Biomedical Engineering Project Exchange

Proceedings

Since WS2014

Vol.**2**, Nr. **1**

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FACHHOCHSCHULE TECHNIKUM WIEN

Contents

Scope & Introduction

Within the study programs Biomedical Engineering (Bachelor) and Biomedical Engineering Sciences (Master) a series of courses was established that use elements of project based learning in groups. We see a clear benefit in these formats, as knowledge only generates progress if it is used in practice.

Our experience is remarkable in that many projects exceeded our expectations by far. We saw students show off their results at international conferences, workshops and publish articles in journals. Fresh forces approaching real world challenges generate a strong innovation drive. This has impressed even longstanding veterans from research and industry.

In the past years we spent a lot of effort in the process of finding project topics and then linking them to groups of students in the courses. It then occurred to us that the projects and individuals better speak for themselves. The Project Exchange will therefore enable direct contact between all involved and serve as a platform for connecting external partners, lecturers and students at different stages of their career.

What exactly is the Project Exchange?

The Project Exchange provides information on several levels:

- Which courses are engaging, what are the specific goals, procedures and timelines
- Which results were generated by ongoing and finalized projects
- Which new ideas are *on the market* and open for cooperation

Based on this information we can then discuss and make decisions for our future:

- Choose a topic for your team project
- Assemble a team around your idea
- Know more about the specific area where you want to be an expert in the future

The Project Exchange therefore starts with presentations from existing projects and courses in the study programs. It further highlights new ideas to be elaborated in the future. Finally discussions will take place in small groups on the projects, ideas and teams that are represented.

Biomedical Project Exchange – Program

Venue

Fachhochschule Technikum Wien
Höchstädtplatz 6, 1200 Wien
Lecture room F2.03

Detailed travel instructions are available at
www.technikum-wien.at/en/about_us/locations/map_main_building_/

Date, time, schedule

Friday, 20th February 2015

Time	Topic	Who
8.45	Welcome, setting up	Technikum Wien, lecturers
9.00	Introduction on all of us, on courses and projects.	Technikum Wien, lecturers
9.15	Poster presentations from finalized student projects. Ideas for further work.	Students of BBE, 6th Semester
10.00	Presentations from ongoing work in student projects.	Students of MBE, 2nd Semester
10.40	Presentations of new incoming ideas.	Partner institutions from research and industry, Technikum Wien lecturers
11.10	Project puzzle: People meet projects. Discussion according to individual interests.	Everybody
12.00	Final round, summary.	Technikum Wien lecturers
12.15	Optional lunch at Mia & Masons.	Technikum Mensa, All

Contact

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Dipl.–Ing. (FH) Michael Windisch,
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Mathias Forjan, MSc,
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Benefits

For MBE students and BBE students in the 4th and 5th semester

- MBE students will strengthen their networks to companies and research partners already closely related to Technikum Wien.
- They will make contact to students in other courses and programs. Students may join existing teams. Existing teams will find new talented team members, adding strength to their own projects.
- Receive inspiration and ideas to kick start the individual master's thesis

For students

- Approaching graduation and the job market students will strengthen their networks to companies and research partners already closely related to Technikum Wien.
- Towards their individual bachelors and master's thesis students receive inspiration, contacts and ideas to kick start their work.
- At any time students will make contact to students in other courses and programs. Students may join existing teams. Existing teams will find new talented team members, adding strength to their own projects.
- Students in the early semesters will get a clearer idea where a career in the fields of medical devices and software may lead

For research institutions and companies

- Make contacts to students, lecturers and study programs in the biomedical engineering fields, right in the region of Vienna, close to your
- Learn about windows of opportunity for cooperation. What is underway in the university, where can we expect new developments, . . .
- Provide input to study programs, so that future graduates will be even more productive in your company

Programs and courses involved

Courses from two programs are part of the activity:

- Biomedical Engineering (BBE, Bachelor)
- Biomedical Engineering Sciences (MBE, Master)

Biomedical Engineering (BBE, Bachelor)

Becoming familiar (3rd Semester)

In this semester students decide which specialization they will choose. The BBE program offers four specializations. The Project Exchange covers two of them. Students from the 3rd semester are invited to the Project Exchange in order to get a clear idea of the topics that they might encounter in the future as part of the following courses:

- Introduction to Medical and Hospital Technology
- Introduction to Medical Imaging and Data Engineering

Conducting group projects in the 4th and 5th Semester

In these semesters within the BBE program consecutive group projects take place focusing on two areas:

- Software development: *Medical Data Engineering, Mobile Computing in Medical Imaging and Data Engineering*
- Medical devices: *Biological Signals and Medical Sensors 1, Bioelectrical Signals and Medical Sensors 2*

Biomedical Engineering Sciences (MBE, Master)

Conducting group projects in the 1st and 2nd semester

- *Project-Related Teamwork 1, Project-Related Teamwork 2*, covering topics on both software as well as medical devices

Deadlines & organization details

This event targets to enhance the cooperation on innovative topics in the fields of device and software development for medicine. We want to prepare for the event and capture what has happened. A basic organizational structure will help us to get the most out of the limited time we all have.

Submission of new project topics

Persons who intend to start a new team project submit a one page project outline using the IEEE_Template_PA2_ProjectDescription.doc template available from the organizers.

Deadline: July 2014 to `mathias.forjan@technikum-wien.at`.

Submission of project result extended abstracts

Ongoing and finalized projects submit a 2 page paper using the *IEEE_Template_PA2_GroupPaper.doc* template.

Deadline: announced by lecturers

Submission of project result poster

Ongoing and finalized projects submit a scientific poster using the *Template scientific poster portrait format* available in CIS.

Deadline: announced by lecturers

Proceedings

At the event a proceedings booklet will be available in hardcopy and electronic form.

Organisers

The Project Exchange is brought to you as a cooperation of departments at the University of Applied Sciences Technikum Wien:

Department of Biomedical Engineering

The Department of Biomedical Engineering coordinates the courses in the study programs that are represented in the Project Exchange. These courses also initiated this activity.

Research Focus eHealth

The Research Focus eHealth at UAS Technikum Wien performs research in the field of eHealth, linking information and processes in systems such as the electronic health records (EHR) and telemedicine. Several departments are involved: Information Engineering & Security, Biomedical Engineering as well as Computer Science and Information Systems Management. UAS Technikum Wien has become a significant and renowned source of know-how in this area. The staff is at the forefront, actively managing the further development – both in terms of the subject and the contents – of the topic in Austria and to a certain degree also at the international level.

Contributions

Bachelor Biomedical Engineering

Development of an extendable data aquisitioning unit for the continuous monitoring of multiple sensors within a transportation device for porcine lungs

Tina Nehring, Saba Shirvani, Raphael Siebenhofer, and Stefan Strohmer
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Introduction

The *mobile Circulatory Module(mCM)* provides a means to safely transport freshly harvested porcine lungs from the slaughterhouse to a laboratory for experiments on the respiratory system[1]. During transport, parameters such as temperature, pressure and flow of perfusion solution, etc. must be monitored carefully using several sensors placed throuhout the mCM to ensure that they remain within specified limits.

Materials & Methods

Analog cicuitry for temperature and pressure sensors were first simulated, then tested on breadboards. CadSoft EAGLE® was used to create trace layouts for PCBs which were then populated using manual as well as reflow soldering. After withstanding initial tests, the installed MCUs – TI's MSP430 family microcontrollers – were programmed in accordance with manufacturer-published guidelines for interrupt driven embedded applications[2].

Results

The final system was composed of a main circuit board – the Data Conditioning and Aquisitioning Module(DCAM) – and four separate submodules which would plug onto the DCAM via a common connector.

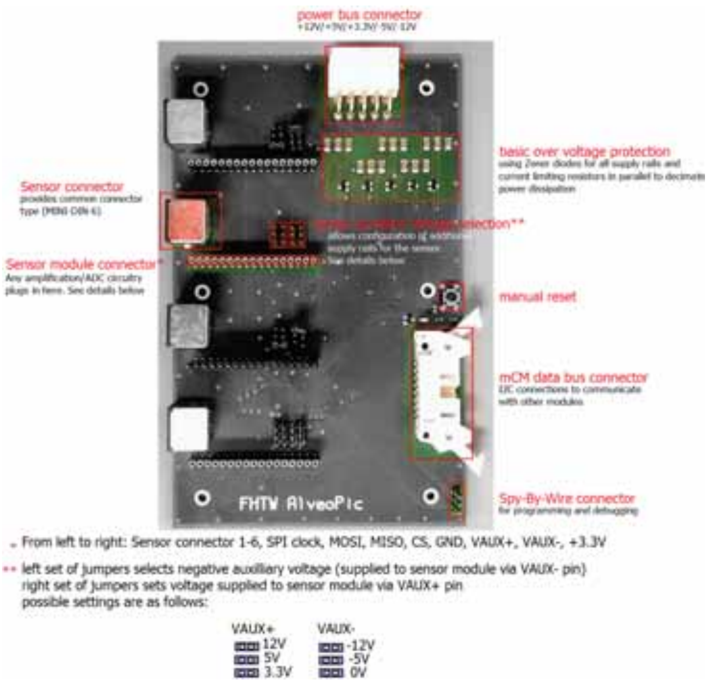

Fig. 1: Photo of the finished PCB. Important connectors and jumpers are highlighted. The PCB design allows stacking of the module with the rest of the mCM

The DCAM would read data from each of the submodules using a specially developed SPI based protocol. This data is then be relayed via I2C to the mCMs main processor for further processing.

Fig. 2: Simplified flow diagram of slave discovery and support for variable SPI clock speed.

The solution allows for simple integration with many different sensors by providing a common electrical interface including configurable supply voltages, flexible SPI data rates, detection of sensor presence and hot-swapping of individual sensor modules.

Discussion & Outlook

Communication with the other modules of the mCM is still pending their respective completion. Other than that, the concepts developed within this project provide a promising base for a generic data aquisitioning device with applications beyond the scope of this particular project.

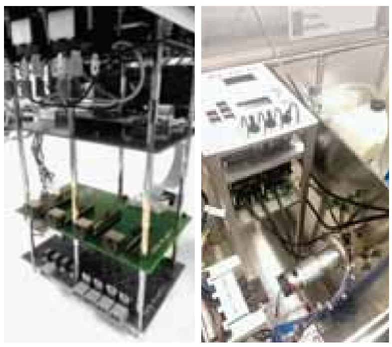

Fig. 3: *Left*: The sensor unit stacked alongside the other mCM modules just on top of the pump and heater driving circuit. *Right*: Mounted inside the mCM with sensors plugged in via Mini-DIN connectors. The pump motor can be seen near the bottom.

References

[1] M. Forjan and M. Frohner, *Development of the mCM – mobile circulatory module – for ex-vivo physiological lung tissue for breathing simulation*, Prague: ALTEX, 2014.
[2] K. Quiring, MSP430 Software Coding Techniques, 2006. [Online]. Available: http://www.ti.com/lit/an/slaa294a/slaa294a.pdf.

INTERACCT
LIS integration and visualization

Jakob Winkler[1], Michael Mörtenhuber[1], Nadine Dorsch[1], Konrad Peters[2] and Stefan Sauermann[1]

[1]University of Applied Sciences Technikum Wien, [2]University of Vienna, Vienna, Austria

Introduction

INTERACCT is a project realizing an eHealth platform improving the treatment compliance for Haemopoetic Stem Cell Transplantation patients at home [1]. Core functionality of this project covers monitoring of recovering patients at home and reacting in situations of need by providing an immediate, online, paperless data exchange between patients at home, laboratory system (LIS) and physicians in hospitals.

The aim of our part of the project is to develop a standardized data exchange (Fig 1) based on medical HL7 2.x messages (Fig 2) between the LIS and the Interacct database. Furthermore a presentation and graphical visualization is part of the scope.

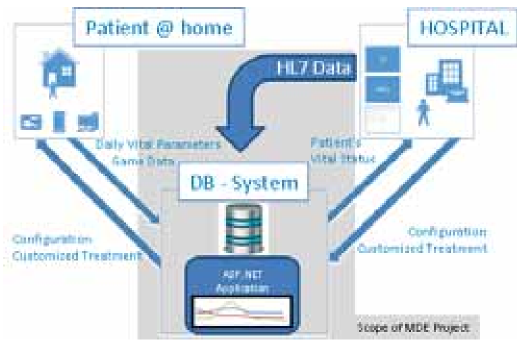

Fig 1: Interacct Data Flow

Materials & Methods

To achieve knowledge guidelines from IHE Laboratory Technical Framework, Volume 2 (LAB TF - 2)[2] as well from HAPI sourceforge were used. NHapi, an open source object model, was used for parsing and encoding HL7 v2.3.1 messages. Visualization was done using ASP.NET.

```
PID|||0123456789||Maier^Hans^^^Titel||Geb.Dat.|Geschl.|||
MSH|^\~&|PG-MLS|ZLABANNA||SZTA|201404132100||ORU^R01||P^A|2.3.1
OBX|1|FT|0|1|HÄMATOLOGISCHE BEFUNDE
OBX|2|NM|126^Leukozyten^ZLAB^LEUKO|1|8.5|G/l|4.50-13.00|~5||AS|F
```

Fig 2: Messages handled by the parsing system

Results

By using NHAPI existing HL7 v2.3.1 ORU_R01 test messages of the St. Anna Children's Hospital's LIS can be parsed and packed into a structured model to be saved into a database.

Discussion & Outlook

The solution developed during AMIDE can be included into INTERACCT project. The visualization based on ASP.NET can be customized to end-users needs. A tendency of values can be easily observed.

References

[1] K. Peters. *Interacct – Serious Game Scores as Health Status Indicator.* Poster presented to the MIE2014. Istanbul. Turkey [online]. Available. `http://www.interacct.at/project/publications.aspx`. September 2014, [2] IHE International. *Integrating the Healthcare Enterprise Laboratory Technical Framework, Volume 2 (LAB TF-2) Transactions, Revision 2.1.* [online]. Available. `http://www.ihe.net/Technical_Framework/upload/ihe_lab_TF_rel2_1-Vol-2_FT_2008-08-08.pdf`. 2008

Project funded by FFG

Electromyograph as an input device for computers

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Introduction

Electromyography (EMG) is a method to measure electrical currents generated in muscles during contraction. It is the result of the summation of all Motor Unit Action Potentials (MUAP) in the region near the electrodes. This physiological process can be used to trigger events like mouse clicks on the computer.

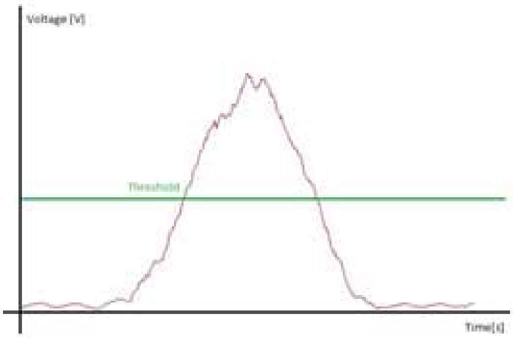

Fig. 1: MUAP captured by using surface electrodes.

Figure 1 shows an EMG signal recorded using the EMG device of this project. The green line represents a threshold meaning if the amplitude of the EMG signal reaches a certain value, an event occurs (e.g. mouse click on computer).
The aim of this project is to give handicapped people who lost certain extremities the opportunity to control their computer via muscle signals. In addition this device could be used for home assistive purposes like turning lights on and off.

Fig. 2: Surface electrodes placed on the biceps.

Materials & Methods

The electronic circuit was created using Eagle. In order to process the EMG signal and to transmit the result to the PC the Arduino Uno was used. The source code was written in AVR Studio 4. Furthermore AsTeRICS, a sofware which provides a Human-Machine-Interface, enabled the controlling of the PC.

Results

Fig. 3: Block diagram of the complete circuit.

The EMG device measures the muscle activity via surface electrodes. Afterwards the microcontroller of the Arduino Uno converts the analog signal to a digital signal (ADC) and processes it. Finally the signal is transmitted to the computer and events can be triggered using AsTeRICS.

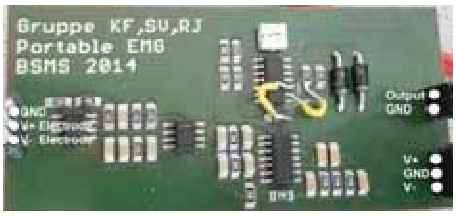

Fig. 4: Circuit board developed in this project.

Figure 4 pictures the circuit board of the EMG device. The inputs for the electrodes are found on the left side. The output pin as well as the supply pins are located on the right side. The output pin is connected with the ADC input of the Arduino Uno.

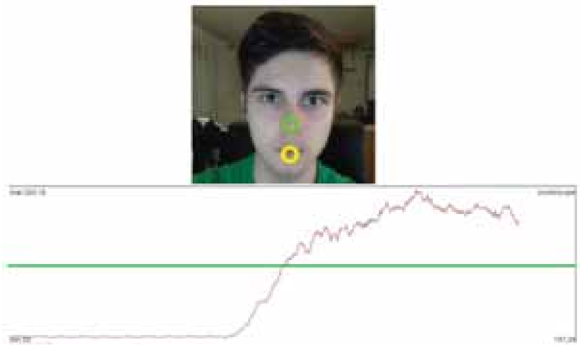

Fig. 5: Controlling the mouse via EMG device and AsTeRICS Face Tracking.

Discussion & Outlook

We achieved our main goal and were able to control the computer using our own muscle signals. Since AsTeRICS provides a solution for mouse movement via face recognition , we were able to move the cursor and execute mouse clicks without using a mouse. Plans for the future are to design a user interface and a case for the device. Furthermore wireless surface EMG's could be used to give the user more movement freedom.

References

[1] CadSoft Computer GmbH. *EAGLE Version 7.2 ist jetzt erhältlich!*. [Online] Available. `http://www.cadsoft.de`. 12.01.2015

[2] Arduino. *Startpage.* [Online] Available. `http://arduino.cc`. 2015

[3] Kompetenznetzwerk KI-I Projekt AsTeRICS. *Assistive Technology Rapid Integration & Construction Set.* [Online] Available. `http://www.asterics.eu`

Redesign of a Bluetooth Low Energy EEG–Device

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Introduction

- Small and portable way for EEG measurement
- Basis of the project – EEG amplifier circuit board developed during the project *BLE-EEG*
- Redesign of EEG amplifier circuit board
- Testing, redesigning and refining of the circuit board

Materials & Methods

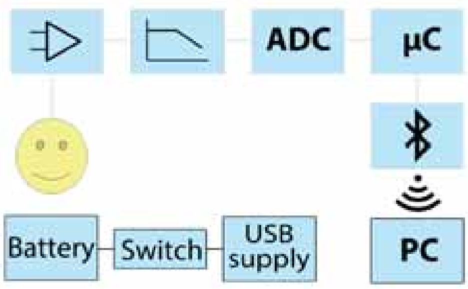

Fig. 1: circuit diagram of the BLE EEG module.

- EEG amplifier circuit board
  - Preamplifier stage
  - Filter
  - Analog Digital Converter
  - Microcontroller (AT90USB1286)
  - Bluetooth low energy (BLE) module
- PC
  - Brain Bay (recording of EEG, ECG,...)
  - Matlab (analysis of measurements)
  - Hterm (inspection tool – BLE module)
  - AVR Studio (development environment)

Results

- Feature–complete EEG amplifier circuit board with software for sending and recording measurement data
- Measurement setup for ECG and EEG measurement

Fig. 2: EEG amplifier circuit board mounted in the HAMMOND housing.

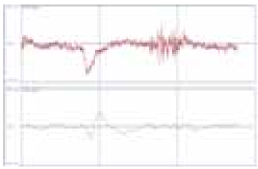

Fig. 3: Measured EEG with surface mounted electrodes.

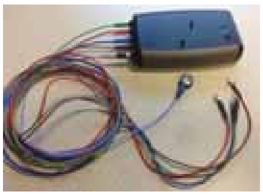

Fig. 4: Measurement setup for two channel EEG measurement (green – CH1+, red – CH1-, blue – Ch2+, brown – CH2-, gray – RLD).

Discussion

- Fixed hardware defects
- Working software for measurement purpose

- Working ECG and EEG measurement
- Improvement of usability
  - HAMMOND housing
  - LED module
  - Reset button
  - Programmable User button

References

[1] Atmel Corporation. *Datasheet of AT90USB1286*. San Jose. U.S.A. [Online] Available. http://www.atmel.com/devices/at90usb1286.aspx. 2012
[2] BrainBay. *BrainBay - an OpenSource Biosignal project*. [Online] Available.http://www.shifz.org/brainbay/. 2015
[3] Mathworks. *Startpage*. [Online] Available. http://de.mathworks.com/. 2015

Mobile ECG

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Introduction

The aim of this project is to build a mobile device for a multichannel electromyography measurement.[1] It is possible to monitor the cardiovascular potentials which are measured on different parts of the body due to heart activity with a Windows computer software program as well as a software program for an Android mobile phone. [2] The ECG is transportable and so the system runs on battery.

Materials & Methods

Filters were incorporated in the hardware of the device to reduce noises. The filtered signal from the patient enters a microcontroller where digital filters were added to guarantee a noiseless signal. The ECG signal gets transmitted via Bluetooth to a PC or a smartphone.

Fig. 1: Connection between ECG device and monitoring device.

Results

- Measurement of the ECG signal
- Mobile ECG measurement via battery
- Software to visualize the signal on PC
- Software to visualize the signal on smartphones
- Digital Filter for reduction of the 50Hz AC hum

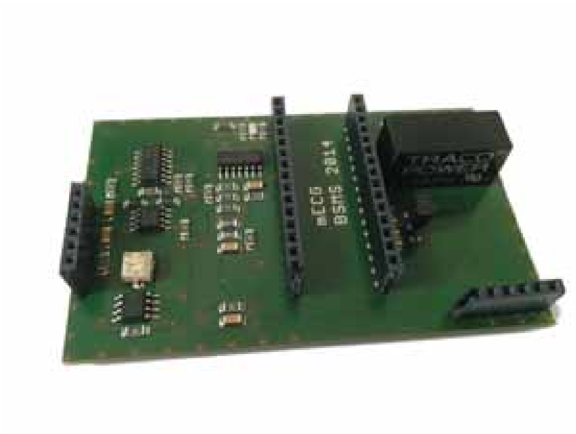

Fig. 2: PCB of the mobile ECG.

Fig. 3: ECG signal measured and digitalized with the mobile ECG.

Discussion

A transportable ECG device has been designed and developed. The prototype was fully functional and transmitted a useable signal constantly to a monitoring device.

References

[1] N.M. Kesto. *Electrocardiography Circuit Design.* [Online] Available. `http://www.egr.msu.edu/classes/ece480/capstone/spring13/group03/documents/ElectrocardiographyCircuitDesign.pdf`. 4.5.2013.

[2] V. Acharya. *Improving Common-Mode Rejection Using the Right–Leg Drive Amplifier.* Texas Instruments. SBAA188. pp.1–11. [Online] Available. `http://www.ti.com/lit/an/sbaa188/sbaa188.pdf`. July 2011.

A mixing device for minimal invasive micro foam

Anna Huber, Markus Königshofer, Martina Krizanac and Oliver Stangl
University of Applied Sciences Technikum Wien, Höchstädtplatz 6, 1220 Vienna, Austria

Introduction

To prevent a retrograde blood flow, normal veins have so called leaflet valves. If those leaflets do not close properly and the valves do not work any longer, the veins become varicose. Due to this problem blood can flow backwards and the veins get swollen, tortuous and are generally blue or dark purple (Figure 1).

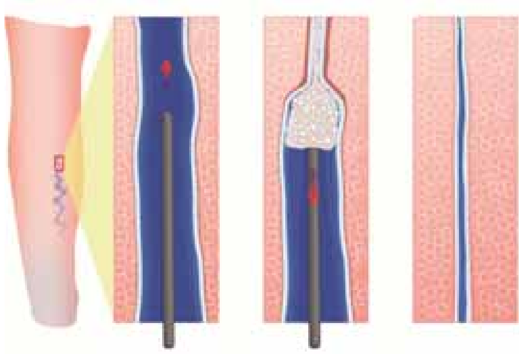

Fig. 1: Treatment of a varicose vein with micro foam. Modified and taken from [1].

Physicians offer several different treatment techniques for varicose veins. One common option would be to atrophy the affected vein by injecting minimally invasive micro foam. This foam is produced by manually mixing Aethoxysklerol® and air within two syringes (Figure 2). The aim of our project was to design and construct a device, which is able to mix this foam automatically and additionally shows its progress on a display. This method enables also people with less experience to mix the foam.

Fig. 2: Manual preparations for producing micro foam.

Materials & Methods

The design of our device was developed in the CAD program CATIA. For creating the electronic circuit (stepper motor driver) the layout program Eagle was used. The source code for controlling our device via Arduino was developed in AVR Studio 4. Additionally we used a 16x2 LCD Display.

Results

Figures 2 — 4 show the process of the development of our project, starting from the CATIA design (Figure 3), over the printed circuit board (Figure 4), to the final device (Figure 5).

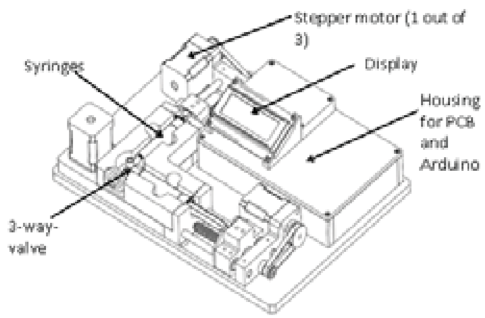

Fig. 3: Connection between ECG device and monitoring device.

Fig. 4: PCB of the mobile ECG.

Discussion

By now we manufactured an efficient device, that exceeds our expectations. The device automatically mixes the Aethoxysklerol® between the syringes to a foam, while displaying the steps to do on the LCD. It is easy to use and works reliable.
Still there is the vision of perfecting our project in order to use it for clinical purposes. The user interface and the design could be improved as well as the speed of the whole system. In addition standards and laws should be considered and satisfied.

References

[1] DDr. Martin Torzicky. Hautarzt Wien. *Startpage*. [Online] Available. `www.hautinstitut-wien.at`. 2015

Contributions

Master Biomedical Engineering Sciences

Design and Realisation of a Simulation of an ex–vivo Lung Perfusion Circuit

Anton Eschli, Ifeoma Martins, Peter Rothmund and Damandeep Singh
University of Applied Sciences Technikum Wien Supervisor
Mathias Forjan, mathias.forjan@technikum-wien.at

Abstract— **This paper deals with the design and realization of a simulation of an ex vivo lung perfusion circuit. The aim of this project was to build a working mock-up circuit that contains a lung equivalent, sensor units, a pump and a Raspberry PI. With this setup it is possible to measure flow, temperature and pressure of the perfusion of the lung. The measured values can be stored on the PI and are displayed graphically on a webpage, which is also stored on the PI. Finally with this data a complex model of a lung will be implemented and the motor of the pump can be adjusted.**

I. Introduction

Lung transplantation has become the backbone of therapy for the patients suffering from end-stage lung disease prior to medical administration. The introduction of ex-vivo lung perfusion (EVLP) as an instrument to assess and recondition lungs from insignificant donors has brought about a new era in the field of lung transplantation [1,2]. In order to evaluate the lung in an ex vivo system, a solution must be circulated through the lung via an extra-corporal perfusion circuit which allows continuous flow of nutrients and gas at any given rate [3].
The existing EVLP system (mobile circulatory module-mCM) of the AlveoPic project is able to perfuse a porcine lung [4] but has no ability to test the system on its function or any calibration unit. Therefore the aim of this project was to create a lung equivalent what can be used to test and calibrate the AlveoPic EVLP system. For this reason a mock-up circuit, providing the same conditions as the mCM has to be designed first. In the next steps a lung equivalent has to be implemented, tested and further developed.

II. Materials & Methods

Considering the fact that our project topic has to do with design and simulation of EVLP circuit, a set of different research methods were applied. It was decided to divide the workload within two groups. One group was focusing on the physiological parameters and anatomy of the porcine lung.
The second group was designing the mock-up circuit and in a second step the group developed the mock-up system.
Both groups were in close contact regarding progress and merged together in the middle of the project.

III. Results

To create the mock up circuit a basic design was implemented first. The idea of a modular system was created to exchange parts in a proper way. Therefore a mounting plate was used.
The system must provide a mean pressure of 10–25 mmHg pressure and a mean flow of 3.8 l per minute [1]. In the first step the nutrition solution would be clear water and the lung equivalent would be a tubing with an inner diameter of 8 mm.
The Raspberry PI (PI) as well as the analogue part were mounted in a measurement casing. In addition the sensor modules were attached together in a sensor casing in connection with the lung equivalent. Both casings were mounted together with the pump and the reservoir on a breadboard for a better manipulation of the

parts. The measurements are taken twice (before and after the lung) to observe the behavior in the lung equivalent.
As already mentioned a PI was used to store and display measured data from the lung circuit. The PI was also used to control the motor of the pump, which handles the perfusion of the lung circuit.
Due to the fact that flow sensors and temperature sensors are hard to test under real conditions, first a light sensor was connected to our circuit. The light sensor can be seen as an adjustable resistor, which is connected to an analogue-digital converter that is connect to the GPIO pins of the PI. This circuit can handle up to six different measurement units.
The software was written in Python to store and display the data of the sensors. With time delay of 0,5 seconds values are measured and automatically stored and displayed. To store the data a MySQL database was designed and installed on the PI. To display the data a webserver was installed on the PI, which hosts an html webpage where the data is displayed graphically.
For our fist tests the database was kept simple. The webserver is important because the PI has no graphical interface and by using this method, the webpage can be accessed from any device (cross-platform) that is in the same network as the PI (smartphones, tablets and laptops).
The only disadvantage here is that the pi needs a working wireless network all the time to display data. Therefore a smartphone or tablet has to build up a hotspot and the PI has to join this hotspot.
To control the motor of the pump two methods can be used. On the one hand the speed of the motor can be changed manually (on the webpage) and on the other hand it can be modified automatically based on the outcome of the connected sensors. To test the function of the motor a normal DC-Motor was used because the motor of the pump is still missing. This should not lead to any problems because the Pump has also a DC-Motor.

IV. Discussion

Till our midterm presentation we were able to test and built a working mock up circuit. The Pi is able to measure temperature and pressure of the lung perfusion. Furthermore this data is stored on a database and displayed graphically. Next steps will be to fine tune our system and implement the flow sensor, which is still missing. To accomplish this we decided to use a hot wire mass flow sensor.
The lung consists out of a simple tube and one of the next steps is to build a more sophisticated one. With the mock-up circuit we will be able to design a lung that hopefully will perform like a real lung.
Due to the fact that all team members are coming from different fields (Medicine, Biology, Informatics, Electro technics) on the one hand it sometimes was hard to find common thread but on the other hand it was helpful to have different basic knowledge combined in one team. Due to the fact we divided our work to have a better outcome it was hard to keep the overview of the progress and to keep everybody up to date. It was important for us that everybody knows about every part of the project.

References

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Electronic Control Device for a Model Eye

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***Abstract*— Since cataracts, a clouding of the lens, is affecting millions of people worldwide with vision loss, a method to prevent blindness (implantation of intraocular lenses -â€“ IOL) was invented. In order to determine the optical properties and quality of the IOLs testing of the lenses is required. For pre-implantation testing a mechanical eye model with precise drive electronics for tilt and shift of the lens is used. The aim of this project is to depict the accuracy of the drive electronics (µm–range) as well as the testing of the electronics for their properties and working requirements. Additionally a PCB and housing for user friendly application are built.**

I. Introduction

Cataract is the most common reason for vision loss of people over the age of 40 [1]. This illness requires the implantation of artificial intraocular lenses (IOL) to give the patient its sight back. Before implantation the IOLs have to be evaluated for their performance and their optical quality. At the after surgical healing process movements (tilt of shift) of the IOL may occur and change the optical properties. This requires adequate pre-implantation testing methods and set ups to predict the effects of tilt and shift. Therefore a mechanical eye model V1.0 was already set up in cooperation with the project Laser and Optics in Applied Life Sciences (LOALiS) at the FH Technikum Wien, which is adapted from the Liou & Brennan eye model from 1997 [2]. For precise determination of tilt and shift of the IOL electromechanical drives are used in combination with a reference switch. These drive electronics are tested and evaluated for their accuracy as well as their performance within the whole eye model.

II. Materials & Methods

A. Getting started with preexisting electronics

The pre-existing eye model V1.0 is used to test the electronics (stepper motor and reference switch) together with the already existing LabVIEW software. Additionally an A3967 Allegro demo board [3] and a frequency generator are used to control the drive electronics manually, due to the nonfunctioning of the existing breadboards. With this setup the motors were tested for strengths and weaknesses, as well as their electrical properties and power consumption.

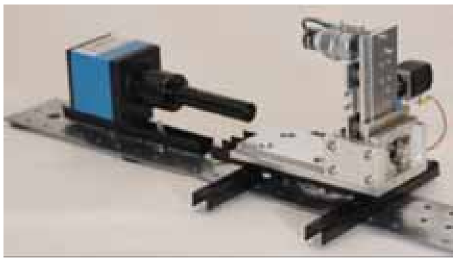

Fig 1: Mechanical eye model V1.0.

B. Reference switch measurement

To determine the accuracy of the reference switches, which stop the stepper motors a new measurement set up was implemented. Over half of the lens of the camera a black paper was fixed creating a sharp edge between light and dark parts in the image. This allows seeing even small changes of the lens positon in the later image. With the LabVIEW software the shift motor was moved from its initial position 100 steps to the left, where an image was taken. To get valid results the process was repeated 50 times and then analyzed in Matlab, by detecting the edge between light and dark in one pixel line of each image. To compare the results, this was done for two pixel lines per image.

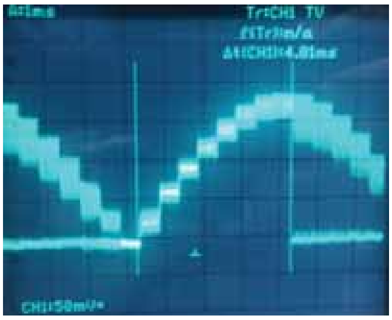

Fig 2: Voltage curve of stepper motors with rectangular steps in form of a sine wave.

III.Results

For both, the tilt and shift motor the operating currents were calculated via the measured voltage signal (at three different trim potentiometer adjustments) and the internal resistance of the sense pin. It could be proven, that the voltage signal has rectangular steps in form of a sine wave (as seen in Figure 2), for correct control of the motors.
From the existing circuit boards each pin was separately tested, where none of the four boards revealed a proper control of the drive electronics. Apart from this the eye model V1.0 has several strengths, including user friendly software, combining the system to the A3967 board was working quickly, as well as the idea of putting all electronics into one housing. Despite it also reveals weaknesses, starting with the vibration of the shift motor, partly non insulated wires and corrosion of metal parts. The accuracy measurement of the reference switch displayed a standard deviation of 2.72 pixels (≙11.35µm). The measured data ranges from -17.21µm to 12.56µm from all 50 images.
For separating the data groups, due to their non-normal distribution, group 1 revealed a standard deviation of 3.19µm and group 2 2.69µm.

IV. Discussion

According to the signal needed to control the motor the adjustment of the trim potentiometer on the A3967 is determining the amplitude of current and voltage, turning the trim potentiometer from minimum to maximum results in a decrease of the amplitude both of voltage and current.

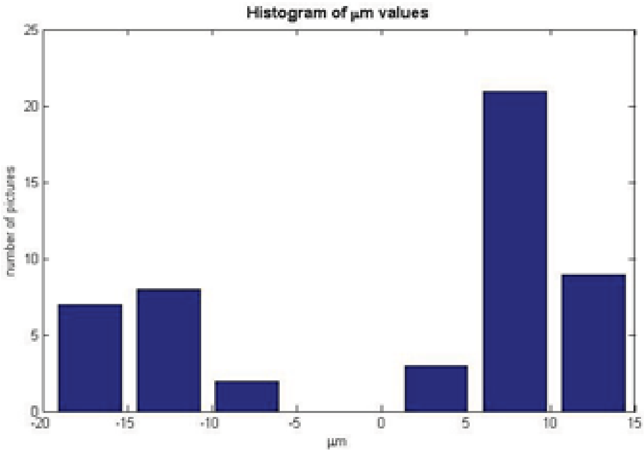

Fig 3: Histogram of the measured Î¼m values of all 50 images.

The four existing circuit boards could not be implemented none of them revealed proper results, even after soldering new parts onto the board. Weaknesses of the eye model (especially the vibration and the insulation problems of several wires) will have to be overworked in the near future, to guarantee more precise measurements and reproducibility.
Considering the resolution of the stepper motors, of 20µm, the results of the reference switch are acceptable. With a standard deviation of 11.35µm of all (non–normally distributed data set) images, the deviation is lower than the resolution of the stepper motors. Comparing this to the two groups of data and their standard deviation (3.19µm and 2.69µm) these values are even lower. The large range between the values (on average 23.25µm) can be explained by a stepping error of the motor, where one step equals 20µm. This also represented by Figure 3, showing a step between the measured values.

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Acquisition of the Retina Image in an Eye Model

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***Abstract*— A mechanical eye model is used as testing environment for intra ocular lenses (IOL). Environmental factors like stray light or vibrations negatively influence the reliability of measurements. A controlled environment like an optical table in a dark room would increase the quality of the measurements.**

I. Introduction

Cataract is one of the main causes of vision impairment in industrialized and developing countries. In Austria more than 12% of people over 60 years of age suffer from cataract. Drugs can reduce the speed of progress but they cannot cure the vision impairment. Surgical methods are used to cure patients. The human lens is replaced with an artificial lens a so called intra ocular lens (IOL). In order to test these IOLs a mechanical eye model was developed at UAS Technikum Wien. This model uses a mechanical mounting which can tilt and rotate the IOL. Saline solution or distilled water can be used to mimic the chamber water.

II. Materials & Methods

A. Acquisation of images and processing

The information obtained out of the mechanical model is processed using highly sophisticated networks like Lab View for capturing images and are interlinked with communication protocols which are equipped with perfect medical standards. Here the main objective of this condition is to capture a set of images as data and compare with different image standards for the proper anatomy of an image.[1]

Digital Image and Communication in Medicine (**DICOM**) is a global Information- Technology standard that is used in all hospitals for handling, storing, printing, and transmitting information in medical imaging. The received data from the industrial camera is stored in system the storage of one or more images with high resolution, which have been captured during the test, into a remote system. These images are enhanced and encapsulated with virtual modeling for each and every frame by using some parameters like Value Resolution(VR), Value Length(VL),Value Field(VF) for every part of the image which is processed and stored [2].

B. Concepts for the laboratory

Concept1: In the first concept the whole room is declared as restricted area due to laser beams (Laserkontrollbereich). This concept requires coverage of all windows (to outside, to hallway) with laser and fire proof materials (e.g. sheet metal). A box with protective glasses as well as a red warning light which lights up when the laser is in use needs to be installed at the outside of the room. Furthermore an interlock system which cuts the power supply to the laser needs to be installed at the entrance door.

Concept 2: In contrast to the first concept an enclosure for the optical table is used. This enclosure can either be a laserprotective curtain or a sheet metal enclosure. The interlock systems as well as the warning signs are directly placed at the optical table. A box for protective glasses needs to be installed at the inside of the laboratory[3].

C. Lab arrangement

Both concepts described above are applicable to the two designs for the optical laboratory described in this section, *Lab arrangement 1* and *Lab arrangement 2*.

Laboratory arrangement 1: allows placing the optical table in the upper-right corner of the room following Figure 1a. This would constitute an advantage in case we want to use curtains to protect from laser beams since the curtain needed would be 5m and we can take advantage of two walls. However, current location of the cupboard, projector, projector screen and tables should be shifted in order to allow having additional space around the optical table. This additional space is needed to fulfill the requirements for some measurements so that the optical table is accessible in at least three sides. Finally, connections to the sealing lab have to be rearranged in order to have stable measuring conditions and no disturbances due to unwanted switching of lights.

Laboratory arrangement 2: allows placing the optical table in the right side of the room following Figure 1b. Since in this arrangement only one wall directly surrounds the optical table, more curtain would be needed (7,1m at least), this is an important factor to take into account in monetary terms. The main advantage of this design is that not shifting of current furniture is needed, although the issue related to light switches has to be fixed also for this case.

Laboratory arrangement 3: uses a different approach in comparison to laboratory arrangement 1 and 2. The dark area is bigger which allows placing more devices into it, as seen in Figure 1c.

Fig 1: Scheme of lab arrangement 1a (right) and lab arrangement 1b (left) and lab arrangement 1c.

III.Results

A. Optical Table

In order to select a suitable optical table that also fulfills budget requirements, crucial calculations were computed in order to ensure that our optical system is enclosed in the farfield region. Having into account that the reflective power of the eye is around 60 diopters, the focal distance, f, is:

$$\frac{1}{f} = 60\text{dpt} \quad \rightarrow \quad f = 16.7\text{mm} \tag{1}$$

By using a focal distance of 16.7mm the image distance was calculated using the thin lens approximation given in equation 2.

$$\frac{1}{f} = \frac{1}{i} + \frac{1}{o} \quad \rightarrow \quad i = \left(\frac{1}{0.0167} - \frac{1}{o}\right)^{-1} \tag{2}$$

Tab 1: Relevant values regarding image and object distances for optical table length determination

Object distance o(mm)	Image distance i(mm)
2500	16.81
2000	16.84

B. Results of test measurements

Measurements were done in the control engineering laboratory with and without sealing lights and nearby monitor. We analyzed the histogram variations depending on shutter time and aperture as well as on amplification.

IV. Discussion

A. Dimensions of the optical table

To ensure that the system is measuring in the far- field zone, object distance o value should not vary significantly as image distance i varies. Having into account the values showed in Table 1, an optical table of 2 meters long or 2.5 seemed the best option. However, prices for optical tables of 2.5 meters almost doubled the price of the ones of just 2 meters (≈7500€). Since image distance i value does not vary significantly between both and due to the fact that the price greatly exceeds the budget an optical table of 2 meters was considered as a suitable one. After searching which are the current available metric optical tables of 2 meters long with isolator legs, optical table offered by ThorLabs was chosen.

B. Measurements using the eye model V01.00

Stray light has a great influence on the results decreasing the quality of the images. A dark surrounding would make the measurements more reliable. The monitor nearby the model should be outside the dark area.

D. Room concepts and arrangements

If the whole room is assigned as restricted area as mentioned in concept 1 more adaption to the room have to be realized. In concept 2 only the optical table is assigned as restricted area. This does not lead to major changes in the room's electrical system. Also the personal safety equipment can be stored inside the room which makes it harder to steal. Using concept 2 also offers the possibility to use the room for two different purposes at the same time because of the enclosing of the optical table. Both concepts are applicable on both room arrangements. Arrangement 1 allows to use less meters of curtain if a shielding with curtains is used (∼5malthough florescent lamps and beamer inputs have to be moved. In room arrangement 2 no changes to the room have to be performed but if a enclosure by curtains is used more meters of fabric are needed (∼7m). Room arrangement 3 allows to place and to run more experiments at the same time. Moreover no plugs or switches have to be moved. The switches for the sealing light have to be rewired to ensure that the dark area is controlled separately.

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Redevelopment And Evaluation Of A Control System To Monitor The Position Of An IOL Within A Mechanical Eye Model

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I. Introduction

The mechanical eye model at the UAS Technikum Wien is manufactured according to the principle of Liou and Brennan [1]. It is used to simulate the optical effects that occur when an intraocular lens (IOL) tilts or shifts away from the optimal position during the healing process after surgery. These movements of the IOL happen when the anterior chamber of the eye changes in morphology and the intraocular pressure reduces after cataract extraction surgery [2]. Simulation of such tilts and shifts in the mechanical eye model is achieved by the use of two motors who move the chamber which contains the IOL either laterally (shift) or, by pushing against a lever, in an angular way (tilt). The optical image quality is determined by evaluating the contrast and sharpness (resolution) with modulation transfer function (MTF). The images that are used to perform such an evaluation are acquired with a camera from The Imaging Source [3], which connects to the LabView software through an extension [4]. The LabView software development environment hosts the control system that is used to monitor the position of an IOL within the mechanical eye model. The old version of the software had some weaknesses and problems that led to the decision of a redevelopment. This redevelopment was split into two parts: motor control and camera control. Upon completion of these separate pieces of software it became a real challenge to merge them into one final release version, in fact it was impossible for the time being. One of the solutions for this problem was to reconsider the old version as a possible basis to which the enhanced features could be added. The first step in that process was to change also the old version from a DAQ-Assistant system to a development version (dummy) that could be used without the hardware available. This too proved more difficult than expected so the challenge of merging the camera control with a motor control software still remains.

II. Materials & Methods

In this subsection, methods for the development of the motor control and camera setup software are described.

A. Motor Control

The Motor Control software has to be able to control two motors, one shift and one tilt motor, according to their mechanical conditions, which is performed with LabView.

B. Camera Setup

In order to observe the optical effect of a shift or tilt of the IOL a camera is used which displays the actual image to the user. A user should be able to store the pictures recorded with this camera either manually or sequentially during an automatic sequence run.

III. Results

In the result section the software development of the *EyeModel* software, using LabView, is described. In order to work parallel within the group the workload was divided in the two parts *Motor Control* and *Camera Setup*. Furthermore the old EyeModel software, version 3.0, was evaluated.

A. Motor Control The *EyeModel* consists of two motors: one shift and one tilt motor which can be accessed independent from each other. Through them it is possible to adjust the optical lenses to find out at which position the picture taken by the camera is the sharpest. In the previous eye model software, version 3.0, it was said that bugs occurred. Unfortunately it was never possible to test the previous software because the corresponding hardware wasnâ€™t working. It was thus decided not to take any code from the previous version and instead redevelop the software from the start. To be able to focus on the software development without a need for the actual hardware it was decided to make a development version (dummy) that does not connect to the real world. So instead of connecting to the motors via the *DAQ–assistant* LabView control parts, this software outputs to waveform charts which are the software equivalent to oscilloscopes.

B. Camera Setup

The camera setup was first re-created in a dummy program that used an AVI–file to mimic the hardware. To mimic individual frames that would be recorded with a camera, each frame of the AVI–file was sequentially read out and shown to the user on the front panel. Information about this virtual measurement, which would represent details about the used camera and lenses, were also displayed with an option to save the information in a CSV file. Images that are saved in this dummy version contain information about the total and current frame number both in the file name as well as directly on the image in the upper left corner. In the upcoming development it will be possible to replace these frame numbers with the motorsâ€™ tilt and shift positions.

C. Combination of Motor Control and Camera Setup
During the initial software development the motor control and the camera setup were prepared in separate VIâ€™s. For the final software these two parts had to be combined into one. This offered some problems, which remain to be solved in the further development.

IV. Discussion

In this part faced challenges and possible upcoming changes will be described. It has to be mentioned that the current software is only a simulation software, once all issues are resolved it will have to be adapted to include the link to the real motors via the DAQ–assistants.

A. Motor Control
Currently the output for the movements of the shift and tilt motors is only shown on waveform charts. However it was also tested with a *DAQ assistant* and an oscilloscope in order to check the codesâ€™ behavior. So in the final software the waveform charts only need to be replaced with *DAQ assistants*: The output connections for each motor, whereas one each is forwarding the amount of steps and the second one forwards the motorâ€™s movement direction, and two input connections which send an impulse *high* if the motors reached their minimum positions. The motors movements can then be entered either as a number of steps or as a distance in µm.

B. Camera Setup
The simulation of a camera setup by using either an AVI–file or the XY–graph as image source proved to be a handy development tool. The images can now be saved with a timestamp and the motor positions both in their file name as well as directly on the image. A user can thus directly relate each image to its corresponding measurement run. Additionally the camera configuration can now be saved to a CSV-file, either manually or automatically at the start of an automated sequence.

C. Combination of Motor Control and Camera Setup
The combination of motor control and the camera part of the program will still require further work. The two options seem to be to either add the *save image* code to every one of the loops that are used to control the motors in an automated sequence, or, preferably, recode the motor control to allow it to make use of LabViews inherent multitasking capabilities.

D. Comparing the previous version of the software with the newly developed version To enable direct comparison of both versions of the software, the old one was also turned into a development version (dummy) that displayed the motor movement on waveform charts. By comparing the old software with the new one the following results were achieved:

- Firstly, it is still difficult to compare the two pieces of software, as the motor control seems to act on the motors much faster than in the new version, with almost no delay between the steps.
- It seems that the old version is always started with the button: *Start with tilt motor* and it is not clear why. A user might want to rather start with the shift motor, as the selector switch is by default on that position.
- The icon for creating the pulses is the same in both versions.
- The motor selector in the block diagram is the *shift motor* and it is not immediately obvious that it will select the tilt motor when it‘s in *false* position.
- In the old version both Snake and Hopper sequences are used, the new version was agreed to use only the Snake sequence.
- Like the *shift left end* and *tilt left end* switches in the new version, the old version has switch M1 and switch M2 which can be used to simulate the button press at the minimum position.

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Developing Alternative Input Methods for Computer Control

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***Abstract*— In order to allow individuals with motor disabilities to efficiently interact with computers, alternative input methods for computer control are required. This paper presents the four types of input method prototypes that were developed for this purpose. To get usability feedback, most of the models were tested by an individual with muscular dystrophy.**

I. Introduction

Computers are rapidly becoming an irreplaceable part of every personâ€™s daily life. Unfortunately, there are many people living with disabilities, such as muscular dystrophy, that prevent them from being able to use a computer. In order to make computer interaction possible for such people, alternative input devices must be developed. In this paper, we will discuss the development of different input methods, ranging from low tech solutions to more complex devices, which would be usable by people with disability. Most of the models were developed using a teensy++ microcontroller board.

II. Materials & Methods

Four different alternative input devices were developed: optical mouse model, capacitive mouse model, mouse model using switches, and a lipmouse model. Aside from the optical mouse model, all of the models included a teensy++ microcontroller board. The optical mouse model was based on a simple store-bought mouse with a laser, which was altered to create a joystick-like mouth and hand controlled device. The capacitive mouse model was created using copper foil for the touch sensors. The model using switches involved four microswitches arranged in a way that allowed for easy control of the mouse movements using a single digit. The lip mouse was developed using force sensitive sensors for movements in each direction and a sip-puff sensor. The mouse software was developed using the Arduino IDE with the Teensyduino plugin. For the PC application, Visual Studio was used.

III. Results

Currently, the lipmouse and the model using switches are one of the most promising according to the usability feedback. The old switches model was adjusted according to the usability feedback, and its current status is shown in Fig. 1 on the right. The main adjustment for this model was the rearrangement of the switches, which decreased the interference between the switches.

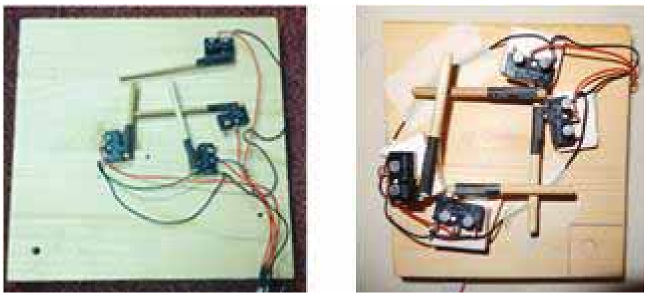

Fig 1: Model using switches, left first prototype, right improved prototype.

The capacitive model was also adjusted to provide haptic feedback, by giving the user a center rest position in the middle of the device. The wiring connections were also improved in this model. The second prototype of the model is shown in Fig. 2 on the right.

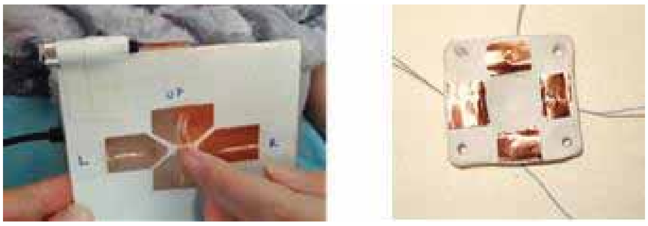

Fig 2: Capacitive model, left first prototype, right improved prototype.

The lipmouse model was the model with the best usability. It has been programmed to work without additional software. A PC application was developed to adjust the speed and deadzone of the device, as well as calibration. The lipmouse model is shown in Fig. 3.

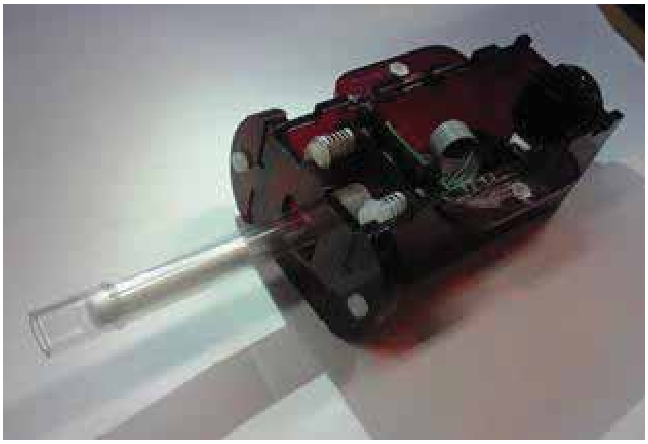

Fig 2: The lipmouse model.

IV. Discussion

The models discussed in the paper represent very promising prototypes which are a great starting point for assistive affordable input devices, developed for patients with muscular dystrophy. In the switches model, the switches have a clear action point and a good haptic feedback; therefore it can be used efficiently. The disadvantage was the unstable set–up of the device in the first prototype, which was improved in the second model. One new task concerning the switches is to develop external switches, which can be used as additional tools for the other models. The capacitive measurement device showed a non-reliable handling in the first model: It was difficult for the patient to control the direction of the mouse icon on the computer via the sensor areas. Often, more than one finger touched the sensitive areas, and due to the missing haptic feedback, the desired direction was missed. The new model, with an integrated deadzone in the middle of the device, mitigates this problem by providing proper haptic feedback. The capacitive model can be improved as a standalone version, but capacitive input can also be included in the lipmouse to replace the current sip/puff sensor for clicking in order to remove problems with humidity. The next steps for the PC application for the lipmouse are to implement options to fine tune the performance of model. An additional idea for the following semester is to build a low tech device using a store bought computer mouse as base for a joystick, controlled with an AsTeRICS Software.

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Construction of a Mobile Ergometer Test Station

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***Abstract*— Ergometer test stations are used to compare the measured power with the power displayed at the ergometer. The aim of this project is an evaluation of existing test station and the construction of a mobile ergometer test station according to the applying standard EN957. Existing test station can cost up to 20.000€ and weight 52kg, consequently and cost–efficient light–weight solution was desired. Therefore a motor with a gear box and frequency inverter drives the ergometer. Within the shaft to the ergometer the torque and speed is measured with a sensor and the power calculated. Software for Excel was developed to control a microcontroller and therefore the test station. The components were selected and first programs written. With 5.200€ for the parts and 25–30kg for the whole test station, it is lighter and cheaper compared to available products.**

I. Introduction

As defined in the Medical Devices Act regulations concerning the safety, quality and functionality need to be fulfilled. Moreover an ergometer used for the detection and monitoring of a disease is a medical device [1]. Consequently according to the Medical Devices Directive appendix 2 ergometers, which are intended for diagnostic stress examinations on a patient, are subject to metrological control every 2 years [2]. This control is used to verify the power displayed on the ergometer. The standards EN957–1 and EN957–5 apply to ergometers and ergometer test stations. It is required to use a speed and torque or speed and power measuring device. Moreover it is necessary to determine the data by ±2% of the measuring range [3, 4]. Various systems are available on the market, which rely on the same principle as defined in the standard. In general they use a motor to drive the ergometer and sensors to measure torque and speed on the driving shaft. The measuring speeds vary from 40–200rpm, the power from 40–4000W with a price from 10.000€ up to 20.000€. Moreover the ergoline ergocal 610p weights 52kg. Consequently the aim of our project is to build a low–weight, accurate, mobile and cost–efficient solution which can be handled by one person.

II. Materials & Methods

A. Concept

The concept, with an overview in Fig. 1, consists of reversing the operational process of the ergometer. Instead of the patient pedaling, an electric motor is used to provide a constant and reliable torque and speed. The drive unit consists of a tri–phase induction motor connected to a reduction system consisting of a planetary gearbox, adapting the generated mechanical output to the needs of the testing environment. The control of the drive unit is realized by a frequency inverter, changing the frequency of the sine wave supplied to the motor. Thus the output generated by the drive unit is in the desired range, with 150rpm and 75Nm.

The shaft of the planetary gearbox is connected with removable couplings to the shaft of the speed and torque sensor. The output of the sensor is delivered to the microcontroller, which commands the frequency inverter according to the received input.

To ensure a high stability and to reduce the dimensions of the main shaft, the sensor is mounted on the side of the case, eliminating the need for a shaft bearing.

The connection between the test station and the ergometer is made through an extendable shaft containing two universal joints, for improved stability, mounting flexibility and operational safety. A removable flange is the direct contact between the end of the extendable shaft and the shaft of the ergometer. The purpose of this flange is to be able to easily adapt the device for a large variety of ergometers as easily as possible.

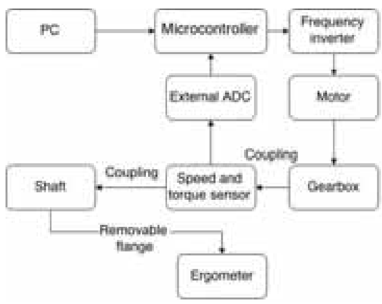

Fig 1: Overview of the concept including the single blocks and connections.

B. Sofware
For the concept development, Autocad 2015 was used. Regarding the software development, the PC Visual Basic for Excel was used. Visual Basic for Applications (VBA) can be used to program Macros for Excel and include Buttons, additional graphical user interface (GUI) for the communication to the user and a lot more. For the microcontroller, the MPLAB software and MPLAB ICD3 programmer/debugger was used.

C. Usability
The main concern was focused on the user interface usability, so that the physical UI is clear, with all the control lights, switches and display, but also the GUI on the PC is easy to use. Other requirements of the project include: a light weight solution for an easy transport, an easy assembly of the system, and an emergency stop button.

III. Results

A. Part selection
Various options of the motor and reduction were found and a first selection made with a Siemens motor with 1.1kW and a gear box with a ratio of 10 resulting in max. 141.5rpm and 74Nm [5]. Moreover Siemens supplies a frequency inverter with the motor. The selected sensor DRFL–III–100Nm–n is brushless with maximum 100Nm measuring range and an accuracy of $\leqslant$0.1%fs. Furthermore a speed measurement is included [6]. For the couplings various options have been searched for, the supplier selected and the final coupling will be decided according to the specifications. Moreover a casing will be used and tri-stand to elevate the test station if necessary. Moreover the controller PIC24FJ64GB002, a display and external ADC will be used.

B. Assembly
Fig. 2 shows an Autocad drawing of the internal structure of our system. It shows the single components and assembly.
Fig. 2: Internal structure of the test station including motor (yellow), gear box (red), couplings (cyan) and sensor (blue) and shaft to the ergometer (green)

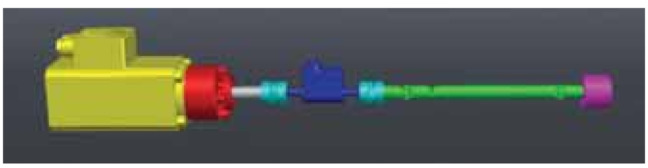

Fig 2: Internal structure of the test station including motor (yellow), gear box (red), couplings (cyan) and sensor (blue) and shaft to the ergometer (green).

C. Software
First demo–programs where written and tests conducted on the PIC and VBA for Excel. With USB–OTG a connection to the PC could be established using a COM–port and data transferred to the GUI. A template of the test report was generated, which meets the requirements of the standards. The GUI was programmed and the measured values automatically filled into the template. Fig. 3 shows the GUI, written in VBA for Excel.

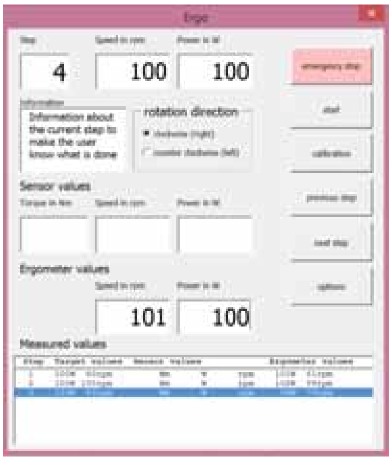

Fig 3: Graphical user interface (GUI) without the implementation of the sensor values. It shows information relevant for the measurement and inputs.

IV. Discussion

It can be seen from the cost estimation of our project that with about 5.200€ we are below prices for available test station with 10.000€ to 20.000€. The weight of the test station from the TÜV ergocal 610p is 52kg and 120kg including additional equipment. The estimated weight of our system resulted in 25–30kg. The single parts were selected in order to meet the requirements and specifications. In general there was good progress during the first semester and with this price and weight estimation it makes sense to proceed with this project. Next semester the ordering of the parts, assembly, further development of the software, testing and quality assurance will be conducted.

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Implementation of an electronic clinical report system for daily ward round

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***Abstract*— To reduce paperwork during daily ward rounds in a hospital, a student project was started to develop an android application for a tablet device. Thereby, new and additional information should be stored and callable on the tablet itself and be visible on the PCs in the hospital. After adjusted goals the main focus was laid on the usability of the tablet application and the development of different frontends. Thereby, obtained feedback of users should help improve a final version of a graphical user interface for the tablet.**

I. Introduction

Nowadays paper work is reduced more and more as it is difficult to store. So information is converted into electronic data which is easier to store and find. The main idea behind this project was the implementation of an electronic clinical report system for daily ward rounds in the hospital Rudolfstiftung. Thereby, an android applications should be developed and used on a tablet to insert and save new data as well as other parameters of a patient. The application should consist of present and past status of the patient and graphical plots of vital parameters to increase the better overview. All the information should be visible both on the tablet and on the PCs used in the hospital.

II. Materials & Methods

Basis for all the following steps in this project was to analyze the sheet of paper that is currently used for the collection of ward round data in the hospital Rudolfstiftung. First designs for a possible graphical user interface were created using the tool *Balsamiq mockups* which is highly diverse in implementable functionalities and allowed us to easily create a frontend that is ready for obtaining feedback. Additional information for the best possible approach for our project was collected in meetings with our supervisors and experts for healthcare IT. As our goals for our project shifted into the direction of focusing on usability aspects of such a mobile healthcare application. Currently the main part of our methods contend a literature research about state of the art applications in medical sectors. The literature research was performed by querying various databases, including Google Scholar and a literature database of the UAS Technikum Vienna, where we got access to by Benedikt Salzbrunn.

III. Results

By using the mentioned design tool from Balsamiq, we designed and presented our first mockup at a meeting with employees of the IT group of the hospital and Systema, a company working in the medical health sector for datahandling and representation.

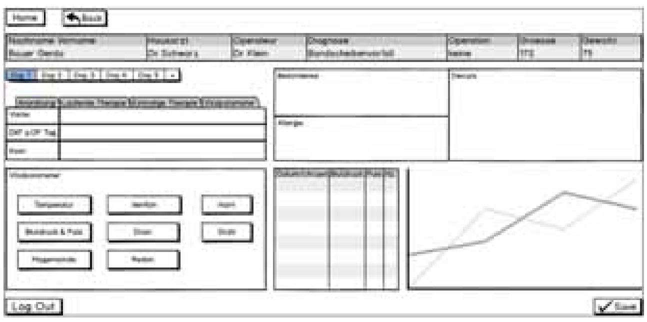

Fig 1: Application mockup showing the display of the vital parameters which can be changed by buttons including a table and additional graph for a better overview.

As Systema is already working in the medical health sector since a longer time in areas of data- handling and representation, they explained that we should focus on different goals than we set up at the beginning of our project. There are various approaches to solve the problem of the electronically enhanced ward round and Systema already developed Desktopsolutions for the entering and representation of patient data. However, due to the fact that our approach to this problem is a mobile device solution it has to be clear that the attempt to implement all functionality of a Desktop-solution could easily lead to an overload in a different solution for a mobile device.

Therefore, we came to the conclusion that it would be best for us and also for a possible cowork with Systema that we set our main goal on mobile device usability for such an application. Literature research on the topic of usability aspects in similar mobile applications or other healthcare applications became the focus of our work for the first semester. Thereby, it was often repeated to reduce the information on the screen as much as possible to avoid an information overflow of the user. Additionally, the application should be easy to handle, which means fast to work with and also memorable. A very good application also implements a straight line the user can follow and therefore produced errors can be minimized. The more the application can be used intuitive the smaller will get the amount of errors and the easier it will get to handle and memorize the working method on the device. Other resulting goals for this project are the development of different mobile application frontends, pointing out advantages and disadvantages of the different solutions as well as obtaining user opinion on the developed frontends.

IV. Discussion

Summing up the results of our project so far, it can be said that there are some general guidelines that can be followed in order to achieve a generally satisfying usability in a GUI for a mobile application like the one we want to develop for the daily ward round. However we still do not see our research as completed and will try to find more ideas and state of the art information about usability. Therefore our on-going work will continuously consist of additional literature research and the design of our own mobile frontends.

The next big steps will be to design mock-ups for different GUI solutions and to develop the actual software that can be tested. Only when we have results that can be shown and tested by users we will be able to improve our results based on feedback. It can also be said that usability is highly dependent on the end user and without obtaining the required feedback there will be no optimal results for the design of GUIs.

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New Projects

Healthcare Toolbox Light

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- Telemedicine, it means, using of video conferencing solutions in the medical field is an important project that will become more and more important in the future. Teleconferencing solutions will affect the existing health care throughout the world and also in the term of savings.

  Characteristic of the Telemedicine is not only the spatial distance of doctor and patient at both therapeutic and diagnostic procedures but also bypass the long waiting times in the medical practices and walk-in clinics.

- Teleconferencing solutions as an important part of telemedicine could be just Basic for better medical care for people in many countries of the world where the population is very low and infrastructure is poor. Telemedicine will be probably the only way to bring that medical help closer to the patient.

- MEC in Vienna, Austria has been successfully working in IT for over 25 years and is experienced in remote patient care. MEC claims to have developed a plan which will end such problems.

- MEC in cooperation with FH Technikum aims to assist both patients and doctors alike in the provision of medical services and treatment.

- Healthcare Toolbox Light, currently being developed, is a small and easy to use device designed for home use.

- Healthcare Toolbox Light is designed to be extremely user friendly. The patient registers via a form of identification and the toolbox then connects the patient to a doctor or an eHealth centre where our video conferencing software is installed. The patient is registered and waits at home or where he/she is for further health assistance.

- Imagine you are on vacation, and suddenly become ill thus requiring medical assistance. With Healthcare Toolbox Light, you can contact your doctor, who would have access to your medical history, via any Internet connected device and receive medical attention. You would no longer have to rely on a foreign hospital with the language and financial barriers that come along with it.

Temperature Control for a mechanical Eye Model

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I. Introduction

– Cataract is a clouding of the eye–lens, in the worst case can lead to blindness.

– To treat cataract, the clouded eye lens can be replaced with an artificial intraocular lens (IOL).

– These lenses are tested with in the standard ISO 11979-2 [2]

– Within the project Laser and Optics in Applied Life Sciences LOALiS a mechanical eye model for testing IOLs is in development.

– Compared the ISO-Model the LOALiS-model attempts to represent the human physiology as close as possible

– A not jet implemented feature is the heating of the aqueous humor to the correct physiological temperature.

II. Materials & Methods

A. *Current Version of the model eye*

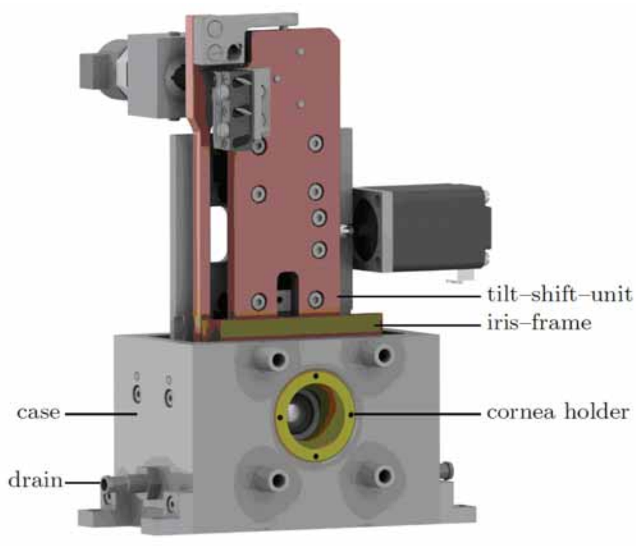

Fig 1: CAD Model of the current version Figure 1 depicts the current CAD version of the CAD model.

Currently the model is manufactured by the IOF Jena and will arrive in Vienna in May 2015.

Compared to the old version the model features to connectors (*inflow* and *drain*) to change the aqueous aqueous humor in the model.

B. *Concept of solution*

– The aqueous humor has ether be heated in an external compartment and transferred to the model via circular flow or

– A heating cartridge and a thermos sensor are directly inserted into the model eye without the need of a circular flow

– In both cases a closed control loop has to be implemented to precisely heat up and control the fluid's temperature

C. *Tasks*

– Evaluation and selection of one concept

– Selection of sensor and heating element

– Implementation of a closed control loop

– Testing and documentation

III. Discussion the greater good

IOLs are used to replace the clouded eye lens to cure cataract. To ensure their quality, they are tested according to the ISO 11979-2 [1] standard. New highly sophisticated IOL designs require in parallel the development of new measurement devices and standards to ensure that these new designs positively affect the patient's vision.
Until now the influence of the temperature on the image quality is rarely investigated. The this project enables these investigations and can led to future projects

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Controllable Two Degree of Freedom for a Computer-Generated Hologram Projector

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I. Introduction

- Controllable mechatronic devices are a fundamental part of many medical devices. e.g. controlled robot arms for surgery robotics.
- To learn the concept of combining mechanics, electronics and software (mechatronics) in a practical example a two degree of freedom (2DoF) controllable mount for a hologram projector will be designed and implemented within this project.

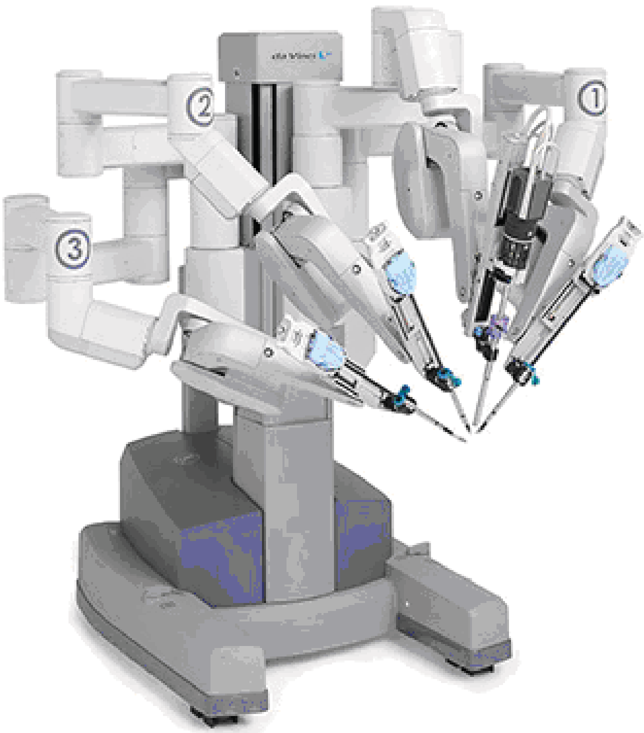

Fig 1: DaVinci surgery robotics, each surgery tool can precisely be controlled in many degrees of freedom [1].

II. Materials & Methods

A. Projection using Computer-Generated Holograms
To learn the concept of mechatronic devices on a real example a hologram projector shall be guided in 2DoF.
The diffractive holographic element projects the stars of the sky on the inside of a small (≈ ”0.5m diamerter) sphere. This half sphere represents the sky, as it is done in a planetarium.
To simulate the earth' rotation about its own axis (one rotation per day) the projector has to be about one axis inside the half sphere This axis itself has its own precision movement with duration of 25700 to 25800 years.
This biaxial rotation can be simulated with a 2DoF movement mechanism.
B. Tasks

- Construction of a mechanical mounting for the projector in 2DoF
- Designing the electronics to control the movement in both axis
- Developing a software to set the two positions to any predefined date to simulated the appearance of the sky on any date
- Implementation of a quick–motion mode to speed up both movements to make the two axis movement comprehensible for human perception

III. Discussion the greater good

The knowledge on buildung mechatronic devices is universally applicable in medical devices. In ths project you also have the abilty to get in tuch with modern optical technologies.

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EMG Data–logger

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I. Introduction

The aim of the projects below is to assist the development of a data-logger for use in the biomedical/rehabilitation field of the UAS Technikum Wien. The main purpose of the data-logger is to measure EMGs from a test person. The measured values are recorded with a frequency of 1 kHz and can be displayed in a live-mode to observe the measurement in real-time. In addition the data is stored on a SD card. The stored data could be used to analyse the motion later on. The data-logger is equipped with a battery as well as an Wi-Fi module for a connection with the PC. The capacitance of the battery should provide a operating time of about four hours. An additional feature of the system should be a wireless charging function.

II. Tasks

(A) Redesign of the existing EMG-shield. (Eagle-board optimization). Breadboard solution of the sensor unit and testing. EMG data acquisition and visualization.

(B) Connection of two different Wi-Fi modules with the PC. Testing of alternative wireless connections with the PC.

(C) Communication between the microprocessor and the SD flash memory. Saving and processing of EMG data packages.

(D) Design and development of a wireless charging unit. Implementation on the system.

(E) Elaboration of the standard conformity for the development of the datalogger.

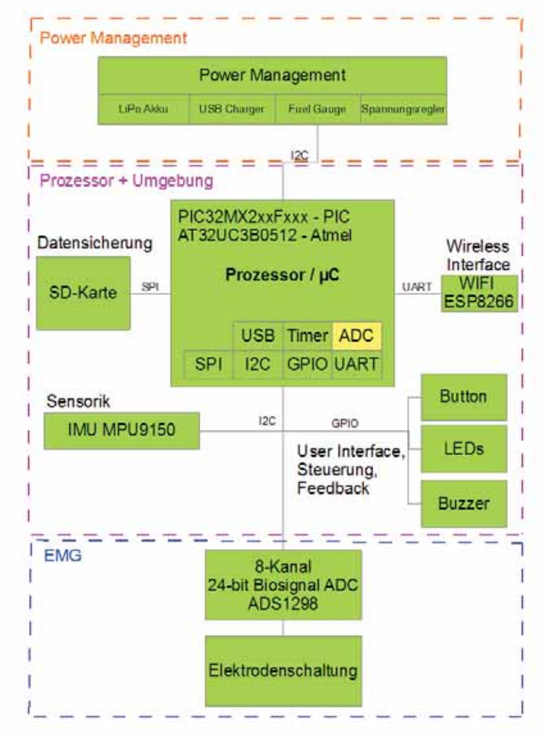

Fig. 1: Schematic of the interacting parts of the data-logger.

III. Discussion the greater good

The EMG data–logger would be an enrichment in data acquisition within the student projects of the UAS Technikum Wien. The possibility to create parts of a complex measurement system and the resulting working device gives the student a realistic view on the situation of real live manufacturing in a biomedical context.
The full autonomously working system gives the possibility of a huge variety of test setups.

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Project AlveoPic: Design and Realisation of a Simulation of an ex-vivo Lung Perfusion Circuit

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I. Introduction

The funded project AlveoPic is designing a transport and re–conditioning container for a porcine lung. Within this container the *vital parameters* of the lung are monitored and data is transferred to the Android App LUMOR. The upcoming task for the project AlveoPic is to design and develop a mock–up circuit of an EVLP system.

In human transplant medicine lung tissue is preserved after explantation in an ex vivo lung perfusion circuit (EVLP). These circuits are constructed by using multiple medical devices, which usually are not interoperable enough to send data to an external service. Moreover these systems have been designed as medical products individually. Therefore size is one of the critical issues for such a system.

II. Tasks

A. Design of the electronical components

- Literature research
- Design of the motor control unit.
- Design of the sensor unit. (flow, pressure, temperature and Perfusion-solution level)
- Transmission of the data between the modules single modules (shields) of the system.
- Wireless communication between the system and a tablet PC.

The project AlveoPic targets ventilation research, with a focus on aerosol deposition measurements, without the need for animal models. The porcine lungs are expected to be explanted during the slaughterhouse process of the regular meat industry. However, the explanted lungs need to be re-conditioned, and that's the task of mCM. During re-conditioning the parameters are going to be monitored with LUMOR in order to optimize the nutrition of the lung.

Fig. 1: Mobile Circulatory Module (mCM) housing for ex-vivo lung perfusion

III. Discussion the greater good

The final version of the mCM system will help to increase the precision of measurements, taken at the FHTW, by using porcine lungs in several testing enviroments.

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Development of an Impedance Analyzer for In-Vitro Impedance Spectroscopy

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I. Introduction

Impedance Spectroscopy is a versatile analytical method to monitor in-Vitro Cell cultures continuously and non-invasive. However, commercially available impedance analyzers are expensive and therefore limited to labs with an analytical focus on impedance. To overcome this drawback a commercially available integrated impedance analyzer should be adapted in a way that it can be used for cell culture monitoring. Therefore an electrical circuit has to be designed which enables impedance monitoring using 4-point electrode configuration.

II. Tasks

– AD5933 needs a positiv power supply. Because this the operating point has to be lifted up for Impedance Spectroscopy measurements (Bias Voltage).

→ A consequence of the Bias Voltage would be a constant voltage on electrodes, which could damage the tissue.

→ Bio–Impedance Spectroscopy must be performed at the zero point: $V_{\mathrm{DC}} = 0\mathrm{V}$, $V_{\mathrm{AC}} = 10 \ldots 50\mathrm{mV}$

– This can be guaranteed by an additional protective circuit according AD5933.

– A 4–point measurement setup as shown in figure 1 solved this requirement.

– A test circuit according figure 1 has be realized on a PCB.

– The basic functionality of the PCB has to be tested in lab.

– The PCB has to be calibrated on a commercial AD5933 IC.

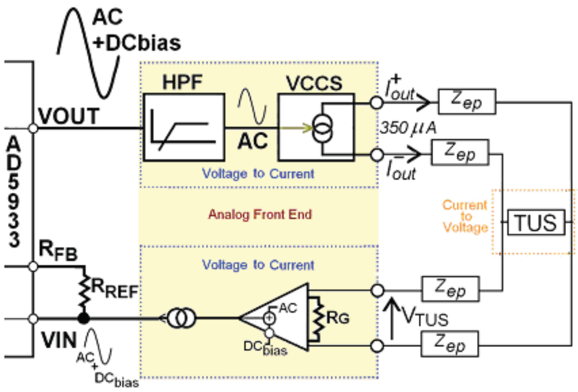

Fig. 1: The cicuit design, which should be realized and tested [1]

III. Discussion the greater good

The final version of the mCM system will help to increase the precision of measurements, taken at the FHTW, by using porcine lungs in several testing enviroments.

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Nutzbarmachung und Analyse klinischer Daten für die medizinische Behandlung und Forschung

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I. Introduction

Der Wiener Krankenanstaltenverbund (KAV) verfügt über eine Vielzahl strukturierter und unstrukturierter patientenbezogener Datenbestände. Ziel dieses Projekts ist es, die vorhandenen Daten für die verbesserte Behandlung der PatientInnen sowie für klinische und translationale Forschung nutzbar zu machen.
Aus zahlreichen bestehenden IT Systemen im Wiener Krankenanstaltenverbund entsteht eine umfangreiche elektronische PatientInnenakte. Daten entstehen etwa als Labor-, Pathologie-, und Radiologiebefunde, oder Entlassungsbriefe aus medizinischer und pflegerischer Sicht. Evidenzbasierte Medizin zielt darauf ab, diese Daten zur medizinischen Behandlung individueller Patienten und auch zur laufenden Verbesserung der Behandlungs-Abläufe zu nutzen. Ziel dieses Projekts ist es, vorhandene Daten aus den klinischen Systemen zu extrahieren und daraus über gezielte Analyse neues Wissen zu klar definierten Fragestellungen in der Medizin zu generieren.
Aufgrund der Österreichischen Gesundheitsreform und der damit einhergehenden Umsetzung der elektronischen Gesundheitsakte ELGA laufen aktuell tiefgreifende Veränderungen sowohl administrativ, in der IT und in den klinischen Abteilungen in den meisten Spitälern in Österreich. StudentInnen der FH Technikum Wien können in diesem Projekt diese bahnbrechende Entwicklung sehr konkret miterleben und mitgestalten.

II. Tasks

A. Verständnis des vorhandenen strukturierten und unstrukturierten Datenaufkommens.Definition von Anwendungsfällen.

Zunächst sind in einer Analysephase grundlegende Rahmenbedingungen zu erheben, und Wissen ist aufzubauen. Welche medizinischen Fragestellungen sollen betrachtet werden?
Welches neue Wissen wird für diese Fragestellungen benötigt?
Welche Daten stehen zur Verfügung?
Wie kann ich diese Daten nutzbar machen?

B. Umsetzung exemplarischer Abläufe

Für ausgewählte Anwendungsfälle werden in Kooperation mit dem KAV und Partnerfirmen Prototypen umgesetzt.

III. Discussion the greater good

Daten an sich sind eine wichtige Ausgangsbasis für die medizinische Behandlung. Die entscheidende Herausforderung der nächsten Jahre ist es, die zunehmend besser strukturierten Daten auch verstärkt zu nutzen, im Sinne der PatientInnen und für die Forschung. Damit kann die medizinische Behandlung sowohl für individuelle PatientInnen als auch für groȣe Gruppen in Disease Managment Programmen langfristig weiter verbessert werden. Darüber hinaus wird so eine breite Datenbasis für die klinische und translationale Forschung geschaffen.

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Data Bay for Respiratory Sciences

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I. Introduction

In a research environment, like a university, data acquisition takes place in multiple fields. The data which is available is highly heterogeneous, but should be stored in a central storage unit. A standards based framework shall be developed which is capable of collecting multiple data formats. The data has to be available in a fast response database for allowing post processing and big data analytics.
In a research environment, like a respiration laboratory, data acquisition takes place in multiple fields. The data which is available is highly heterogeneous, but should be stored in a central storage unit. A standards based framework shall be developed which is capable of collecting multiple data formats. The data has to be available in a fast response database for allowing post processing and big data analytics. Data includes samples like:

- Breathing values
- Aerosol Deposition
- Pictures (Surveillance)
- Sensor data

This set of highly heterogeneous data is collected continuously during projects, thesis works of students and daily testing routines.

II. Tasks

A. Overall Goal of the project

- An architecture for a data acquisition framework should be designed
- System requirements have to be specified
- A prototypic version should be implemented allowing the collection of minimum 3 different data types

B. Specific Goals to be achieved

- Design an architecture for the framework
- Define system requirements
- Choose 3 data types for prototypic implementation
- Build up a small, but scalable version of the framework
- Work along international standards for medical IT
- Ensure interoperability with the Medical IT Database of the university
- Show in a pilot that the concept works (proof of concept)

III. Discussion the greater good

If data would be stored centrally and holistic, covering the entire range of collected information, more useful data analysis could be performed. Statistical analytics could be performed. More information about an ongoing test could be cross-linked.

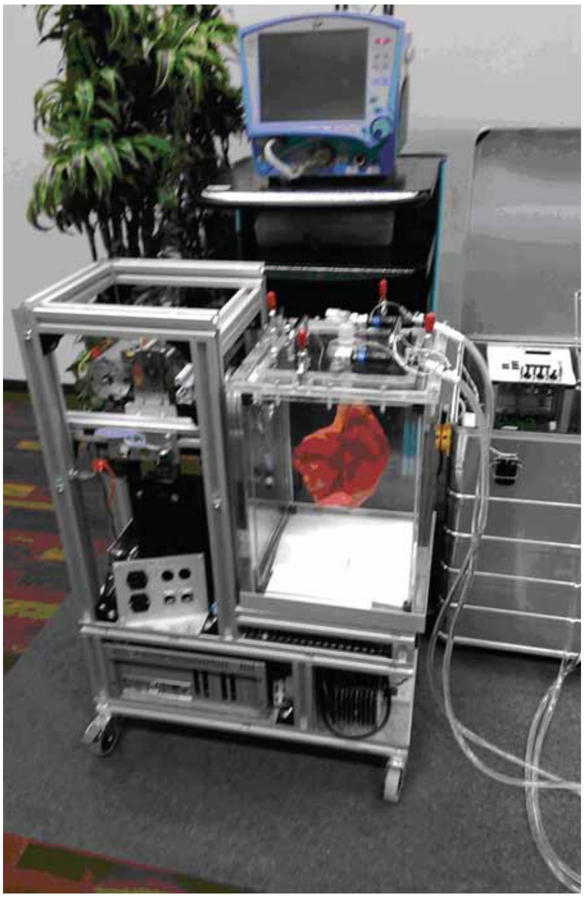

Fig. 1: Exemplary setup for data acquisition including breathing values, sensor data, aerosol measurements

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IT Infrastructure for Multipurpose Medical data Acquisition

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I. Introduction

In a research environment, like a university, data acquisition takes place in multiple fields. The data which is available is highly heterogeneous, but should be stored in a central storage unit. A standards based framework shall be developed which is capable of collecting multiple data formats. The data has to be available in a fast response database for allowing post processing and big data analytics. In a research environment, like a university, data acquisition takes place in multiple fields. The data which is available is highly heterogeneous, but should be stored in a central storage unit. A standards based framework shall be developed which is capable of collecting multiple data formats. The data has to be available in a fast response database for allowing post processing and big data analytics. Data includes medical vital data like:

- Blood pressure
- Pulse
- Blood oxygenation
- Weight
- EEG, ECG

Furthermore medical data includes also formats from:

- Gait analysis
- Movement analysis of organs
- Breathing data

This set of highly heterogeneous data is collected continuously during projects, thesis works of students and daily testing routines.

II. Tasks

A. Overall Goal of the project

- An architecture for a data acquisition framework should be designed
- System requirements have to be specified
- A prototypic version should be implemented allowing the collection of minimum 3 different data types

B. Specific Goals to be achieved

- Design an architecture for the framework
- Define system requirements
- Choose 3 data types for prototypic implementation
- Build up a small, but scalable version of the framework
- Work along international standards for medical IT
- Show in a small pilot that the concept works (proof of concept)

III. Discussion the greater good

If data would be stored centrally and holistic, covering the entire range of collected information, more useful data analysis could be performed. Statistical analytics could be performed. Medical information about a test person (patient) could be cross-linked. Example could be the link between a gait analysis, a simultaneous ECG and pulse oximetry data.

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