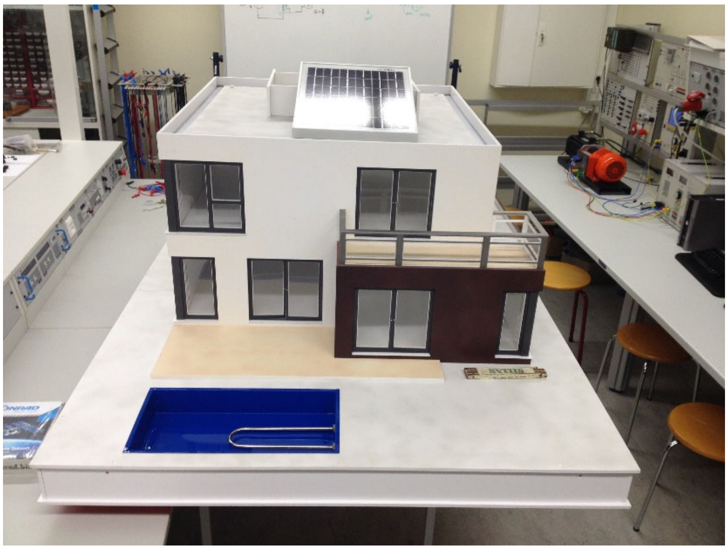
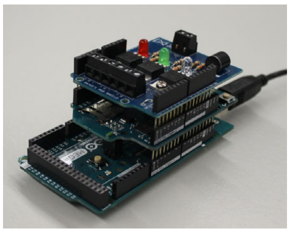
international smart home project

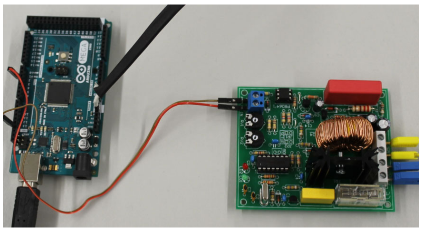
– practical part

Course Syllabus



smart home model scale 1:10





Mixed groups of American and German students are working on several topics around a smart home model of a real house. Several tasks can be controlled and monitored by a smart-phone.

Time and Location

This international German-American smart home project will take place from March until September 2020. Time details are listed below and in the 2020 schedule. The syllabus is adjusted to reflect special circumstances related to the international experience. The tabular schedule is a guideline; we will try to follow it closely, but be prepared to adjust to changes in pace dictated by our collective experience.

Timeline 2020:

March until July	assigning of German and American students to the sub-projects
	selfstudy and long distance groupwork
	Contact between students via Adobe Connect, Skype etc.
	Literature research, preparation for sub-projects through self-study
July/August	six weeks in Germany - practical work after basic classes
	Monday July 6th 2020 – Friday August 16th 2020
	at Jade University of Applied Sciences in Wilhelmshaven
August/September	two weeks long distance groupwork, documentation
September	last week final project work at TTU
	final presentation of the project results at TTU

Instructors

Josef Timmerberg, Prof. Dr., Jade Hochschule, Wilhelmshaven, Germany
Phone: 0049-4421-985-2372 (The 0049 is Germany Country Code)
E-Mail: jt@jade-hs.de
Web: https://www.jade-hs.de/team-info/suche/?user=5243

Folker Renken (FR), Prof. Dr., Jade Hochschule, Wilhelmshaven, Germany
Phone: 0049-4421-985-2265 (The 0049 is Germany Country Code)
E-Mail: folker.renken@jade-hs.de
Web: https://www.jade-hs.de/team-info/suche/?user=6214

Paul Beckmann (PB), Dipl.-Ing. Jade Hochschule, Wilhelmshaven, Germany
Phone: 0049-4421-985-2321 (The 0049 is Germany Country Code)
E-Mail: pb@jade-hs.de
Web: https://www.jade-hs.de/team-info/suche/?user=5244

TBA, B.Eng. Jade Hochschule, Wilhelmshaven, Germany
Phone: 0049-4421-985-xxxx (The 0049 is Germany Country Code)
E-Mail:
Web:

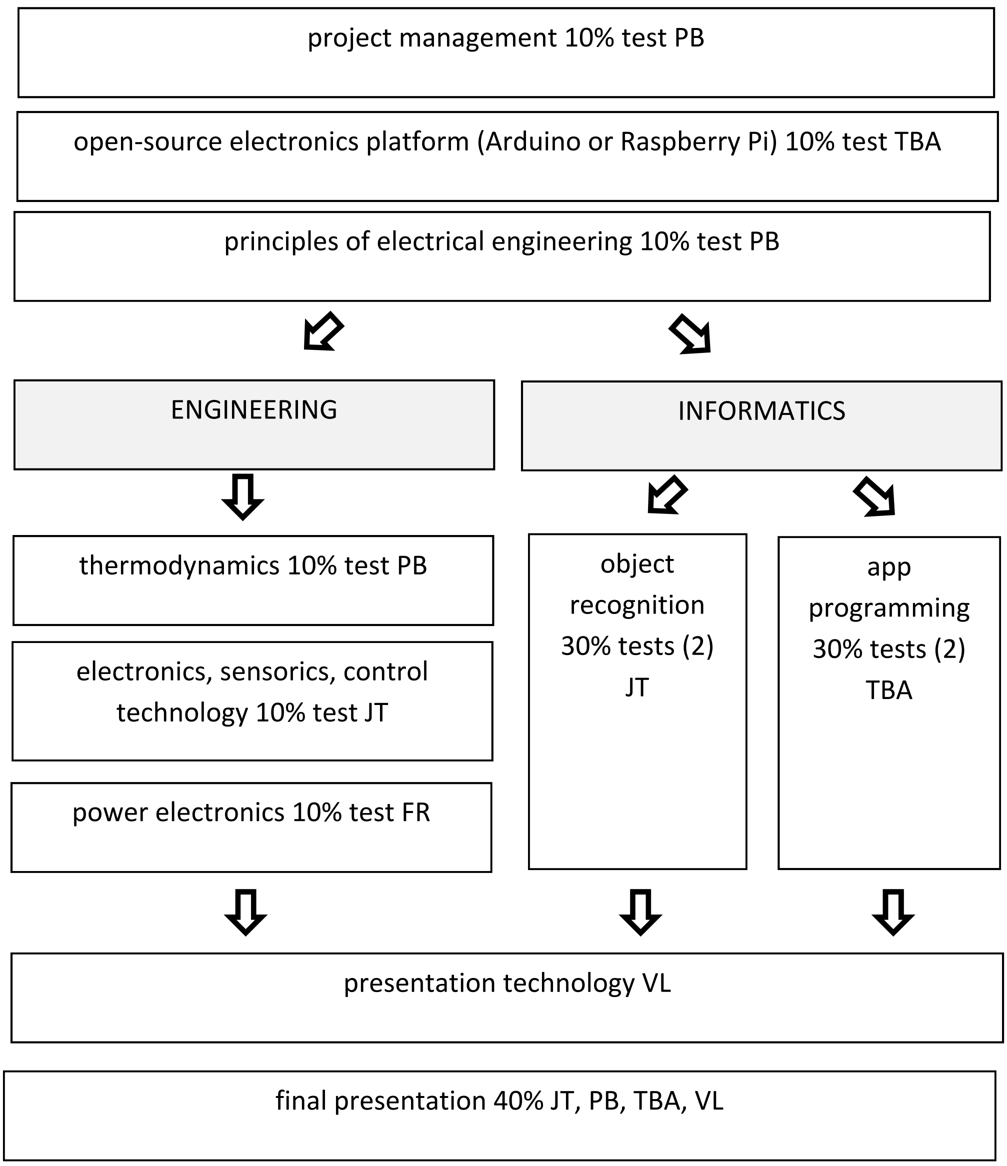
Office Hours

We can meet after each class or lab for questions or on appointment.

The international smart home project consists of two parts:

- **smart home project - theoretical part**
- **smart home project - practical part**

Content of the smart home project - theoretical part



Content of the smart home project – practical part

Sub-projects, student chooses one out of five:

A: **heating pool**

prerequisite:
smart home project - theoretical part - branch ENGINEERING

B: **app development**

prerequisite:
smart home project - theoretical part - branch INFORMATICS

C: **elevator**

prerequisite:
smart home project - theoretical part - branch ENGINEERING

D: **photovoltaics**

prerequisite:
smart home project - theoretical part - branch ENGINEERING

E: **optical movement and shape recognition**

prerequisite:
smart home project - theoretical part - branch INFORMATICS

This syllabus is for the **international smart home project - practical part!**

Catalog Description and Prerequisites

American and German students will participate in an international project. Mixed student groups are working together in a laboratory. The Student will work on his assigned sub-project.

Prerequisites: Classes of the related international smart home project - practical part.

Possible sub projects (student chooses one out of five A - E):

A: heating pool

prerequisite: smart home project - theoretical part - branch ENGINEERING

description:

Supervisors

Paul Beckmann, Josef Timmerberg

Detailed description of the topic

The basis of the ISRP is to automate a two-story flat roof residential building on a scale of 1:10. The automation task is split into subprojects. Group A's job is to control the water temperature in the outdoor pool. Different power controllers and controller strategies are to be tested. For state-of-the-art controls, operation should also be possible via mobile phone.

Previous preparation in USA and D (Literature you can get in Moodle)

- Manfred Schleicher, Frank Blasinger; Control Engineering, A guide for beginners
- Prof. Pohl, Reglerentwurf, FH Bochum
- Control Engineering; http://www.allaboutcircuits.com/technical-articles/an-introduction-to-control-systems-designing-a-pid-controller-using-matlabs/
- Power Electronics Handbook, Muhammad H. Rashid; http://educypedia.karadimov.info/library/HB206-D.PDF

Plan of procedures

<table>
<tr><th>subgroup 1 (2 students)</th><th>subgroup 2 (2 students)</th></tr>
<tr><td>• measure the step function response of the control process (without the module of subgroup 2)
• build the mathematical model from the step function response
• simulate (Scilab, Xcos) the control process with the mathematical model</td><td>• analyse an existing phase controlled modulator for the pool heating
• simulate the circuit with LT-Spice
• test the existing hardware
• analyse an pulse packet controller for the pool heating
• simulate the circuit with LT-Spice
• test the existing hardware</td></tr>
<tr><td colspan="2">• control unit design (with the math. model and the frequency response characteristic)
• simulation of the overall system</td></tr>
<tr><td colspan="2">• programming the controller with Arduino</td></tr>
<tr><td colspan="2">• measure the step function response of the overall system and make the presentation and a movie</td></tr>
<tr><td colspan="2">• create the mathematical model with physical knowledge and compare it with that of measurement</td></tr>
</table>

• calculate the frequency response characteristic from the step function response • simulate (Scilab, Xcos) the control process with the mathematical model and the frequency response characteristic • create the presentation and documentation and make a movie

Hardware needed
After the introductory lessons in project overview and project management, the students should work out which hardware extensions such as sensors or actuators or … they additionally need.

Software needed
In the same way as with the hardware extensions, they should work out whether and, if so, which additional software tools have to be procured.

Examinations and Presentations
Each group will have an internal, non-graded final presentation in Wilhelmshaven together with a person who will be the assistance in Wilhelmshaven during the presentations in Lubbock.

During the second distance learning time, Students are requested to finish their report and prepare the final presentation (both graded).

B: app development

prerequisite: smart home project - theoretical part - branch INFORMATICS

description:

Supervisors
Jan Dierks, Josef Timmerberg

Detailed description of the topic
The basis of the ISRP is to automate a two-story flat roof residential building on a scale of 1:10. The automation task is split into subprojects. Group B's job is to combine all values gathered by other groups via MQTT in an Unity Application. This Application should also be capable of sending values to other groups.

Previous preparation in USA and D (Literature you can get in Moodle)
- Unity Beginner Tutorial (Sections 1 and 2): https://unity3d.com/learn/beginner-tutorials
- Unity Tutorial on User Interfaces: https://unity3d.com/learn/tutorials/s/user-interface-ui
- Unity Tutorials on Scripting: https://unity3d.com/learn/tutorials/s/scripting
- MQTT: https://www.hivemq.com/mqtt-essentials/

Plan of procedures

• Draw a possible interface consisting of User Interface components (2D) • Develop possible scenes, keep them as generic as possible • Research a suitable MQTT Library	
subgroup 1	**subgroup 2**
• Build interface for 2 other groups (Elevator and Object Detection / Movement) • ask them for possible in- and outputs • Add word recognition	• Build interface for 2 other groups (Pool Heating and Photovoltaic) • ask them for possible in- and outputs • Build an interface which is able to display developments over time

• split source code in reusable functions • document source code • document use cases and program in one (or more) Flowcharts • create the presentation and documentation and make a movie

Hardware needed

There is no special hardware needed.

Software needed

This Group needs installed personal (free) versions of Unity.

Examinations and Presentations

Each group will have an internal, non-graded final presentation in Wilhelmshaven together with a person who will be the assistance in Wilhelmshaven during the presentations in Lubbock.

During the second distance learning time, Students are requested to finish their report and prepare the final presentation (both graded).

C: elevator

prerequisite: smart home project - theoretical part - branch ENGINEERING

description:

Supervisors

Paul Beckmann, Jan Dierks

Detailed description of the topic

The basis of the ISRP is to automate a two-story flat roof residential building on a scale of 1:10. The automation task is split into subprojects. Group C's job is to control the external elevator attached to the house.

Previous preparation in USA and D (Literature you can get in Moodle)

- How stepper motors and drivers work
- Study possible types of sensors for floor detection and emergency stop
- MQTT: https://www.hivemq.com/mqtt-essentials/

Plan of procedures

• Research on different elevator dispatch mechanism • Summarize possible sequences
• Control the motor using an Arduino • Use Sensors to locate the elevator • Add security features • Broadcast values via MQTT • Add buttons and displays
• document source code • document use cases and program in one (or more) Flowcharts • create the presentation and documentation and make a movie

Hardware needed
The elevator is moved by a nema17 motor, which needs a driver board and an Arduino to control it. Students have to decide, which sensors are suitable and how security mechanism can be implemented.

Software needed
This Group needs Android IDE.

Examinations and Presentations
Each group will have an internal, non-graded final presentation in Wilhelmshaven together with a person who will be the assistance in Wilhelmshaven during the presentations in Lubbock.

During the second distance learning time, Students are requested to finish their report and prepare the final presentation (both graded).

D: photovoltaics

prerequisite: smart home project - theoretical part - branch ENGINEERING

description:

Supervisors
Josef Timmerberg, Paul Beckmann

Detailed description of the topic
The basis of the ISRP is to automate a two-story flat roof residential building on a scale of 1:10. The automation task is split into subprojects. Group D's job is to supply the house with renewable energy by a PV system. The renewable energy system should consist of the solar module, an accumulator and a controller, which also contains an mpp-tracker. For state-of-the-art controls, operation should also be possible via mobile phone.

Previous preparation in USA and D
- Wiki: https://en.wikipedia.org/wiki/Maximum_power_point_tracking
- https://forum.allaboutcircuits.com/threads/12v-battery-solar-charger.45814/page-2
- https://de.wikipedia.org/wiki/Maximum_Power_Point_Tracking
- https://de.wikipedia.org/wiki/Photovoltaikanlage
- https://de.wikipedia.org/wiki/Solarmodul

Plan of procedures

• plan the energy supply of the house model – energy independent / grid independent • create an energy supply with "normal" components: PV panel, battery, .. • measure the characteristic curves I(U) and P(U) of the PV panels • dimension the battery • create a concept of a mpp-controller	
subgroup 1	**subgroup 2**
• analyse the existing control hardware and the existing mpp tracker with LT-Spice and test it	• develop the software for the Arduino • test the software with the simulation of the PV-panel
• join the hardware and the software • test the whole system, draw characteristic curves • create the presentation and documentation and make a movie	

Hardware needed
After the introductory lessons in project overview and project management, the students should work out which hardware extensions such as sensors or actuators or … they additionally need.

Software needed
In the same way as with the hardware extensions, they should work out whether and, if so, which additional software tools have to be procured.

Examinations and Presentations
Each group will have an internal, non-graded final presentation in Wilhelmshaven together with a person who will be the assistance in Wilhelmshaven during the presentations in Lubbock.

During the second distance learning time, Students are requested to finish their report and prepare the final presentation (both graded).

E: optical movement and shape recognition

prerequisite: smart home project - theoretical part - branch INFORMATICS

description:

Supervisors
Josef Timmerberg, Jan Dierks, Lingyu Qiu

Detailed description of the topic
The basis of the ISRP is to automate a two-story flat roof residential building on a scale of 1:10. The Optical task is split into subprojects. Group E1's job is to signal, if any person or animal is in the garden or at the entry door, if nobody is at home. Group E2's job is to signal, if a special car as ambulance or fire truck enters the estate of the house. For state-of-the-art controls, operation should also be possible via mobile phone.

Previous preparation in USA and D (Literature you can get in Moodle)

- ((Literature list is missing, will be submitted later))

Plan of procedures

<table>
<tr><td colspan="2">• configure a Raspberry Pi 3 including a camera
• getting started with Python
• analyse the data from of camera (picture format, compression, origin, …)
• adjust the resolution by your own procedure and find the optimal value
• practise image processing: colour reduction to grey/b-w
• practise image processing: rotate, translate, mirror, scale, edge detection (if time)
• handle the effect of changing the intensity of illumination - offset reduction
• if necessary: filter methods</td></tr>
<tr><td>subgroup 1 (2..3 students)
Optical Movement Recognition</td><td>subgroup 2 (2..3tudents)
Optical Shape Recognition</td></tr>
<tr><td>• empirical approach
• correlation approach
• difference method</td><td>• practise picture segmentation = thresholding
• edge and corner detection such as Canny Edge Detection, Moravec’s Corner Detector</td></tr>
</table>

	• AND/OR edge and corner detection such as Sobel Edge Detection, Harris Corner Detector • Hough-Transformation for a straight line
• compare and discuss your results of both groups • document used methods and program • create the presentation and documentation and make a movie	

Hardware needed

After the introductory lessons in project overview and project management, the students should work out which hardware extensions such as sensors or actuators or … they additionally need.

Software needed

In the same way as with the hardware extensions, they should work out whether and, if so, which additional software tools have to be procured.

Examinations and Presentations

Each group will have an internal, non-graded final presentation in Wilhelmshaven together with a person who will be the assistance in Wilhelmshaven during the presentations in Lubbock.

During the second distance learning time, Students are requested to finish their report and prepare the final presentation (both graded).

Textbooks

Lessons In Electric Circuits, Volume III – Semiconductors; Tony R. Kuphaldt; Fifth Edition, last update March 29, 2009

Control Engineering – A guide for beginners; Manfred Schleicher, Frank Blasinger (free)

Machine to Machine - Protocols:

AMQP: https://www.youtube.com/watch?v=ODpeIdUdClc

MQTT: https://www.youtube.com/watch?v=EH3GOzKvdZw

Arduino / C Programming:

https://playground.arduino.cc/uploads/Main/arduino_notebook_v1-1.pdf

Purpose

In this project, students can apply their theoretical knowledge acquired in their previous studies. With this and some new theory they realize a sub-project of a smart home project. They work together in small groups of American and German students. The solution is a functional device and/or software.

Objectives - learning outcomes

After that project part students should be able to:

- work in international groups of different cultures.
- do literature research on a previously unknown subject.
- communicate over a long distance via multimedia.
- apply their previous knowledge and new features to a **practical** result.
- realize a project with concept phase, executing phase and presentation.
- do first project management.
- have first experience in programming smart phones and single board computers.
- write a project documentation.
- present their results in front of an audience

Course Schedule

Look at separate schedule of the project!

Assessment Instruments

- project meeting 2 times a week
- vocal presentation of project status
- documentation
- final functional presentation at TTU.

Grading Policy

Final grade is determined based on vocal presentation of project status and the final functional presentation. Letter grades will be assigned using University standards. The approximate weighting of graded material in determining the final grade is as follows:

Item	**Percent of Grade**
vocal presentation	30 %
documentation	30 %
final presentation	40 %

Grades will be provided latest 2 weeks after the end of the project.

Academic Misconduct

Cheating, plagiarism and academic dishonesty will not be tolerated.

Disability Policy

"Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructors office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office at TTU 335 West Hall or 806- 742-2405.