Smart Food Delivery System on HKUST Guangzhou Campus

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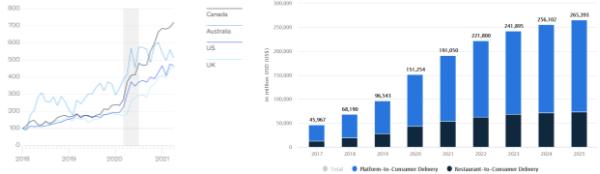
Background

With the pandemic of COVID-19 and the advanced technics in mobile payment, the food delivery market, in foreign area or in China mainland had grown so rapidly in the past few years and is believed to boost more in the future and influence our life every day.



By following this trend, a smart food delivery system is highly needed to tackle with the rising problems of high human resource cost, long-term environment pollution, traffic collisions and delivery efficiency.

Objective

Design a smart food delivery system for the HKUST Guangzhou campus, which can provide food delivery services for students and staffs on campus without human-included. Advanced path finding algorithm applied to make sure our system can deal with emergency situations and work for a long time, so that our campus will be more smart, efficient, well-organized, and eco-friendly.

Problem Definition

The problem is how to make sure food delivery system on campus could work efficiently and be convenient to all users.

Our project goals are to design advanced path-finding algorithms for mobile robots and apply intelligence design for robots itself to make it cheaper and easy to use.

There are several requirements from no human-included in all processes, time efficient delivery, no space collision with other robots or human, low power costs.

And there are possible improvements on high timeliness restriction and multi-task optimization:

1. Advanced path-finding algorithm design
2. New communication mechanism design
3. Smart robot design based on electrical power

Measurements

- Data Sources:
  1. Transferring campus construction map to a 3D map and setting several entrance gates as the home points for robots in our system;
  2. Generating the delivery tasks in a time sequence and tacking the continuous time problems to discrete time problems.
- Performance Measurement Metrics:
  1. Time limits for each delivery task;
  2. Delivery paths should have no same-time collision with other paths for other robots;
  3. Totally system time cost under limited tasks;
  4. The completed tasks in a certain range of time.

Analyzation for problems

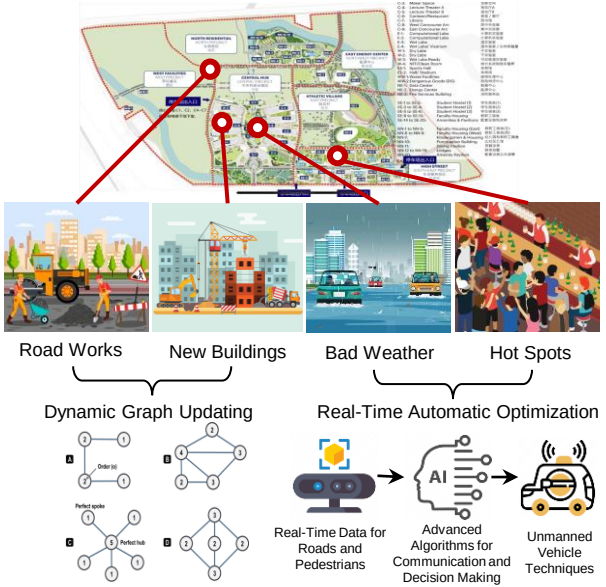
- Not most of the robots in the system can engage the delivery.
  1. The number of robots in each home point are fixed;
  2. The system can not handle long-time tasks assignment.
- The collision will happen sometimes.
  1. The accurate 3D map is hard to generated;
  2. It is difficult to do a path-finding based on a 3D map.
- The map can not work for a long time.
  1. There are new buildings and roads in the future;
  2. The training data are based on previous fixed data.

Improvements

- Using a 2D weighted graph to replace the 3D map;
- Making the whole system more dynamic by setting non-fixed number of robots for each gate and allowing robots to set different gates as their home gate with time goes;
- The graph map can be added with more weighted nodes and edged to represent the new constructions;
- Advanced communication mechanism for robot to share information with adjacent robots to avoid collisions.

Control Processes

The Map of HKUST Guangzhou Campus



Future Works

- *Decentralized Cooperative Multi-Agent Reinforcement Learning*

One key problem is how to transfer this system in different settings, for example, in a warehouse environment, and keep the system reliable and stable. Decentralized cooperative multi-agent reinforcement learning may lead a way to solve this problem.

- *Advanced Deep Learning Techniques*

More powerful deep learning algorithms based on advanced computation power or better communication mechanism could make the whole system more efficient with less time cost.