Meeting Minutes

Date / Time	29 April 2020 / 04.30-6.00pm	Location	ZN804 Blk Z / Online
Attendants	Asif Usmani (AU) Mingchun Luo (MCL) Mustasin Ali Khan (MAK) John WZ Shi (JS) George Huang (GH, HKU, online) Xinyan Huang (XH) Linda F. Xiao (FX) Xincong Yang (XY) Qixin Wang (QW) Xiqiang Wu (XW)	Jose Torero (JT, UCL UK, online) Xinzhen Lu (XL, Tsinghua U, PRC, online) Stephen Welch (SW, U of Edin UK, online) Ryan P.C. Kwok (RK, HKFSD, online) Yaqiang Jiang (YJ, SCFRI PRC, online) Robert Baxter (RB, EPCC U of Edin, online) Young Wong (YW, Arup HK, online)	
Apologies	Heng Li (HL)	Naian Liu (NL, USTC PRC) Jeffery K.H. Leung (JL, HKFSD)	
Topic	SureFire: Progress Meeting, report to partners		

Item	Content	Action
1.0	**General**	
1.1	**Current meeting arrangement**	
	Follow the Hong Kong Government and PolyU's guidelines on office operation and social distance requirements, the team members in PolyU joined in the meeting room ZN804 Block Z and all external partners attended the meeting online.	
1.2	**Overview**	
	A brief outline of the five main project deliverables was provided by AU. Three goals of the project were also outlined and level of their fulfillment at each stage (yearly) was also briefed i.e., after first stage, Goal 1 (30%), Goal 2 (10%) and Goal 3 (10%). Future plan to perform fire tests at SCFRI are outlined and it is proposed to perform some tests for CFD model validation as soon as the current travel restrictions due to Covid 19 are eased off. The management structure for the project and details about each research teams working on distinct work packages was presented. An overview of the external advisory board was also provided by AU.	

	The architecture for SureFire project was presented by FX followed by a detailed discussion. Progress of various work packages WP1, WP2 and WP3 was presented by project investigators followed by important suggestions provided by all members.	
2.0	**Project Architecture**	
2.1	**Project Architecture diagram**	
	A detailed project architecture diagram was presented by FX. Importance of developing a project architecture were described. Due to the communication between various advanced technologies such as Digital Twin (DT), Artificial Intelligence (AI), Machine Learning (ML) and CFD modelling which are going to be used during the execution of this project, a project architecture is required to be developed. The architecture diagram also defines clearly the task associated with each work packages and communication between different work packages. Various important features of the architecture diagram are as follows. • All the data communication and data sharing between different work packages will take place through a cloud-based data repository. • All type of datasets such as fire scenario datasets from FDS simulations, geometry and other information about the building from DT model and real time sensor data will be saved in the common data repository. • The architecture diagram clearly presents the processes executed using online and offline communication using solid and dotted lines, respectively. • Information about various critical events such as flashover, carbon monoxide concentration etc, will be stored in critical information alert system using the domain knowledge. • Real time data coming from existing building automation systems and onsite network systems will also be stored in the data repository. • The AI engine subsystem will extract the fire simulation data and real time data from data repository. • The AI algorithm will then perform the fire scenario matching analysis and predict fire scenarios in close approximation to real time data. • The predicted fire scenarios will be used to predict the dynamic states in the form of critical events such as temperature distribution, visibility and smoke concentration. • A detailed diagram for the project architecture is attached in the appendix. Various suggestions were provided to improve the quality of the architecture diagram and questions were asked about the project architecture. AU advised to include description for each module and subsystems. The large amount of data required by AI to process will mainly be developed using FDS simulations and the real test data will mainly be used to validate the FDS models. The scalability of the AI subsystem does not come under the domain of this project as the project develops the smart fire fighting system for individual infrastructures for example, the AI subsystem developed for a specific tunnel will not be applicable to other tunnels. This research project focuses on the SCFRI tunnel, which is 160m long.	FX/QW

	It was suggested to estimates the volume to data coming from sensor system as it would help in establishing an efficient communication between different data modules. As the real time execution demands instant responses so to speed up the communication process, it was suggested to use the edge computing technology.	
2.2	**Digital twin**	
	The progress of developing the digital twin model was presented by XY. The importance of developing a digital twin model with respect to this project were highlighted. Various functions which have to be performed by DT model are briefed. The DT model is required to provide the building geometrical information for CFD modelling and it also visualise the real time sensor data. Moreover, the DT model is also connected to the predicted fire simulation. Progress of the DT modelling was presented as follows. • Various online and offline platforms were tried to model a DT of a tunnel. • It was proposed to model the DT on an online platform so that the user is not required to install the offline software such as Revit to access the DT model. • Use of commercial and open source platform were also considered such as forge and three.js. • A simple DT model of the demonstration tunnel present in PolyU lab is prepared using open source platform three.js. • Use of MQTT server is proposed to connect different kind of sensors such as temperature sensors, motion sensors and moisture sensors to the DT model. • A user interface for the model will be prepared to enable the user to modify the model. • An ATI will be developed to convert different formats of information coming from sensors and FDS simulations to a uniform format. • It was advised to use the PolyU cloud to store the data and could investigate the commercial cloud services provider to try the cloud engine.	XY
3.0	**Communication Network**	
	Progress regarding the development of communication network for sure fire project was presented by QW. Following are the important developments made in establishing a communication network. • A literature survey was conducted to identify the suitable type of sensor network for the project. According to the survey, the breadcrumb network is found to be the most common and state of art sensor system. The proposed breadcrumb sensor network is mature to communicate data from different types of sensors. • Various kind of wireless sensors are available in the market but the dispenser to deploy the sensors has to be designed by ourselves. • The existing protocols could be used to establish wireless links to communicate the message.	

	• The UAV will act as access point to collect data from sensors. Use of UAV is also suitable if it is required to transmit the video signals. • To transmit the data efficiently, a hub and a UAV is required at every 20 meters. The reliability of data transmission reduces with increase in numbers of hub used in the network. • Information about various devices was also presented which can be useful for this project such as DJI 100 a UAV drone.	
4.0	**Fire Modeling, Database, & AI-Forecast**	
	Progress regarding the fire modelling and AI-forecast was presented by XH. Details of the papers published related to the project was also presented. Following are the important developments made in conducting fire modelling and AI forecast for the tunnel fire. • In paper 1, 1000 case of two-dimensional fires were simulated. Information from numerical database was utilized to predict the possible location of fire. This paper predicts the fire detection followed by fire forecasting. • In paper 2, a summary of all experimental data related to tunnel fire is prepared. All the data is converted to a standardized format so that it could be used in conjunction with numerical data in future. It will also be investigated that if existing experimental data is sufficient to predict the fire using AI engine. • In paper 3, several critical events such as critical ventilation and critical egress time will be predicted using AI engine. • In paper 4, basic equations of fluid flow will be used to understand the fire behavior. Using AI engine, the fire scenario as well as the critical events will be predicted. • A small-scale tunnel has been conducted at PolyU lab. A BIM model of the same tunnel is also prepared. The information from the temperature sensors is communicated successfully to the BIM model in real time. • A database using finite element analysis will be prepared for structural collapse of buildings. AI engine will then be used to forecast the collapse. • Large scale tunnel fire tests are planned to be conducted at SCRFI as the travel restrictions will ease off. Tests for compartment fire and travelling fire in a building are also planned to be conducted in future as they are more complicated compared to tunnel fires. Various suggestions were provided to efficiently perform the CFD simulations. It is suggested to start simulations assuming a simple pool fire with constant HRR as it is quite complicated to model wood cribs in CFD models. Wood cribs are also very difficult to ignite and the resulting fire scenarios are highly unpredictable.	
5.0	**Next Steps**	
	• It is planned to send a RA or PhD student to collect already existed fire test data from SCFRI when the travel restrictions are eased off. • A meeting with HKFSD is to be fixed. • GH and JS are to nominate their RA to work with XY for the development of DT model.	GH / JS

	• All the presentations are to be sent to the partners before the meeting.	

Appendix

Project Architecture