# Digital twin prototype design and validation for connected and automated driving simulation

Project introduction

A digital twin is a real-time digital replica of a physical system. Digital-twin-enabled traffic simulation fully takes advantages of Internet of Things (IoT), cloud computing, and advanced traffic simulation, which can provide real-time interaction between real world and virtual traffic simulation. Overall, the proposed digital twin prototype system is composed of three components: local field sensor system, IoT cloud deployment, and virtual simulation platform, as shown in the following diagram.
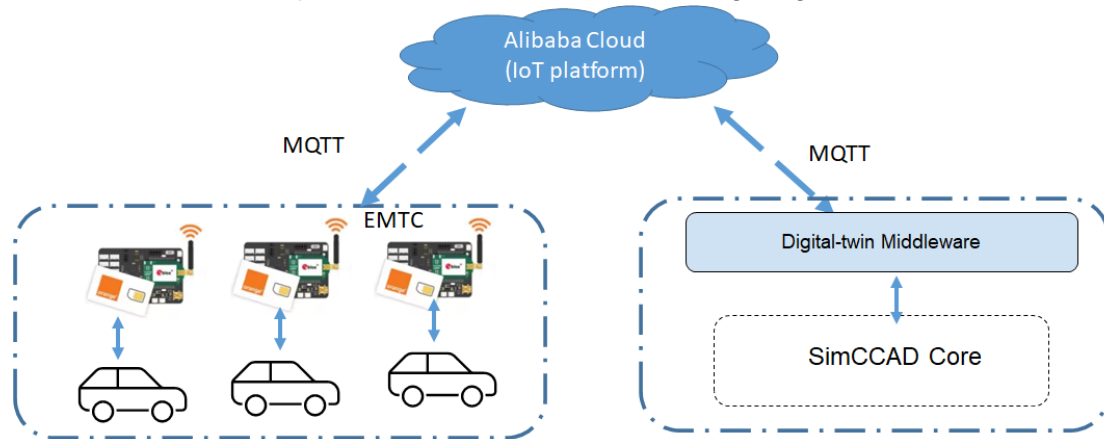
Architecture of Digital-twin prototype

Subtasks definition

(1) Local field sensor system

Local field sensors system will be first deployed in the real world in order to obtain the real-time traffic information, which then will be uploaded to the public IoT cloud for message storage and exchange. Specifically, this project focuses on vehicle kinetic information, .e.g position and speed, collected by GPS modules. Popular embedded hardware platform Arduino/Raspberry Pi (developing in C) is adopted to operate local sensors and build up stable link to the cloud via standard MQTT protocol, a lightweight, publish-subscribe network protocol that transports messages between devices.

(2) IoT cloud deployment

Alibaba Cloud is selected as the IoT cloud platform which can provide stable internet communication with low latency. MQTT broker will be deployed in the Cloud to manages the cloud communication with both local sensors system and virtual simulation platform.

(3) Virtual simulation platform

This component is based on the well-established simulation platform *SimCCAD* developed by PI (integrated **Sim**ulation platform for **C**onventional, **C**onnected, and **A**utomated **D**riving), which tightly combines the core components of V2X communication, traffic networks, and autonomous/conventional vehicle model.

Specifically, the open-source simulator Webots is applied to construct digital replica of real-world traffic environment. To bridge SimCCAD with Cloud, an exclusive middleware (programming in Python) will be designed beyond the Simulation., Also, an additional interface (coding in Python) connecting the middleware via TCP/IP will be design in Webots which is used to periodically update traffic information in the simulation and send advisory control strategy to the real world, so that traffic information can be simultaneously synchronised in both real world and virtual world.

Selection criteria

Students with self-motivation and enthusiasm in research are encouraged to apply for this project. (4 positions in total)

(1) Student one (S1) is responsible for local sensor system development, mainly including GPS module operation via Arduino or Raspberry Pi hardware platform and MQTT protocol design to connect to the Cloud.

Expected candidate should be Interested in IoT application and embedded system design, **proficiency in programming C language**, have a basic knowledge of hardware and embedded system, the ability to read simple schematics. familiar with communication protocols, etc.

(2)S2 takes on duty of developing middleware to connect Cloud with virtual simulation platform (Webots).

Expected candidate should have a **proven experience in Python programming.** Experience of networking programming (e.g. socket program) and client-server programming, knowlege of mqtt protocol is preferred

(3)S3 is responsible for Alibaba Cloud deployment, field/simulation trial design (using Webots), and the whole system validation.

Expected candidate should have a **basic knowledge of network and cloud**, and interested in develop simulation scenario by using Webots, and also closely collaborate with S1 and S2 to implement communication between real-world and virtual world.

(4) S4 is responsible for traffic simulator (Webots) interface design to digitalise the real traffic information in the simulation scenario and synchronise information between the real world and digital world.

Expected candidate should have a **proven experience in Python programming**.

In addition, since this year's SURF will run online, S2,S3, and S4 are expected to have **a decent laptop or desktop** with an independent graphics card such as **GTX1650 or beyond** in order to run the 3D traffic simulation using Webots simulator.

If you are interested in joining the project, please feel free to contact me and send your CV highlighting relevant skills.