Towards a Fully Virtual Space Research Masters Program: A Multidisciplinary Micro-module Approach

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***Abstract*—The COVID-19 pandemic has pushed the existing education and learning system for the engineering subjects towards the extreme possible extent of digitization. Virtual distance learning programs have been always a challenge for the engineering studies that are characterized by a combination of hands-on education and excellent experimental and laboratory infrastructures, as a constructive tool for attaining good learning objectives. Towards this end, in-line with the activities at Högskolepedagogiskt centrum (HPC) and the UNIVERSEH in Space education European project, the Robotics and Artificial Intelligence team at Luleå University of Technology is planning a Space Research Masters Program that can be attended by anyone around the world without demanding for physical presence. In this article, we will provide the baseline of developments for this research master, we will address the list of related educational research activities and we will establish the base for the individual course planning and the full student based customized education, while exploring the concept of micro-modules in various disciplines of studies related to space technologies.**

***Index Terms*—Virtual education, digitization, space engineering, research masters, post-pandemic education.**

I. Introduction

The hands on education is one of the most important educational tools for constructive alignment to the learning objectives that is very often, if not always, met in engineering education. However, COVID-19 required an urgent transition of the majority of education activities into a remote virtual mode that transformed engineering studies to a foreseeable future. In the case of Luleå University of Technology, the technology-enhanced learning was already playing and important role, mainly due to the fact that some courses were being shared between three different campuses, e.g. Luleå, Skellefteå, and Kiruna, where the video conferencing of live lectures between the campuses were playing a very important role. Although with the existing infrastructure, COVID-19 pandemic exposed the gaps in distance learning approaches of almost all the educational activities that created an unseen before pause of the laboratory activities, has banned the ability of the educational programs to link theory with practice, has blocked the ability to create familiarity with reality and paused the learning activities of the students by active experimentation. This gap of lack of hand-on experimental education has been a common issue in almost all the universities worldwide [1]–[4]. In addition, the COVID-19 pandemic has also been responsible for changes in the geopolitical situations, thus blocking the free movement of students or professional tutors crossing country boarders in search of advanced educational/research programs, adding difficulties to the existing educational infrastructure.

With this background, Luleå University of Technology along with the Robotics and Artificial Intelligence group has initiated a pilot project to design a full remote Research Masters (RM) program with specialization in Space Robotics. These efforts of creating this research program are not only inline with the European project UNIVERSEH[1], but also can reach multiple directions of mutual collaboration, inspiration and adoption of success practices in education models in space science. In this article we will discuss our approach towards designing this program, while retaining the quality in the engineering education by protecting and enhancing hands-on experience in remote education and presenting the initial structure of the program and the up to now planning procedures and overall concept.

The planned RM on Space Robotics will be characterized as an intense multi-disciplinary research Master program, with extended hands-on experimentation, large number of project courses and a clear orientation for research activities. This multidisciplinary RM is based on multiple areas that Luleå University has a strong profile, such as electronics, computer science, mechatronics, artificial intelligence, architecture, bio-engineering, mining etc. The overall aim is to build an educational program with multiple branches, while each branch will be based on a baseline set of courses and every sub-branch will also constructed form a small intense courses, called micro-modules based on micro-learning abilities [5]. All the branches and sub-branches will be a priori defined but also allow for a combination freedom and full student based penalisation in order to create educational streams with a full customization. In this approach the constructive alignment to the classical hands on engineering education will be based on realistic and physics based simulations [6], personalized remote experiments, remote-experimental setups [7] and individual hand-on kits, like turtlebot[2], crazyfly[3], etc. This program will also

This work has been partially supported from the European Universities program UNIVERSEH co-funded by the Erasmus+ Programme of the European Union

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[1]https://universeh.eu

[2]https://www.turtlebot.com/

[3]https://www.bitcraze.io/products/crazyflie-2-1/

involve a large number of project courses that will give the educational model the flexibility and the further customization in order to adapt the learning objectives to the exact and unique per student needs and interests.

II. Conclusions

This program will aim at attaining innovative pedagogical activities to develop a full virtual Space Masters Research program to for providing an advanced education in space technologies, while building a strong background for further initiation of PhD studies. This program will be able to include students participation (remotely) in the program without any geographical limitation, and address flexibility and personalization on the learning activities (learn on demand and learn on need) while retaining the quality of engineering education by protecting and enhancing hands-on experience in distance learning.

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