Computer Aided Engineering Education (CAEE) scheme

An approach to on-line practical laboratory work for engineering, science and technology

by

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Outline

- Introduction
  - Engineering education & computer aids
- CAEE
  - Definition
  - Classroom component
  - Practical laboratory component

Computer Aided Engineering Education (CAEE)

INTRODUCTION

Importance of Engineering

- Socio-economic impact
  - Role of Engineers
- Tertiary level education in engineering
  - Teaching & learning 3 objectives
    - Fundamental understanding of how things work
    - Maintain and improve existing things
    - Make new things (innovate)
  - Challenges in engineering depts./schools
    - dwindling in-takes, poor attendance, grades, dropouts due to mis-match in teaching/learning styles.

Learning in Engineering

- Formal learning
  - Learning in a formal setting. E.g classroom always includes practical experience

- Professional learning
  - Learning on the job or needed for the job, mainly through experience

- Informal learning
  - Life long learning, self selected & self paced.

Experiential learning in engineering

- Fundamental Learning styles
  - Auditory, visual and kinesthetic (doing)
    - A picture is worth a thousand words
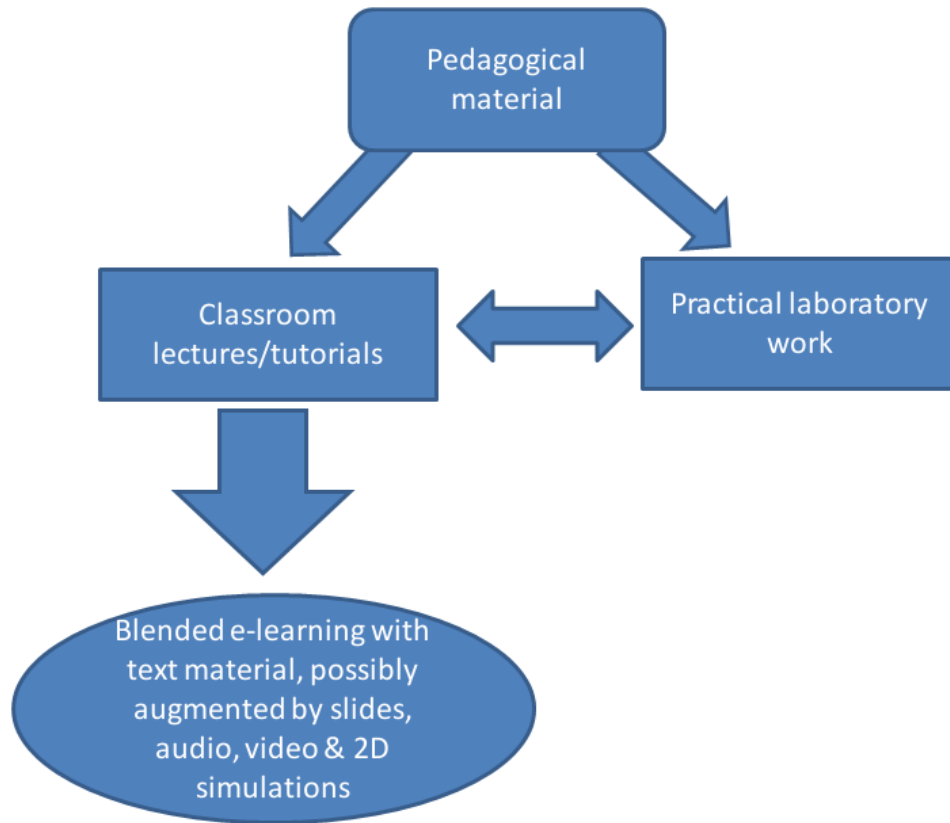   - *Is an action worth a thousand pictures*?
- Experiential learning
  - Action based
  - Remembering from doing..
  - Easier to associate concepts with physical

COMPUTER AIDED ENGINEERING EDUCATION (CAEE)

State of E-learning platforms in Science, Technology & Engineering

Pedagogical material

Classroom lectures/tutorials

Practical laboratory work

Blended e-learning with text material, possibly augmented by slides, audio, video & 2D simulations

– Computer aids
  - Electronic mail, Computer based electronic learning platforms, INTERNET & on-line resources

– Education of Engineers
  - Pedagogy has strong component of practical training (hands-on, group work in supervised environment). *Difficult to satisfied with normal e-learning platforms*

CAEE Definition

- The use of computer based tools to assist in solving challenges in the education of engineers

- The use of Information Technology (IT) to support the education of engineers.

- Examples
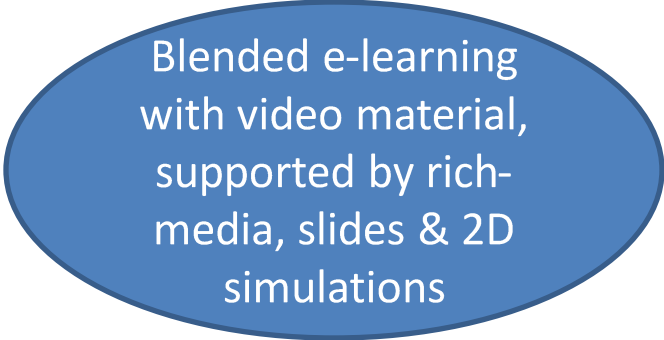 - Computers

Overview of CAEE scheme
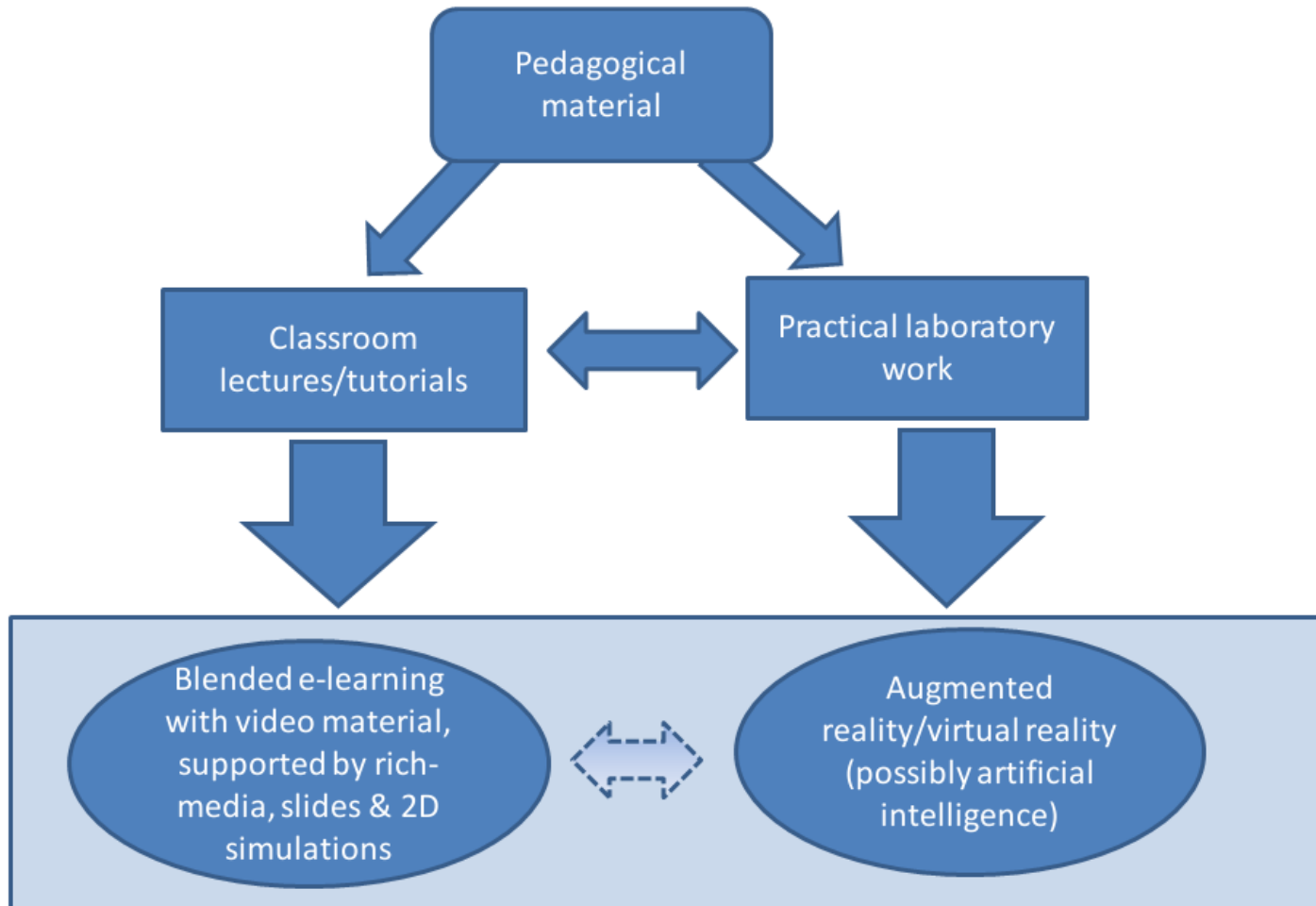
CAEE scheme

- **Component for classroom**
  - Blended e-learning with video based material supported by e-books, slides & simulations
- **Component for practical laboratory work**
  - Augmented reality/virtual reality tools for off-line or on-line use.
    - Useable on mobile platforms and
    - Interactivity is based on semi-immersive virtual reality.
      - *In augmented reality, video of real world (from camera) is combined with computer generated information to create the semi-immersive virtual environment*

CAEE

CLASSROOM COMPONENT

CAEE Classroom component

Blended e-learning with video material, supported by rich-media, slides & 2D simulations

- Capture and translate classroom experience on-line or digitally

- Blended collaborative e-learning platform
  - Emphasis on video based platforms
  - Other media types are supplementary.
  - Portable and versatile

CAEE

PRACTICAL LABORATORY COMPONENT

Objectives

- Capture and translate practical laboratory experience on-line or digitally
  - Minimize transformations
    - Replicate step-by-step procedures of existing experimental procedures
  - Maintain a high level of experience

Technological base

- Virtual reality
  - Computer generated environment.
  - 3D visualization
    - Non-immersive
      - Computer desktop
    - Semi-immersive
      - Flight simulator (large screen)
    - Fully immersive
      - 3D glasses or caves (rooms)

- Augmented reality
  - Layers (combining) different types of media
    - Location services: real-time location information from GPS
    - Live video feed: e.g from camera/webcam or picture from camera
    - Computer generated information such as text-boxs/pop-ups.

Smart-phones as instruments

- Interface sensors
  - Multiple touch with pitch/pan on touchscreen
  - Gyroscope & accelerometer
- Realistic graphics
  - Real time shadows

- Low cost devices
  - Mobiles devices or tablets
    - < 100 USD tablets

- Could be deployed for stand-alone or on-line experiments

CAEE Laboratory component

Innovations

- Interactive
  - Replicates experimental step-by-step procedures, including output of experiment
- Off-line use
  - Low cost mock-up
- Multi-use
  - Smart interactive manual
  - Validation of practical setup

Technical details

- Mobile Augmented Reality
  - Tablets + smart-phones with video camera
  - Low cost marker (location tracking)
- Interactive
  - Touch-screen
  - Pitch/pan
- Low cost
  - Android platform
  - Normal photograph of laboratory apparatus

SUMMARY AND CONCLUSION

Summary

- The CAEE scheme is about the design, development and implementation of a new approach that addresses challenges in education of engineers through computer based aids that emphasize the interactive use of modern technology.

    – The CAEE scheme is also applicable to other areas such as science and technology.
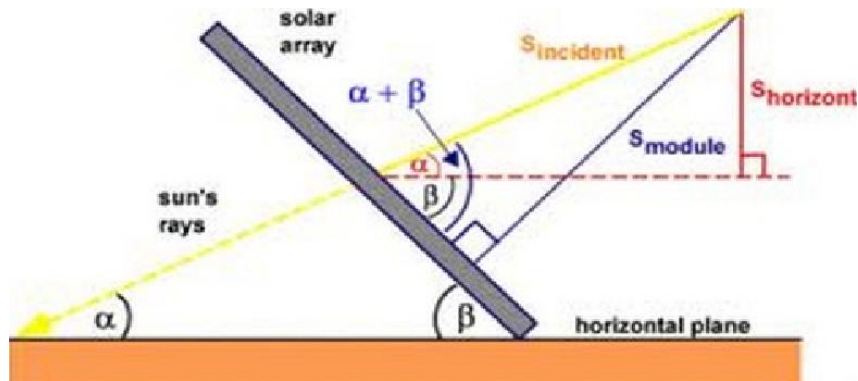
DEMO OF CAEE LABORATORY COMPONENT

Low cost off-line/on-line implementation of an existing hands-on laboratory experiment in electronic engineering
for Dr. M. Zennaro, ICTP's T/ICT4D Laboratory

- Single PCB board used to teach wireless sensors.
- The AR software acts as
  - Smart interactive manual: touching a component calls up information
  - Replicate a full experiment: Simulate Step-by-step, showing connections & expected output
  - Works with photo of board or board.
- Android APK available from

  http://users.ictp.it/~onime/APK/Seeeduino/
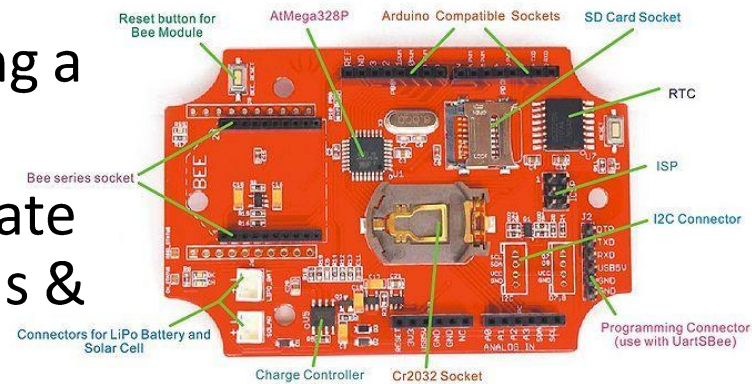
An augmented virtuality based solar energy calculator for electrical engineering for Prof. E. Pietrosemoli, ICTP's T/ICT4D Laboratory

solar array
$S_{incident}$
$\alpha + \beta$
$S_{horizont}$
α
S_{module}
β
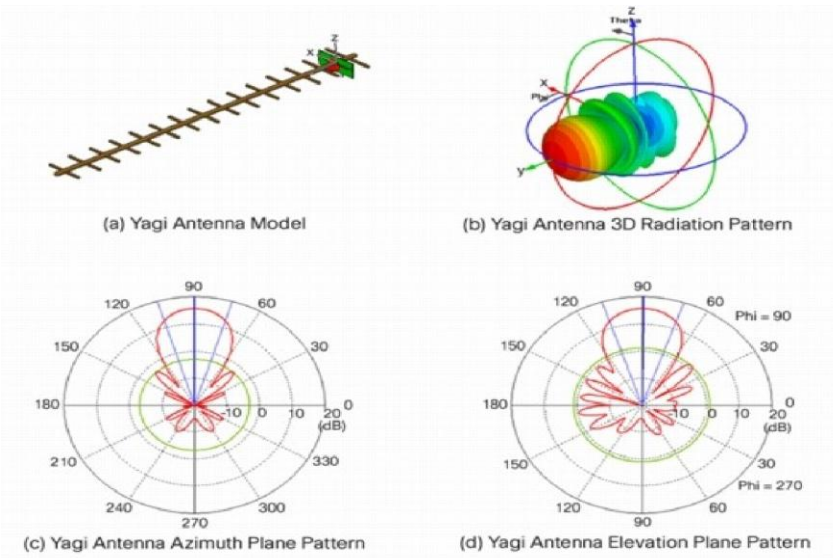sun's rays
α
β
horizontal plane

- AR app will use data from INTERNET databases (EU or NASA) or a heat MAP (off-line)
  – Estimates the theoretical output potential of solar panels using GPS location information and time.
  – Can show the influence of angular orientation.

Android APK download from
http://users.ictp.it/~onime/APK/SolarEnergy/

Enhancing learner perception and understanding of antennae in Communications Engineering practical laboratory experiments for Prof. E. Pietrosemoli & Dr. M. Zennaro, ICTP's T/ICT4D Laboratory

(a) Yagi Antenna Model

(b) Yagi Antenna 3D Radiation Pattern

(c) Yagi Antenna Azimuth Plane Pattern

(d) Yagi Antenna Elevation Plane Pattern

- Antenna radiation patterns better visualized in 3D
- AR app is
  - a companion tool to teaching three different antenna types.
  - Could use several QR codes on real antenna.

Android APK download from
http://users.ictp.it/~onime/APK/Antenna/

Thank you