Co-funded by the Erasmus+ Programme of the European Union

Integrating VR/AR with Haptics into STEM Education

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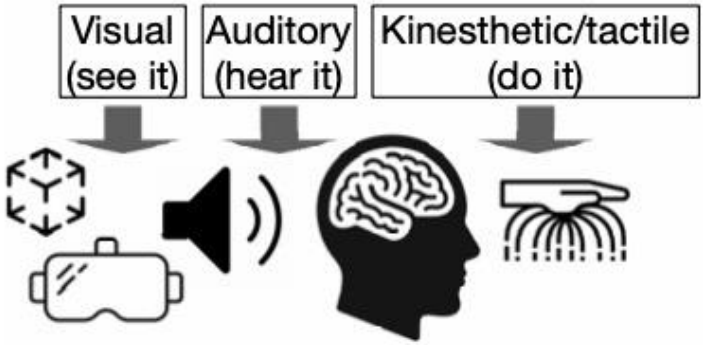
Introduction

- E-Learning courses have been boosted by the Covid-19 pandemic;
- E-Learning brings several possibilities in terms of interactions for the students;

[1] Sanfilippo, F., Blažauskas, T., Salvietti, G., Ramos, I., Vert, S., Radianti, J., Majchrzak, T.A.: Integrating VR/AR with haptics into STEM education. In: Proc. of the 4th International Conference on Intelligent Technologies and Applications(INTAP 2021). Springer (2021), accepted for publication.

Multi-sensory learning approach



AugmentWearEdu Project

Project group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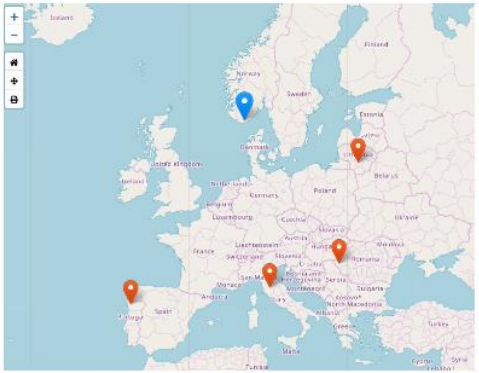


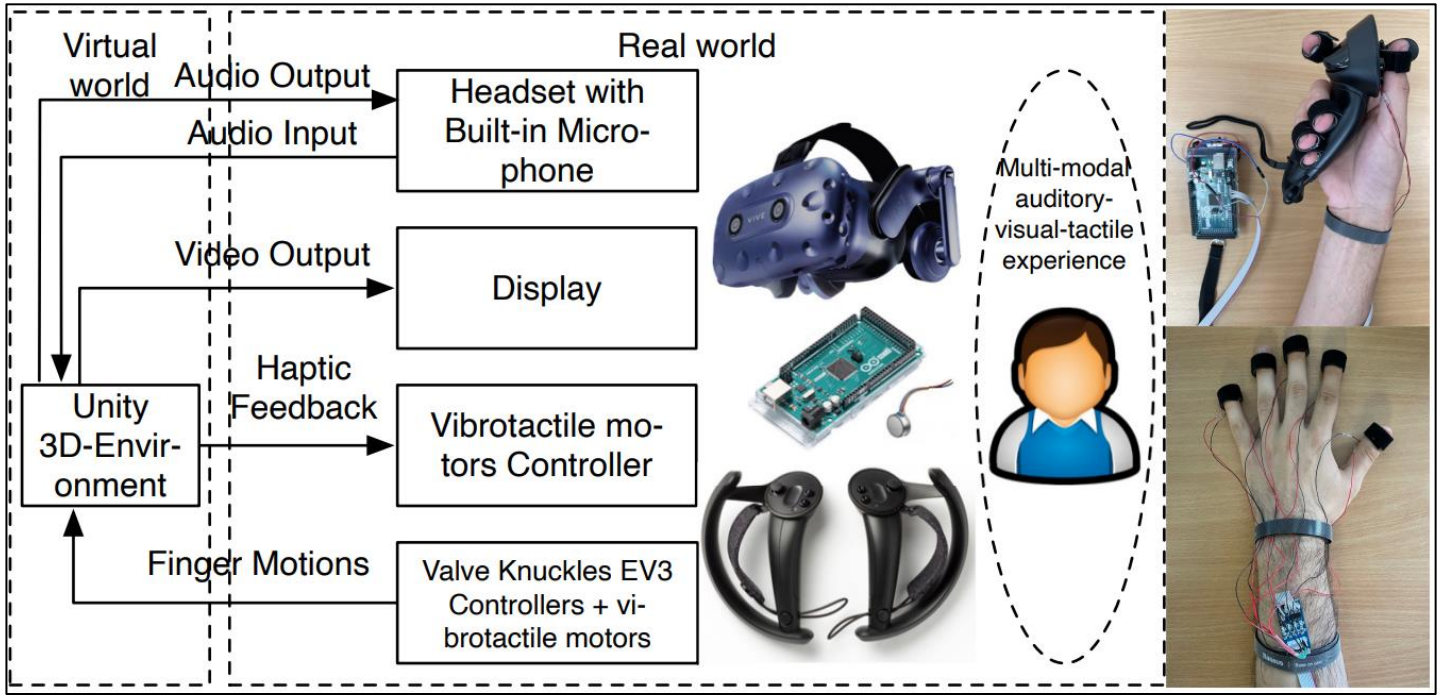
https://augmentedwearedu.uia.no

Motivation

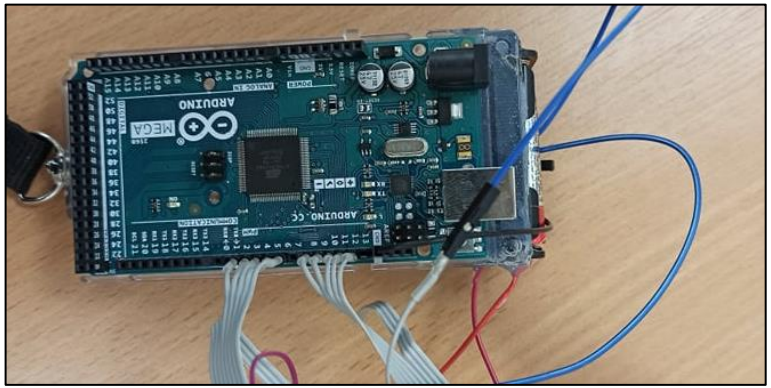
- Wearable haptic devices that enable a multi contact interaction with virtual objects;
- Opportunity of new e-Learning contents that include tactile experience;
- Necessary to develop systems with a reduced cost by using commercially available off-the-shelf (COTS) components.

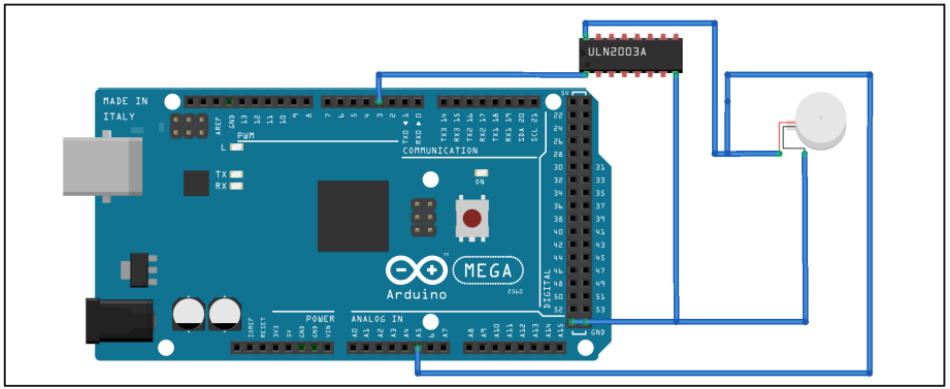
[2] Facebook Technologies, LLC. “Oculus Touch”. 2021. url: https://www.oculus.com/rift/
[3] Valve Corporation. “Valve Index Controllers”. 2021. url: https://store.steampowered.com/app/1059550/Valve_Index_Controllers/
[4] HaptX Inc. “HaptX Gloves”. 2021. url: https://haptx.com/

Framework architecture

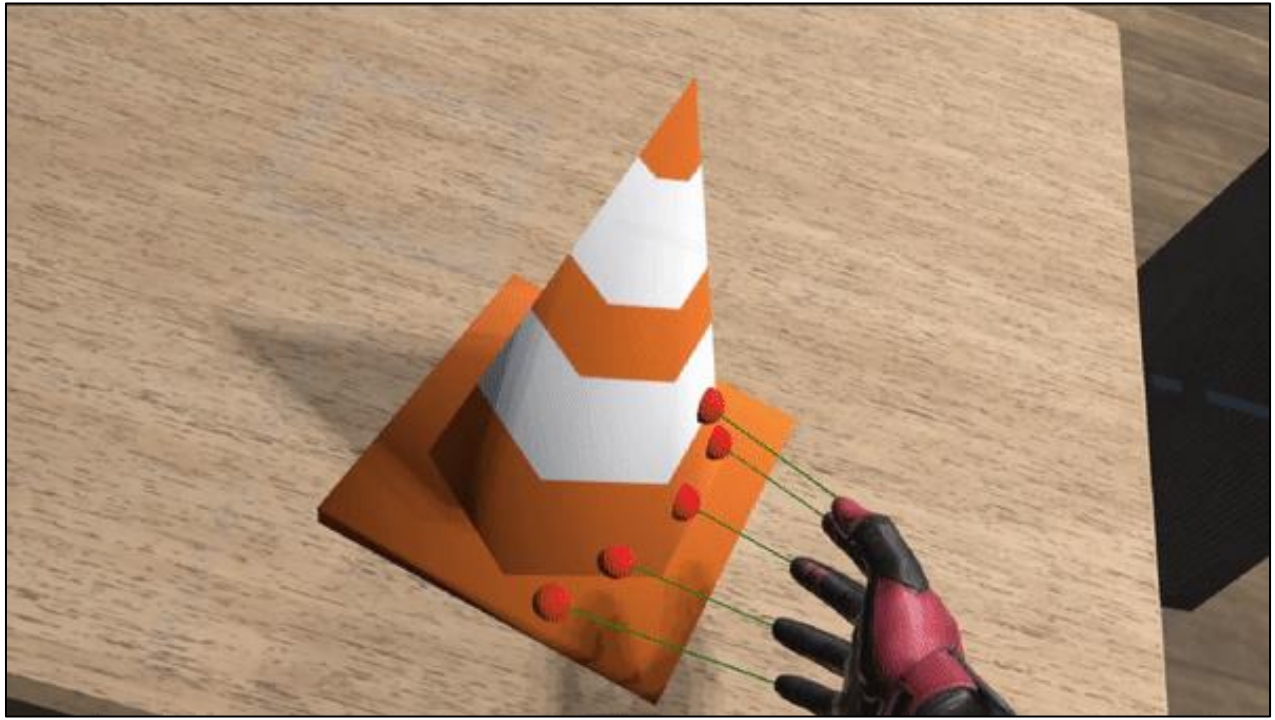


Hardware implementation





Rendering strategies



Equations

- Force calculation: $F_i = k(t - d_i) - k_v v_i,$
- Vibration actuator: $D_i = \frac{\alpha F_i - F_{min}}{F_{max} - F_{min}},$
- Pitch frequency: $f_i = f_{min} \frac{\beta(F_i - F_{min})(f_{max} - f_{min})}{F_{max} - F_{min}},$
- Wavelength: $\lambda_i = f_{min} \frac{\gamma(F_i - F_{min})(\lambda_{max} - \lambda_{min})}{F_{max} - F_{min}},$

F – force;
k – stiffness;
k_v – damping constants;
t – distance tolerance of contact;
d – distance value of contact;
V_i – approaching velocity;

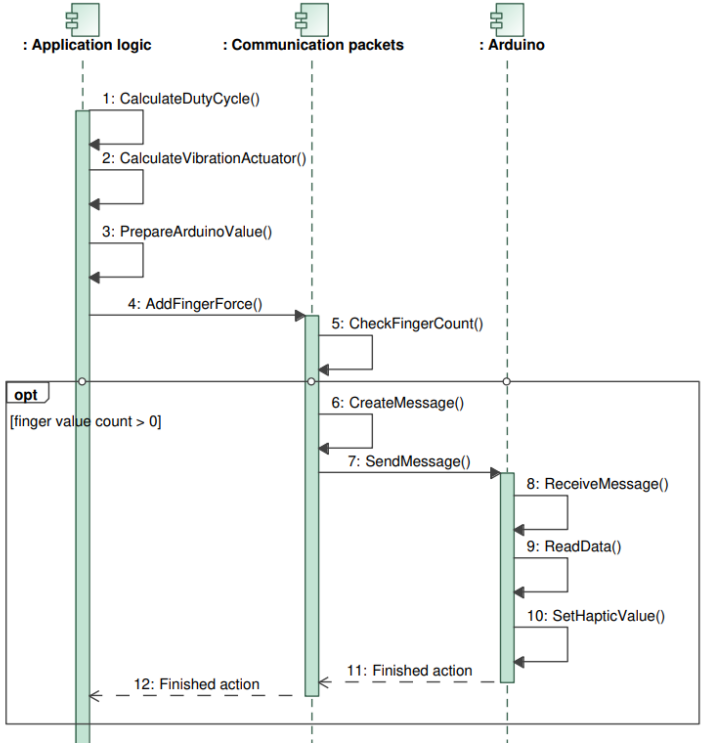
D – vibration actuator;
α – scaling factor;
F_{min} and F_{max} – minimum and maximum renderisable forces respectively;

f – pitch frequency
β – scaling factor
$f_{min} - f_{max}$ minimum and maximum renderisable pitch frequency

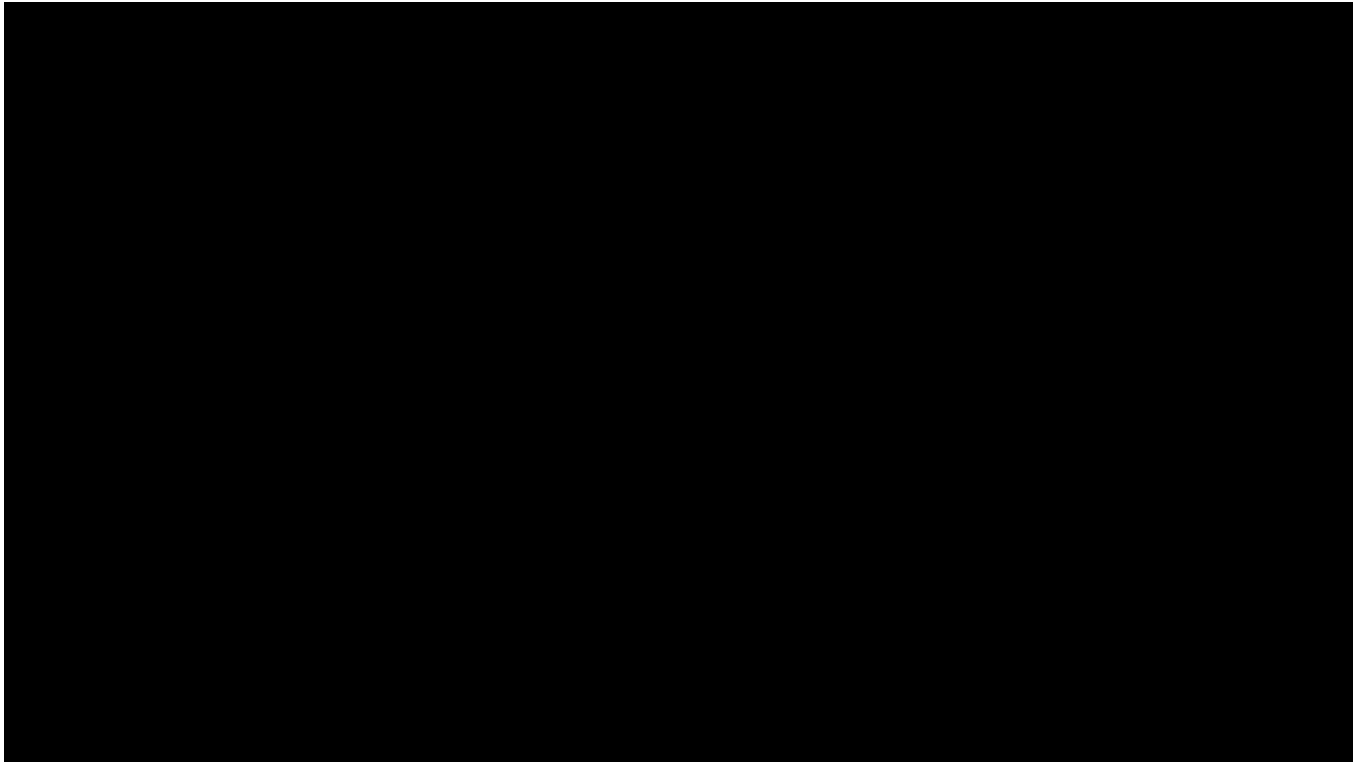
λ – wavelength range (visible spectrum)
γ – scaling factor
$\lambda_{min} - \lambda_{max}$ minimum and maximum renderisable wavelength frequency

Interaction with virtual object

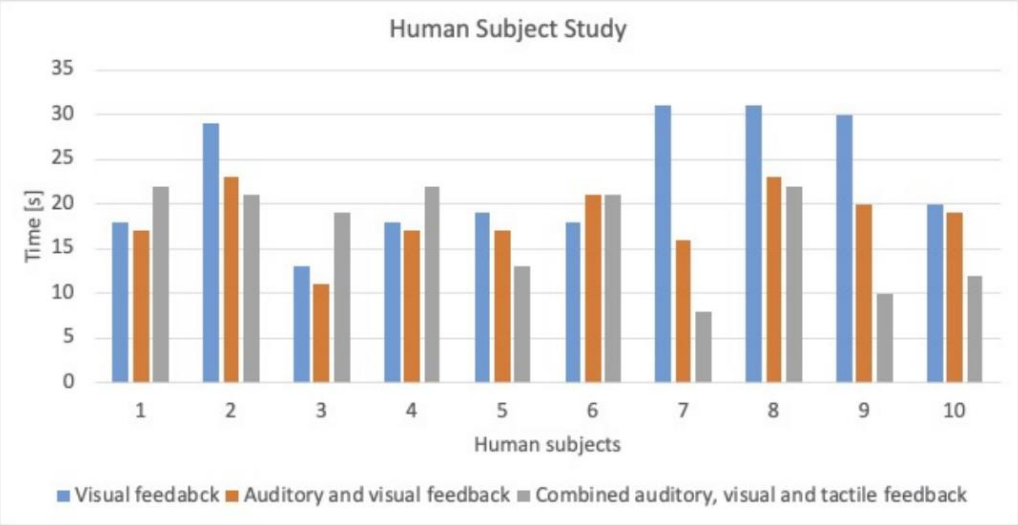
Tactile feedback rendering



Human subject study

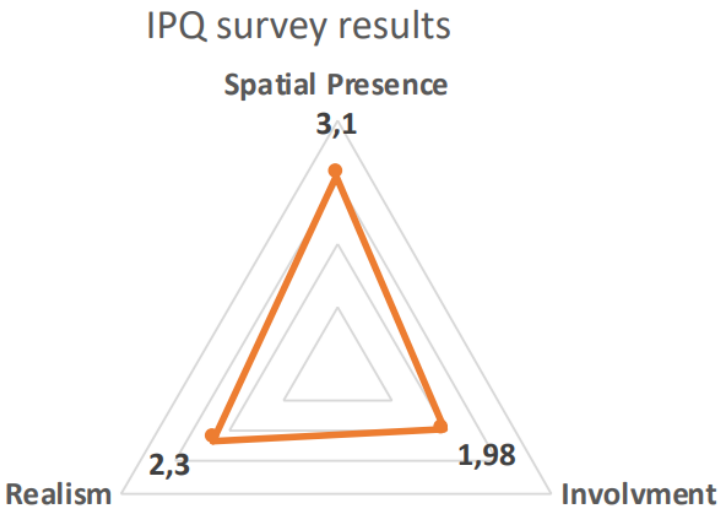


Experimental results



[5] Panahi, S.M., Fathi, A.A., Azad, F.P., Montazer, G.A.: Reliability and validity of igroup presence questionnaire (IPQ) (2009).

Experimental results



[5] Panahi, S.M., Fathi, A.A., Azad, F.P., Montazer, G.A.: Reliability and validity of igroup presence questionnaire (IPQ) (2009).

Conclusions and Future work

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- Merge of virtual reality (VR) tools with a novel wearable haptic device and vibrotactile actuators helped in achieving the immersive learning experience;
- Conducted human subject research helped evaluate the developed framework;
- The framework could be used to develop teaching modules;

Thank you for your attention!

Do you have any questions?

References

1. Sanfilippo, F., Blažauskas, T., Salvietti, G., Ramos, I., Vert, S., Radianti, J., Majchrzak, T.A.: Integrating VR/AR with haptics into STEM education. In: Proc. of the 4th International Conference on Intelligent Technologies and Applications(INTAP 2021). Springer (2021), accepted for publication.
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