L&T Project Application

Project Title		REMO-LAB: Low-cost adaptable infrastructure for remote experiments			
Project Lead		Frederic Surre,	**Project Duration**	12 Months	
Project Co-Lead		External Collaborators: Dr Olivier Bernal, Dr Han-Cheng Seat, LAAS-CNRS & Universite de Toulouse, France.			
List Key Objectives of the Project	1	Design of a system that allows remote access to experiments with enhanced safety and security to support primarily Final Year Projects.			
	2	Propose an architecture for remote experiment including instruments of different generations and user interface for teaching and that can be extended to research			
	3	Design plug-in device that can be adapted to different instruments and can be retrofitted to instrument			
	4				
	5				
	6				
Total Budget			**Project Start Date**	1st Jan 2021	**Project End Date**	31st December 2021

Include a summary of the project including deliverables.

Identified problem:

This project proposes to explore an alternative way to perform remote experiment. It particularly aims to address the difficulty for FYP to access experiments that are located in UofG's main campus. For a subset of FYP students, who are working on research topics, being able to perform, even if remotely, experiments related to their projects would be an added value both in terms of learning (skills acquisition) and outcomes (better papers with a faster time to publication.

The limitation identified for some of the Final Year projects is also relevant if we open MSc programmes in the future as it would help with giving access to graduate students to state-of-art facilities on UofG's main campus, for example during their dissertation work. Finally, if

travel restrictions last for a longer time, students on the dual PhD programme may not be able to travel to Glasgow to perform essential experimental work. In such a case, this project could provide a safe and secure way to perform these experiments remotely.

Proposed Solution:

To address the identified problem, we are looking to design a system that allows remote access to complex experimental set-ups and can add a level of safety, when experiment runs unsupervised. Such a system would be flexible to be adapted to different experiments and can be used for teaching and research experimental work.

The architecture of the system to be designed is presented in figure 1. It includes a programmable local node that will connect wireless to cloud storage and will be adaptable to different instruments in a simple way. The user will be able to access data from the cloud and to control the running envelope of the experiment to guarantee safe operation.

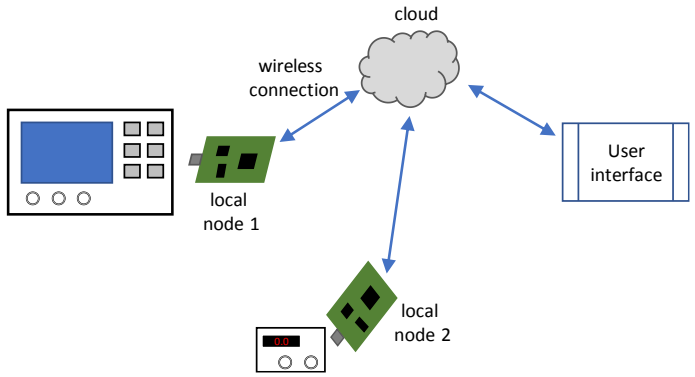

Figure 1: Example of the system to be designed in the case of two instruments to control.

The local node will be built around an embedded processor that will communicate with an instrument, locally control and monitor it, and, subsequently will send and receive data from a cloud storage via wireless communications. It will be designed to be plugged into most equipment (especially those without Bluetooth connectivity). The node will use a USB-type connection as standards and adapters to serial, parallel or ethernet connections will be added as needed.

The wireless communication will be decided during the project but for indoor experiments performed in a University setting, WiFi would be the most sensible choice.

The user will access the cloud via either a web-based interface or an app (decision will be taken during the project). This interface will allow controlling the experiment (both when to start and stop and also set the safety parameters – preset parameters will also be used to avoid risky behaviour from users), collecting data coming from the experiment and access to historical data (within reason). The interface will also add a layer of security as it will require user identification and a log of who used an experiment can be recorded.

Tasks:
The first task will be to identify an experimental set-up that can be used as a testbed. While the system will be designed for this experiment, flexibility and adaptability of the system will be pursued so that the proposed solution can easily be adapted to other experiments.
The second task is focused on the design of the local node. After the design, prototyping and tests will be performed to evaluate the performances and, if required, a second version will be developed. An important element of this task will be how to keep the design as generic as possible and to make any re-programming, e.g. for a different instrument, as easy as possible for the user. During this task, decision on the communication protocol will also be made.
Task 3 will be the design of the backend part of the system, which includes selection of cloud services, design and test of user interface and any part dealing with database and data security.
Step 4 will focus on testing the system in real-life condition.

Strength of team

This proposed project is involved in a collaboration with colleagues at Universite de Toulouse, France and LAAS-CNRS. Funding has already been secure from their University for a different aspect of remote laboratories during the summer. This project is different but complementary of the collaborative efforts that have already commenced.
The two international collaborators will intervene in this project in step 1 to define specifications and possible experiment of common interest and, in particular, in Step 4 as they offered to run a real-life test in their laboratories.

During the project, other staff may be approached to join the project, based on expertise (such as backend design: database and user interface) and need.