Virtual Labs for Digital Electronics to Embedded Systems

Mathini Sellathurai and Mauro Dragone

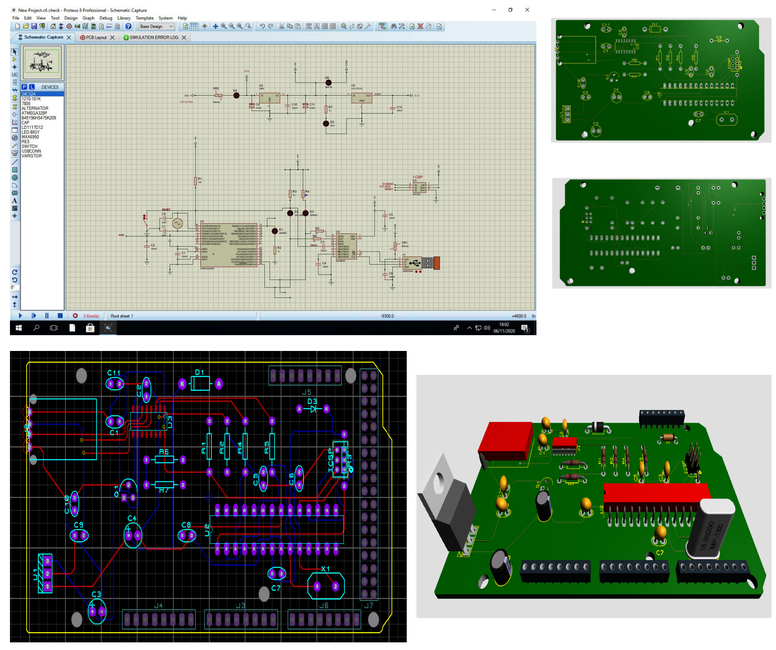
Abstract

We will present some of the ideas developed for Virtual Labs for teaching and learning Electronics to Embedded Systems and programming, remotely or in a hybrid teaching space, using state of the art technologies such as "Digital twins & Internet of Lab Things" for remote access to lab resources such as Robots, Arduino board-based experiments of basic electronic circuits, and professional level simulation environments such as proteus software to learn basic electronics. This approach provided an enhanced experience for global students and the developed virtual Labs also facilitated individual and group projects within the courses.

Methods and Materials

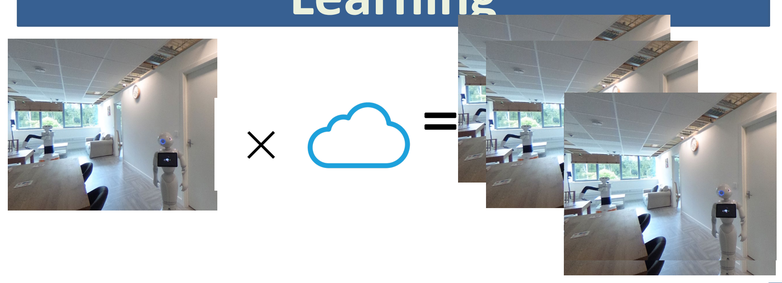
- Software Based Learning of Circuits
- Arduino Board Based Learning and Independent Projects
- IoT- Digital-Twins - Cloud Based remote access Learning and individual/group projects
- Applications in Teaching and Research

Simulation Based Circuit

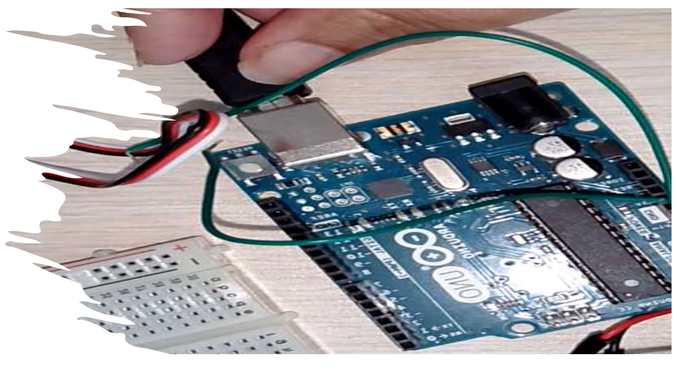


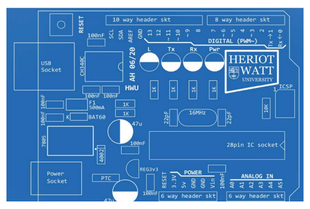
Simulations Packages
(Example: Porteous)

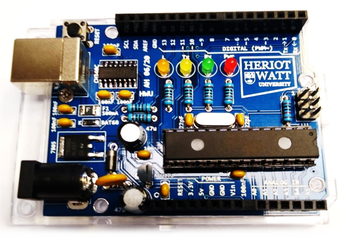
Digital Twin Based Remote Learning

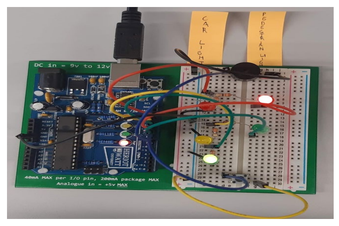


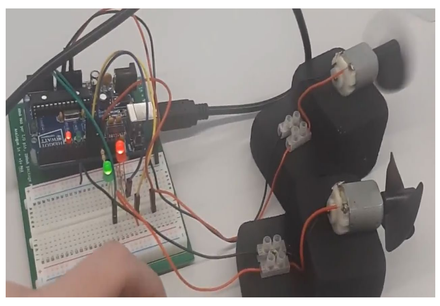
Arduino-Board Based Study

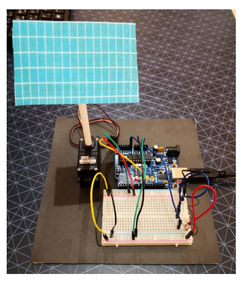


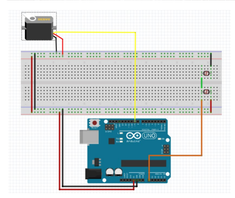










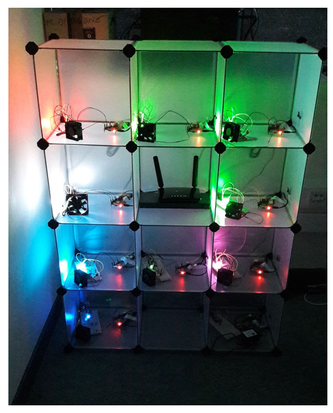


Figures: Auduino board Based Experiments

IAA for Open Ambient Assisted Living (OpenAAL)

Amplify R&D&I and learning and teaching capacity with:

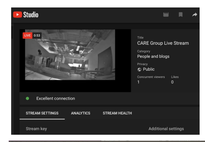
- Digital twins & simulations
- Remote access to lab resources (Robotic & IoT devices

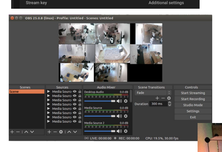


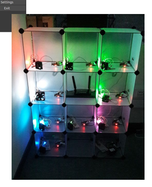
Each cell has:

- Raspberry Pi 4 (X 10)
- Re-configurable experiment hardware
  - (mcu, sensors, actuators)
- Monitoring webcam

Applications







We know that Kirchhoff's current law states that current flowing into a node (or a junction) must be equal to current flowing out of it.
IR1 =IR2 +IR3
In this case, by focusing on node A:
0.60 Amps=0.30 Amps+0.30 Amps
0.60 Amps= 0.60 Amps

Conclusions

- Blended use of simulation environment and practical activities can be carried out using state-of-art technologies.
- Supplementary detailed videos to support students wherever they are completing the project, in the lab, at home, or abroad..
- Offer full class and individual support using online channels.

Contact

Professor Mathini Sellathura and Dr Mauro Dragonei
M.Sellathurai@hw.ac.uk:
Website:
Phone: 1314513356

References

[1] Achuthan, K., Sivan, S., Raman, R. (2014). Teacher Receptivity in Creative Use of Virtual Laboratories. 2014 IEEE Region 10 Humanitarian Technology Conference (R10 HTC). 978-1-4799-7606-5/14/ 2014 IEEE.*
[2] Castelló, M. E., Pellegrino, V. E., Argente, D. A., Gomez-Marquez, J., Gaudenz, U., Randall, G., Pereira, A. C., Alonso, S., Calvelo, J., Young, A., Acosta, F. N., Albarran, N., Gimenez, M1, Sedraschi, P. M., Umpiérrez, M. D., Figares, M., de Sagastizabal, R., Radmilovich, M. D. (2020). Real and Virtual Biological Science Living Laboratory for Science Teachers' formation: promoting global scientific literacy and critical thinking for sustainable development. EPiC Series in Education Science Volume 3, 2020, Pages 27-34. Proceedings of the MIT LINC 2019 Conference.*
[3]Brian Shambare, Clement Simuja Critical Review of Teaching With Virtual Lab: A Panacea to Challenges of Conducting Practical Experiments in Science Subjects Beyond the COVID-19 Pandemic in Rural Schools in South Africa, Journal of Educational Technology Systems (2022) https://doi.org/10.1177/0047239521105805
[4] Drysdale, Timothy D., and N. St J. Braithwaite. "An internet of laboratory things." 2017 4th Experiment@ International Conference (exp. at'17). IEEE, 2017
1.
2