and on which our algorithm is based. Then is the model of digital-twin based simulation system to preliminary schedule, and the measurement of result. The next is the dynamic arrangement algorithm, and the performance it can gain. Finally, is a brief summary to the work.

# Background

The current number of buses in SUSTech is 7. However, in most of time, only 2 or 3 of them are in use, and even in rush hours, only 5 or 6 are in traffic, while the other are waiting somewhere. The current schedule table of school bus is rather complex, while during the rush hours, one bus is sent from start station each 5 minutes. And during the normal time, one bus is sent up to 30 minutes.

But there still very serious traffic problems. First is the capacity of a single school bus doesn’t match the requirements of passengers. Usually, there are over 100 people are waiting at the bus station, and clearly, one bus can’t carry so many people.

Another big problem is, the school bus doesn’t take the weather condition into consideration, especially in rainy day, the traffic condition is even worse.

To make our declaration clear, we define schedule table , containing the bus arrangement in time t, with peak line has status 1 while normal line has status 0. Direction property denotes several directions: 0 from Research Building 1 to Joy Highland, 1 from Joy Highland to Research Building 1, 2 for Nanshan Park to Lychee Hill, 3 for Lychee Hill to So Fun Land, 4 for So Fun Land back to Lychee Hill, and 5 for special line Lychee Hill to Research Building 1.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 |
| RB1->JH | JH->RB1 | NP->LH | LH->SFL | SFL->LH | LH->RB1 |

During work days, all 6 lines are set during schedule table. But during weekends, only line 0, 1, 3, and 4 are enabled. Line 2 and line 5 are closed during weekends. Meanwhile, there isn’t peak line in weekends, all buses are status 0 in weekends.