



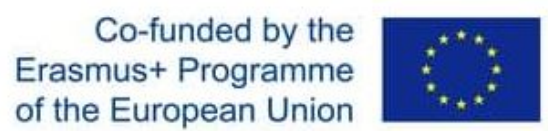
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# A Low-Cost Spectrometry Remote Laboratory

**A. Villazón<sup>1</sup>, O. Ormachea<sup>2</sup>, A. Zenteno<sup>1</sup> and A. Orellana<sup>2</sup>**

<sup>1</sup>*Centro de Investigaciones en Nuevas Tecnologías Informáticas*

<sup>2</sup>*Centro de Investigaciones Ópticas y Energías,  
Universidad Privada Boliviana (UPB), Bolivia*





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## Outline

- Motivation
- Low-cost Smartphone Spectrometer
- Smartphone Spectrometry App
- Low-cost Spectrometry Remote Lab
- Architecture of the Remote Lab
- DEMO
- Conclusions



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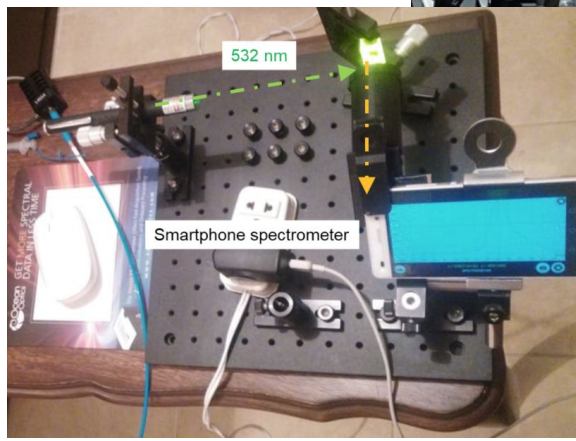
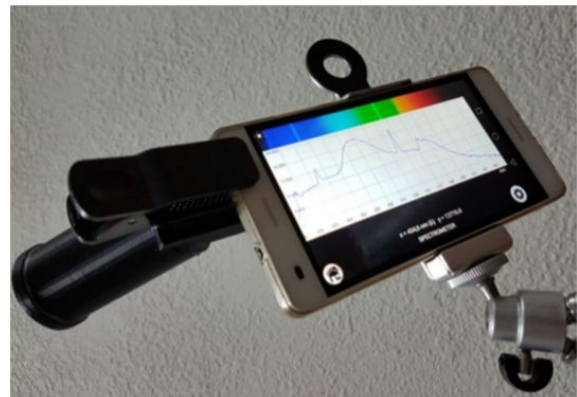
## Motivation

- Drastic drop of experimental activities (labs) in Engineering during the pandemic lockdown
- Students from different cities (3 campuses) following on-line lectures
- Impossibility to distributed lab equipment or material to students
- Find a low-cost solution for spectroscopy experiments



# Low-cost Smartphone Spectrometer

- Our low-cost spectrometry technology [1] was applied to several applications
  - Health: Low-cost ELISA reader and low-cost laser fluorimeter for diagnosis of infectious diseases
  - Industrial: Analysis of Cr(III) in leather liquors
- 3D-printed spectrometer + smartphone + spectrometry software (App)



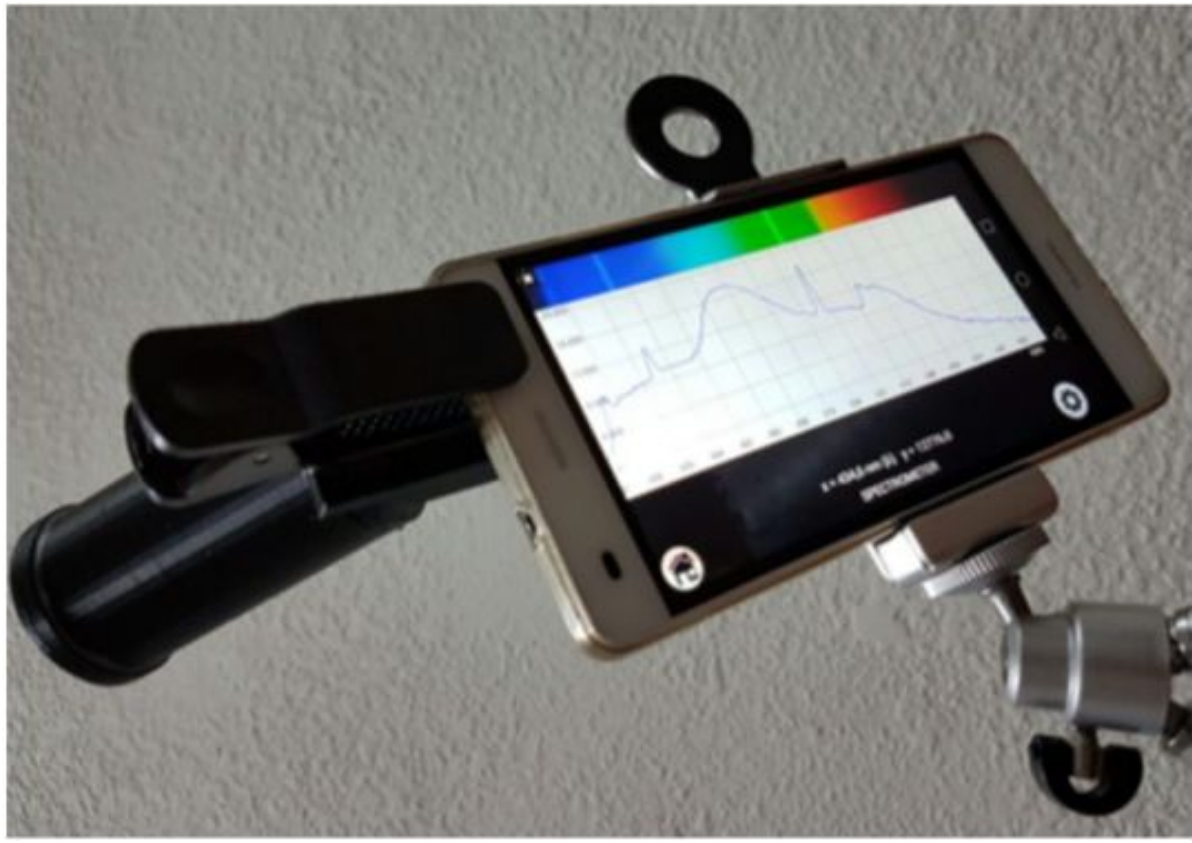
[1] O. Ormachea, A. Villazón, R. Escalera. A Spectrometer based on smartphones and low-cost kit for Transmittance and Absorbance measurements in real-time. Journal Optica Pura y Aplicada Vol 50. No 3, 2017





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# Low-cost Smartphone Spectrometer

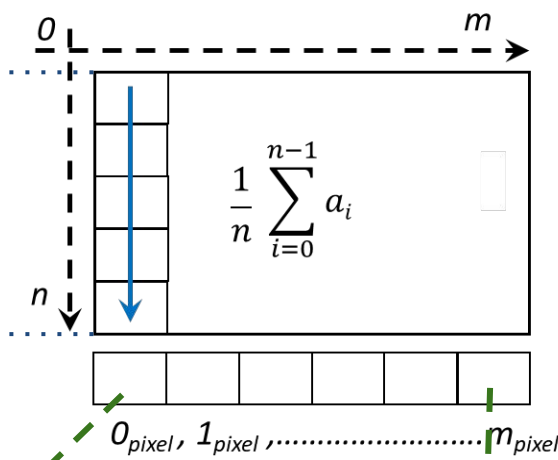


Low-cost spectrometer (~30 USD) + smartphone + software  
    <<  
commercial spectrometer (~3000 USD)



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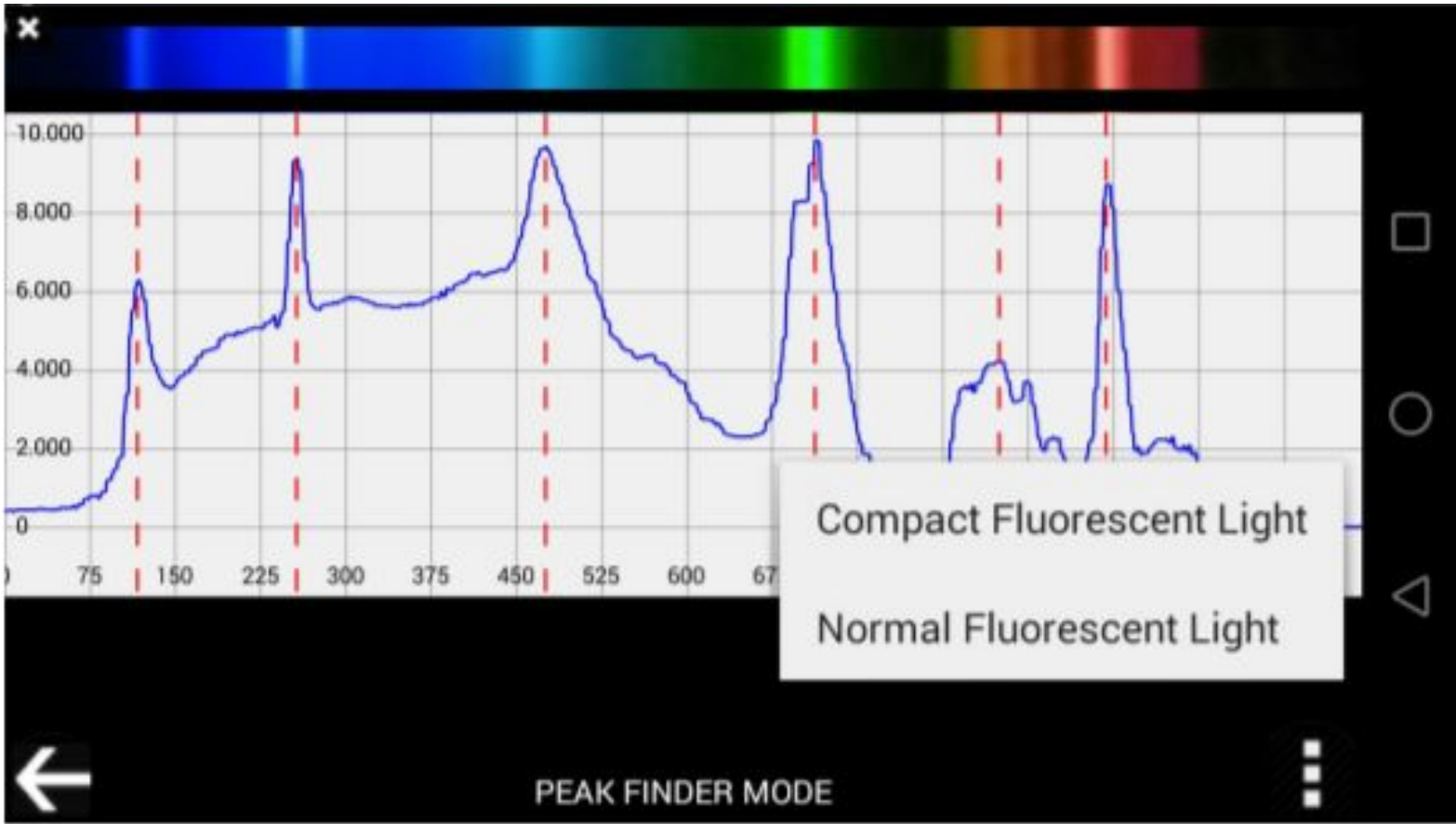
# Smartphone Spectrometry App





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# Smartphone Spectrometry App



**Original calibration: tedious and manual not adapted for a remote lab**



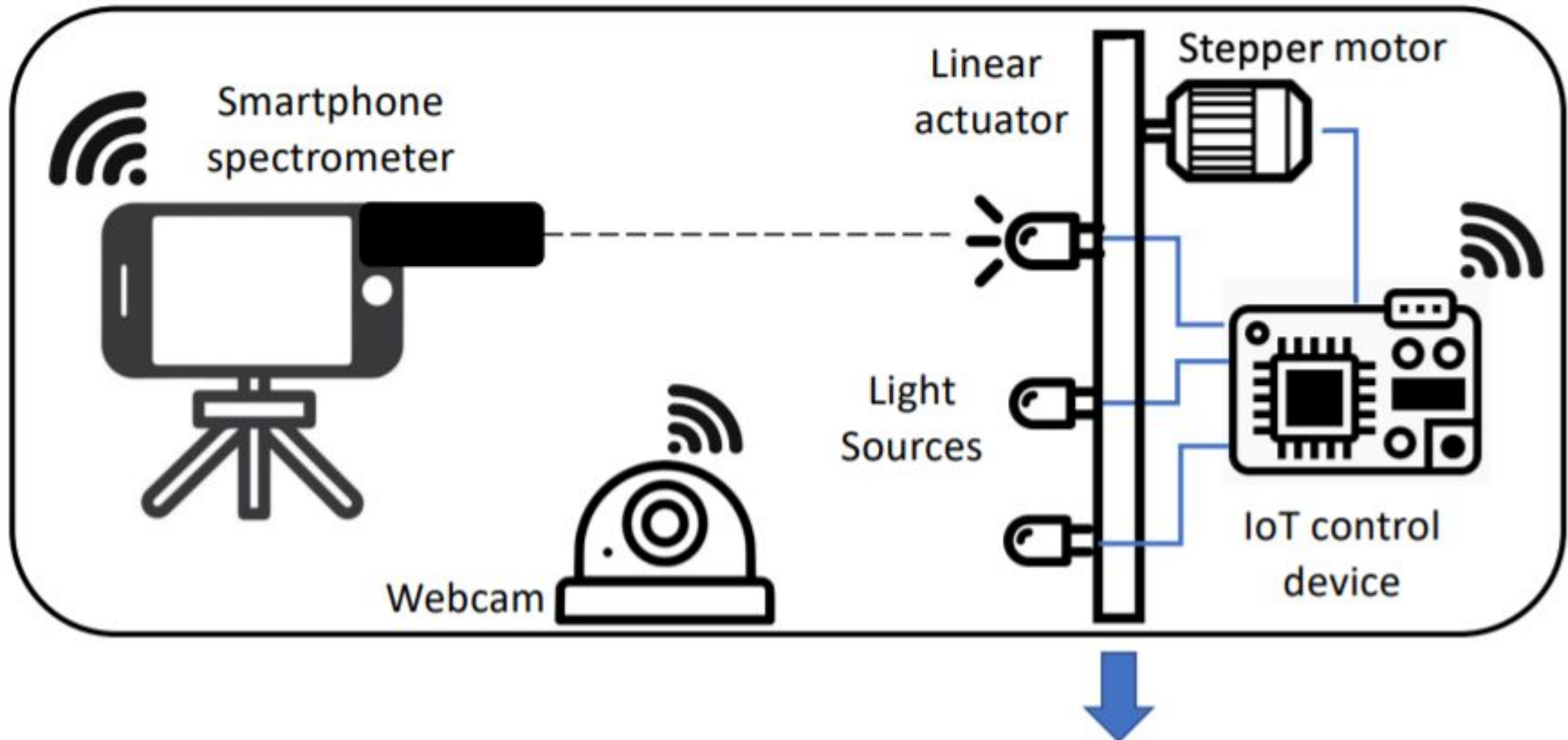
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# Low-cost Spectrometry Remote Lab



## Spectrometry Remote Lab Kit







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# Spectrometry Remote Lab Kit

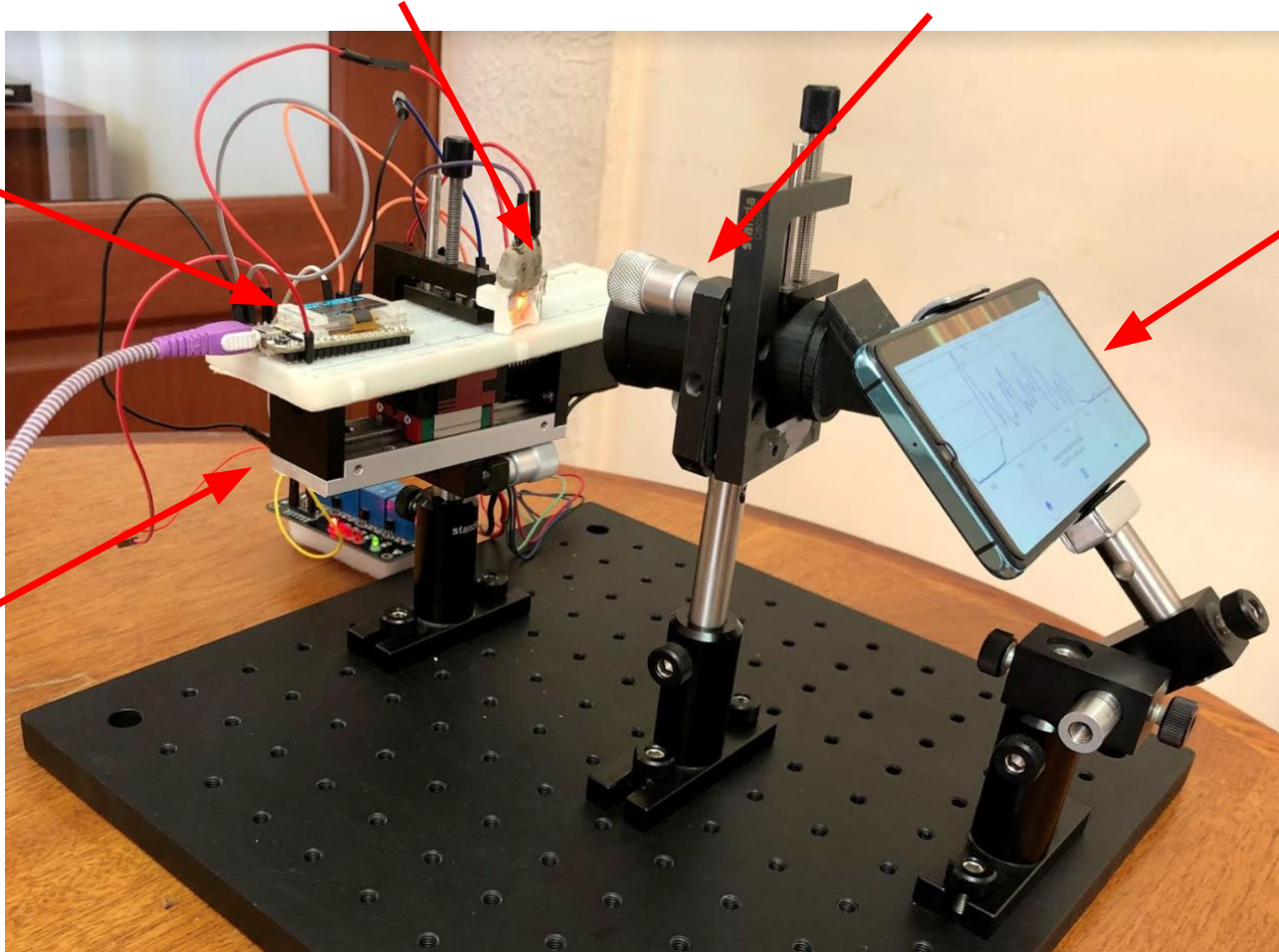
LEDs + Neon light

3D-printed spectrometer

IoT Control (ESP32)

Smartphone

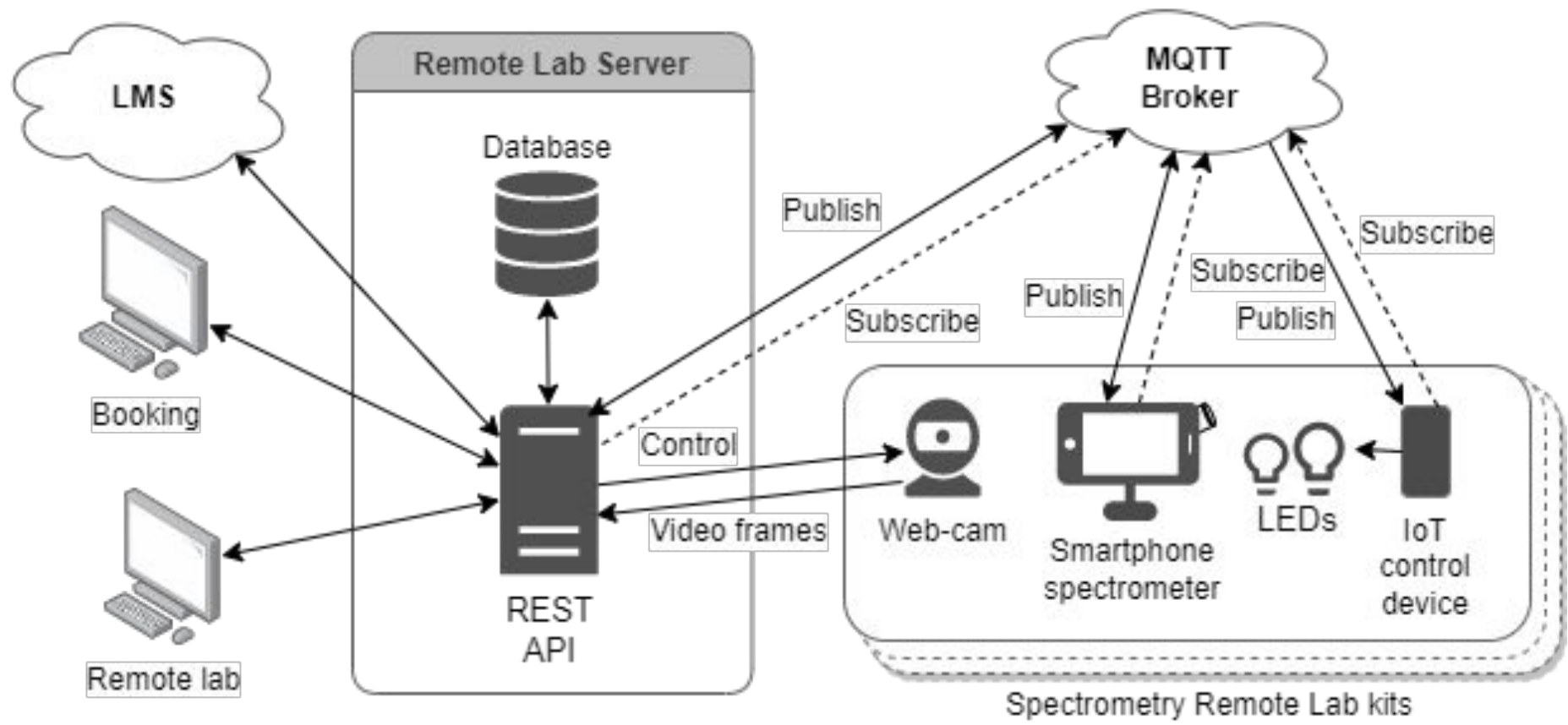
Stepper Motor + Linear Actuator





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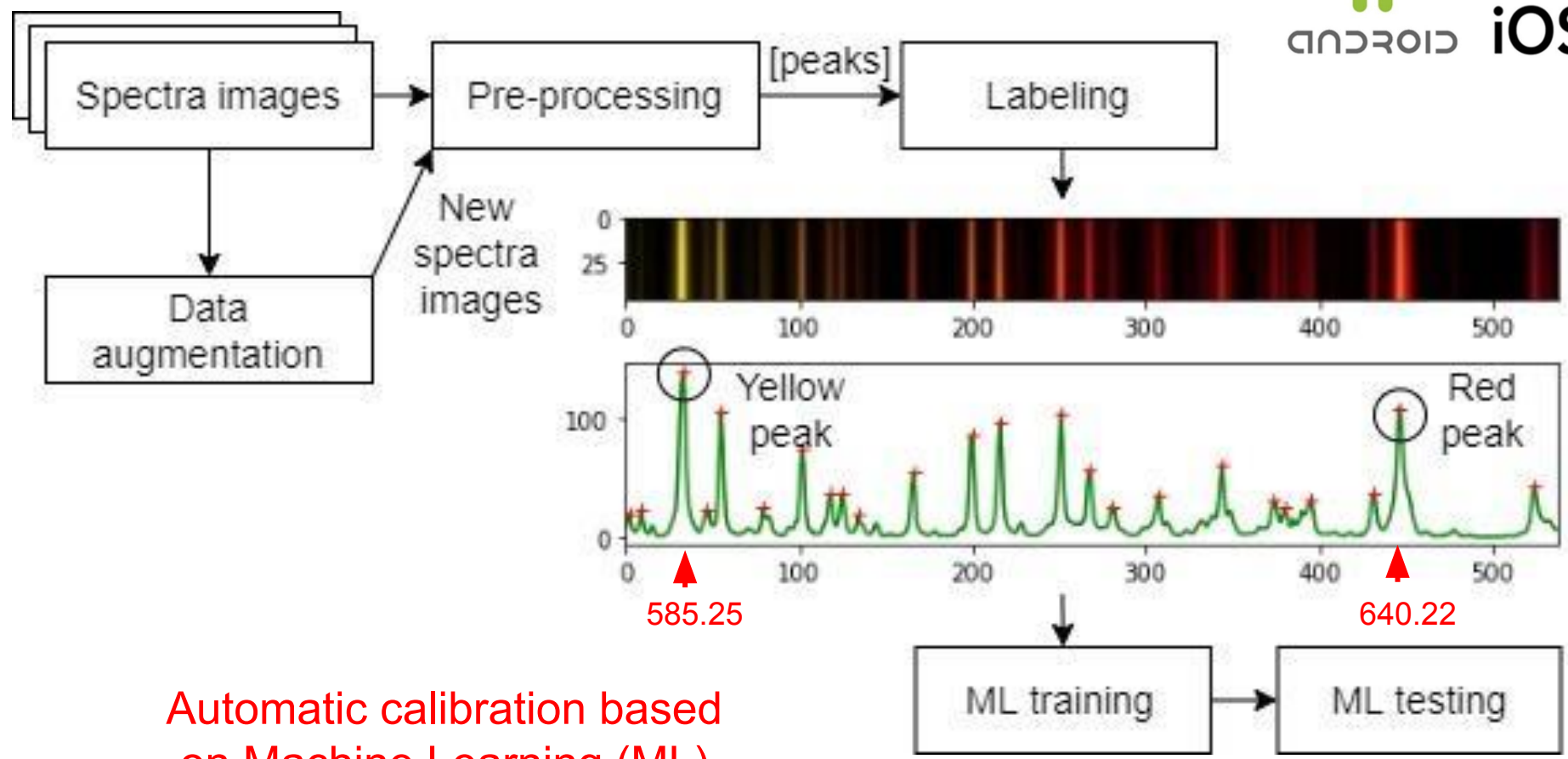
# Architecture of the Remote Lab





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# Smartphone Spectrometry App (New)



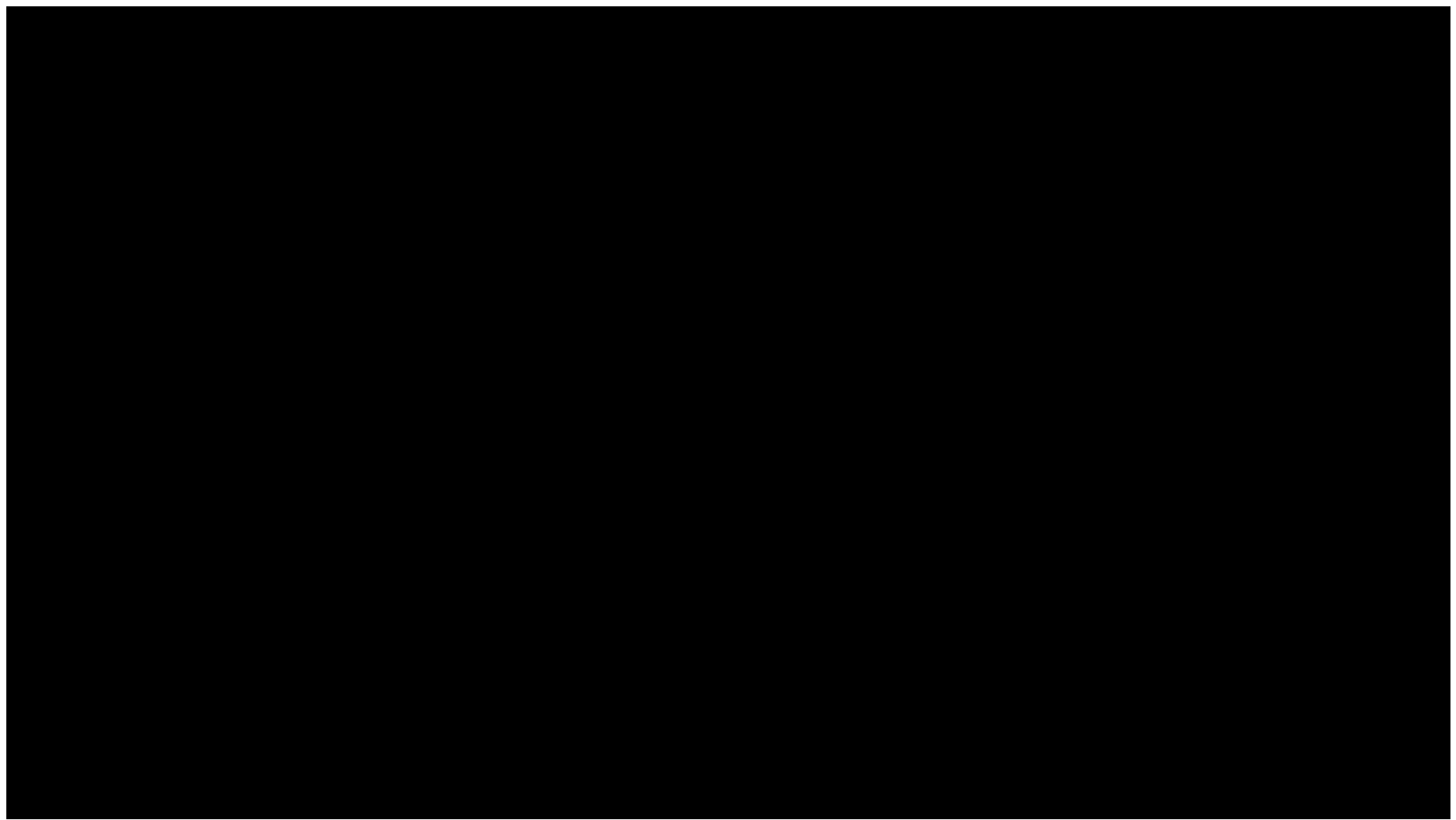
Automatic calibration based on Machine Learning (ML)





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# DEMO





# Conclusions

- Potentiality of low-cost 3D-printed spectrometry technology to rapidly implement a remote lab
- Rapid development thanks to IoT technology for remote controlling and real-time visualization
- Web App + improved App (Android & iOS) with automatic calibration with Machine Learning
- Allow students to perform asynchronous and autonomous spectrometry experiments (24/7) and improve their conceptual learning gains
- “Spectrometry Remote Lab Kits” easy to replicate, can benefit academic and research communities, in particular those in developing countries



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# THANK YOU Q&A