Berner Fachhochschule
Haute école spécialisée bernoise
Bern University of Applied Sciences

2022
Abschlussarbeiten
Travaux de fin d'études
Graduation Theses

Master of Science in Engineering

- Technik und Informatik
- Technique et informatique
- Engineering and Computer Science

Inhalt
Table des matières
Contents

Impressum
Berner Fachhochschule
Technik und Informatik
kommunikation.ahb-ti@bfh.ch

Online
bfh.ch/ti/book

Inserate
bfh.ch/ti/book

Layout
Hot's Design Communication SA

Druck
staempfli.com

Impressum
Haute école spécialisée bernoise
Technique et informatique
communication.ahb-ti@bfh.ch

Online
bfh.ch/ti/book-fr

Annonces
bfh.ch/ti/book-fr

Mise en page
Hot's Design Communication SA

Impression
staempfli.com

Imprint
Bern University of Applied Sciences
Engineering and Information Technology
communication.ahb-ti@bfh.ch

Online
bfh.ch/ti/book-en

Advertisements
bfh.ch/ti/book-en

Layout
Hot's Design Communication SA

Printing
staempfli.com

Editorial
Éditorial
Editorial

Prof. Andreas Habegger
Leiter Master of Science in Engineering
Responsable du domaine Master of Science in Engineering
Head of Division Master of Science in Engineering

Liebe Leserin, lieber Leser

Erneut liegt ein aussergewöhnliches Studienjahr hinter uns. Die schon fast normal gewordenen digitalen Unterrichtsformen konnten wir sukzessive durch vermehrte Hybrid- und Präsenz-Sequenzen ablösen. Was gleichermassen von Dozierenden wie auch von Studierenden geschätzt wurde.

Der Master of Science in Engineering ist ein Kooperationsmaster aller 8 Schweizerischen Fachhochschulen. An der BFH bilden wir spezialisierte Fachkräfte in zehn Profilen aus. Die Studierenden, die dieses Programm absolvieren dürfen, zählen in der Schweiz zu den qualifiziertesten Talenten. Sie werden durch unsere Dozierenden und wissenschaftlichen Mitarbeitenden praxisnah, zukunftsgerichtet und mit vielfältigen Kompetenzen ausgestattet sowie auf die kommenden Herausforderungen in der Berufswelt vorbereitet.

Von grosser Bedeutung sind für uns die Kooperationen mit der Wirtschaft. Ich freue mich deshalb, dass in diesem Jahr erneut zahlreiche Master-Arbeiten zusammen mit Industriepartnern sowie Forschungsinstitutionen durchgeführt werden konnten. Die hier präsentierten Abschlussarbeiten des Master of Science in Engineering zeigen eindrucksvoll auf, dass unsere Absolventinnen und Absolventen über sehr viel Kompetenz, hochaktuelles Fachwissen und Kreativität verfügen und ihre Ziele mit Beharrlichkeit und Liebe zum Detail verfolgen. Damit sind sie bestens für vielfältigste Aufgaben in der Berufswelt gerüstet!

Ich gratuliere Ihnen, liebe Studierende, sehr herzlich zu Ihrem erfolgreichen Abschluss und wünsche Ihnen für Ihre berufliche und private Zukunft alles Gute!

Chère lectrice, cher lecteur,

C'est à nouveau une année académique hors du commun que nous scrutons dans le rétroviseur. Les formes d'enseignement numériques, déjà presque devenues la norme, ont pu être remplacées progressivement par des séquences hybrides et présentielles plus nombreuses, ce qui a été apprécié tant par les professeur-e-s que par les étudiant-e-s.

Le Master of Science in Engineering est un programme d'études proposé conjointement par l'ensemble des huit hautes écoles spécialisées suisses. La BFH forme des professionnel-le-s spécialisés dans dix profils. Les étudiant-e-s qui ont la possibilité de suivre ce programme comptent parmi les talents les plus qualifiés de Suisse. Nos enseignant-e-s ainsi que nos collaborateurs et collaboratrices scientifiques leur enseignent une vaste palette de compétences axées sur la pratique et orientées vers l'avenir, les préparant ainsi aux défis professionnels de demain.

La coopération avec les milieux économiques revêt une grande importance à nos yeux. Je me félicite donc qu'une fois de plus de nombreux mémoires de master aient pu être réalisés en collaboration avec des partenaires industriels et des instituts de recherches. Les travaux de fin d'études du Master of Science in Engineering le montrent avec force : nos diplômé-e-s se distinguent par leurs vastes compétences, leurs connaissances spécialisées de pointe, leur créativité, leur persévérance et leur amour du détail. Ils et elles sont parfaitement équipé-e-s pour faire face aux tâches très diversifiées qui les attendent dans le monde professionnel !

Je saisis cette opportunité pour vous féliciter, chères étudiantes, chers étudiants, pour l'obtention de votre diplôme et vous adresse mes meilleurs vœux pour votre avenir professionnel et privé !

Dear Reader

Another extraordinary academic year is behind us. We have gradually been able to replace the digital forms of teaching that had become almost the norm with hybrid and in-person tuition, a development that was much appreciated by lecturers and students alike.

The Master of Science in Engineering is a cooperative master's programme run by all eight Swiss universities of applied sciences. At BFH, we train specialised professionals in ten profiles. The students who are admitted to this programme are some of the best-qualified talents in Switzerland. They are equipped by our lecturers and academic staff in a practice-driven, future-oriented manner, and with a diverse range of skills, to be prepared for the challenges they will soon be facing in the world of work.

Collaboration with industry being of great importance to us, it gives me all the more pleasure to note that this year, once again, numerous Master's theses have been produced in conjunction with industrial partners as well as research institutions. The Master of Science in Engineering theses presented here demonstrate impressively that our graduates possess a great deal of expertise, cutting-edge knowledge, creativity, and pursue their goals with tenacity and attention to detail. This means that they are ideally equipped for a wide range of challenges in the world of work.

I would like to congratulate all our students on their graduation and wish them every success in their professional and personal life.

Master of Science in Engineering an der BFH
Le Master of Science in Engineering à la BFH
Master of Science in Engineering at BFH

An der Berner Fachhochschule BFH wird anwendungsorientiert gelehrt und geforscht. Das Zusammenspiel von Lehre, Forschung und Entwicklung sowie Weiterbildung gewährleistet am Departement Technik und Informatik Praxisnähe, innovative und zukunftsgerichtete Lösungen, gepaart mit unternehmerischem Spirit.

Der Master-Studiengang Master of Science in Engineering (MSE) ist ein gemeinsames Bildungsangebot aller Schweizer Fachhochschulen. Das MSE Diplom ist der höchste akademische Abschluss, den die Fachhochschulen im Bereich Technik und Informatik, Life Sciences sowie Bauwesen vergeben. Das Studium steht nur den besten Diplomierten der Bachelor-Studiengänge offen. Entsprechend hoch ist auch die Anerkennung dieses Mastertitels, der nunmehr seit über zehn Jahren in dieser Form angeboten wird.

Internationale Ausrichtung

Mit der zunehmenden Internationalisierung steigt die Vergleichbarkeit der Studiengänge. Der internationale Austausch ist ein wichtiger Aspekt dieser Master-Ausbildung: Einerseits sind Studienaufenthalte im Ausland möglich, andererseits bieten mehrere Vertiefungen (Profile) auch eine Mitarbeit in internationalen Forschungsprojekten an. Hinzu kommt, dass die Mehrzahl der zentralen, gesamtschweizerisch organisierten Lehrveranstaltungen in Englisch durchgeführt werden. Dies bringt den Studierenden nebst Kontakten mit Gleichgesinnten aus dem In- und Ausland auch sprachlich einen deutlichen Mehrwert.

Hoher Praxisbezug

Die theoretische Grundausbildung wird von den Schweizer Fachhochschulen gemeinsam an den zentralen Standorten in Lausanne, Zürich und Lugano angeboten. Parallel zum Besuch der Theoriemodule werden die Studierenden von Beginn an in eine Forschungseinheit eingebunden und arbeiten an Projekten aus der Praxis. Die Master-Arbeiten sind alle direkt an

L'enseignement et la recherche à la Haute école spécialisée bernoise BFH sont axés sur les applications. Au sein du département Technique et informatique, l'interaction entre la formation, la recherche et le développement garantit une formation continue axée sur la pratique, des solutions innovantes et orientées vers l'avenir, le tout couplé à l'esprit d'entreprise.

Le programme de Master of Science in Engineering (MSE) est une offre de formation conjointe de l'ensemble des hautes écoles spécialisées suisses. C'est le diplôme le plus élevé décerné par les hautes écoles spécialisées dans les domaines Technique et informatique, Life Sciences et Génie civil. Seuls les meilleurs diplômé-e-s des filières d'études de bachelor y ont accès. La reconnaissance de ce titre de master, proposé sous cette forme depuis plus de dix ans, est d'autant plus élevée.

Orientation internationale

Avec l'internationalisation croissante, il est de plus en plus facile de comparer les filières d'études. L'échange international est un aspect important de cette formation de master : il est d'une part possible de faire des séjours d'études à l'étranger, d'autre part plusieurs orientations (profils) proposent une coopération à des projets de recherche internationaux. En outre, la majorité des cours centraux organisés à l'échelle nationale se déroulent en anglais, ce qui permet aux étudiant-e-s d'entrer en contact avec des personnes de Suisse et de l'étranger partageant les mêmes idées et apporte une véritable valeur ajoutée sur le plan linguistique.

Forte orientation vers la pratique

La formation théorique de base est proposée conjointement par les hautes écoles spécialisées suisses sur les sites centraux à Lausanne, Zurich et Lugano. Parallèlement au suivi des modules théoriques,

Teaching and research activities at Bern University of Applied Sciences BFH place a strong focus on application. At the School of Engineering and Computer Science, the fusion of teaching, research and development and continuing education – coupled with an entrepreneurial spirit – guarantees practice-driven, innovative and future-oriented solutions.

The Master of Science in Engineering (MSE) degree is a programme run jointly by all Swiss universities of applied sciences. The MSE master's degree is the highest academic qualification that these universities can award in engineering, information technology, life sciences and civil engineering. It is only available to the best graduates from the bachelor's degree programmes. This master's degree – which has now been available in this form for over ten years – enjoys an excellent reputation.

International orientation

Increasing internationalisation makes it easier to compare degree programmes. This explains why international exchange is also a key element of this master's programme. Study periods abroad are available and several specialisations (profiles) offer the opportunity to collaborate on international research projects. Furthermore, most of the lectures organised centrally for the whole of Switzerland are held in English, which is of great benefit to students linguistically, as well as giving them the opportunity to meet like-minded peers from Switzerland and abroad.

High degree of practical application

The theoretical foundation courses are provided jointly by the Swiss universities of applied sciences at the central locations in Lausanne, Zurich and Lugano. While undertaking the theory modules, the students are assigned a research unit right away and work on application-oriented projects.

Fragestellungen aus der Wirtschaft gekoppelt. Die Vertiefungen pflegen dabei ihre eigenen Profilierungen, weisen aber eine identische Studienstruktur auf.

Gute Marktchancen

Studienabgänger*innen qualifizieren sich mit dem Master of Science in Engineering für eine Karriere in Forschungs- und Entwicklungsabteilungen, in der Produktion, Logistik, in der Beratung, in der Wirtschaft oder in öffentlichen Institutionen. Oder sie übernehmen Verantwortung bei der Leitung interdisziplinärer Projekte. Weil sie meist schon für ihre Master-Thesis eng mit einem Unternehmen zusammengearbeitet haben, sind ihre Aussichten, anschliessend in der Wirtschaft Fuss zu fassen, exzellent.

Das Weiterbildungsangebot richtet sich an Ingenieur*innen und angehende Manager*innen, die ihre Kompetenzen erweitern oder ergänzen wollen. Nebst den Tätigkeiten in den Bereichen Lehre und Weiterbildung wird anwendungs- und marktorientierte Forschung betrieben, um den Wissenstransfer in die Wirtschaft und die Nähe zur Industrie zu gewährleisten.

Erfahren Sie über diese nützlichen Links mehr über

- den Master of Science in Engineering MSE: bfh.ch/mse
- das Departement Technik und Informatik: bfh.ch/ti
- Forschung an der BFH: bfh.ch/forschung
- Weiterbildungsangebote am Departement Technik und Informatik: bfh.ch/ti/weiterbildung
- ein Bachelor-Studium: bfh.ch/ti/bachelor
- ein Master-Studium: bme.master.unibe.ch bfh.ch/mse precision-engineering.unibe.ch
- die Zusammenarbeit mit der Industrie: bfh.ch/ti/industrie

les étudiant-e-s sont intégrés dès le début à une unité de recherche et travaillent sur des projets pratiques. Les travaux de master sont tous liés directement aux défis du monde économique. Les orientations gèrent leurs propres profilages mais présentent une structure d'études identique.

Bonnes opportunités sur le marché

Avec le Master of Science in Engineering, les diplômé-e-s sont qualifiés pour une carrière dans des départements de recherche et développement, dans la production, la logistique, le conseil en entreprises ou dans des institutions publiques. Ils et elles peuvent aussi assumer la direction de projets interdisciplinaires. Ayant souvent déjà collaboré étroitement avec une entreprise dans le cadre de leur mémoire de master, leurs perspectives de s'implanter dans le milieu économique sont excellentes.

L'offre de formation continue s'adresse aux ingénieur-e-s et aux futur-e-s managers. Ce domaine de spécialité garantit le transfert des connaissances dans le monde de l'économie et la proximité avec l'industrie.

Quelques liens vers des informations utiles sur

- le Master of Science in Engineering (MSE) : bfh.ch/fr-mse
- le département Technique et informatique : bfh.ch/ti/fr
- la recherche à la BFH : bfh.ch/recherche
- Offre de formation continue du département Technique et informatique : bfh.ch/ti/formationcontinue
- les études de bachelor : bfh.ch/ti/bachelor
- les études de master : bme.master.unibe.ch bfh.ch/fr-mse precision-engineering.unibe.ch
- la collaboration avec l'industrie : bfh.ch/ti/industrie

The master's theses are all directly linked to commercial issues. The specialisations develop their own profile but have an identical study structure.

Good market opportunities

Master of Science in Engineering graduates are well qualified for careers in research and development departments, production, logistics, business consulting and public institutions. Some assume responsibility for the management of interdisciplinary projects. As most have already worked closely with a company on their master's thesis, they have excellent prospects when it comes to getting established in their career in industry.

The continuing education programmes are aimed at engineers and prospective managers who wish to extend or enhance their skills. In addition to our activities in teaching and continuing education, we conduct application-led, market-oriented research to ensure an efficient knowledge transfer and close ties to industry.

Here are some useful links to learn more about

- the Master of Science in Engineering (MSE): bfh.ch/en-mse
- the School of Engineering and Computer Science: bfh.ch/ti/en
- research at BFH: bfh.ch/research
- continuing education courses at the School of Engineering and Computer Science: bfh.ch/ti/continuingeducation
- Bachelor studies: bfh.ch/ti/bachelor
- Master studies: bme.master.unibe.ch bfh.ch/en-mse precision-engineering.unibe.ch
- cooperation with the industry: bfh.ch/ti/industry

Steckbrief
Fiche signalétique
Fact Sheet

Titel/Abschluss
Master of Science (MSc)

Studienform
Vollzeitstudium (3 Semester) oder Teilzeitstudium (7 Semester)

Unterrichtssprache
Englisch/Deutsch oder Englisch/Französisch

Vertiefungen
Der Master of Science in Engineering umfasst eine breite Palette an fachlichen Kompetenzen. Diese sind schweizweit in vierzehn Profile gegliedert. Der MSE kann an der Berner Fachhochschule in zehn Profilen erworben werden:

- Business Engineering
- Civil Engineering
- Computer Science
- Data Science
- Electrical Engineering
- Energy and Environment
- Mechanical Engineering
- Mechatronics and Automation
- Medical Engineering
- Photonics

Das gewählte Profil ermöglicht eine beinahe massgeschneiderte fachliche Vertiefung, welche an einer unserer Forschungseinrichtungen in enger Zusammenarbeit mit einem Advisor absolviert wird.

Master-Arbeit
Die Praxisorientierung des Studienganges ist zentral: Studierende werden in Forschungsprojekte einbezogen und schreiben ihre Master-Thesis (im Vollzeitstudium ein, im Teilzeitstudium zwei Semester) in der Regel in Zusammenarbeit mit einem Unternehmen.

Kontakt
Haben Sie Fragen zum Master-Studiengang MSE? Wir freuen uns auf Ihre Kontaktaufnahme!

032 321 62 37
mse@bfh.ch (Sekretariat)

Mehr Informationen
bfh.ch/mse
bfh.ch/book-mse

Titre/Diplôme
Master of Science (MSc)

Forme des études
Études à plein temps (3 semestres) ou à temps partiel (7 semestres)

Langues d'enseignement
Anglais/allemand ou anglais/français

Orientations
Le Master of Science in Engineering englobe une large palette de compétences techniques. Celles-ci sont structurées en 14 profils à l'échelle nationale. Le MSE est proposé en dix profils à la Haute école spécialisée bernoise :

- Business Engineering
- Civil Engineering
- Computer Science
- Data Science
- Electrical Engineering
- Energy and Environment
- Mechanical Engineering
- Mechatronics and Automation
- Medical Engineering
- Photonics

Le profil choisi offre un approfondissement presque sur mesure des connaissances techniques dans l'une de nos unités de recherche, en étroite collaboration avec un mentor.

Mémoire de master
L'orientation pratique de la filière d'études est centrale : les étudiant-e-s sont impliqué-e-s dans des projets de recherche et rédigent généralement leur mémoire de master en collaboration avec une entreprise. Pour la rédaction du mémoire, ils et elles disposent d'un à deux semestres complets selon qu'ils et elles étudient à temps plein ou à temps partiel.

Contact
Avez-vous des questions sur la filière d'études de master MSE ?
N'hésitez pas à nous contacter !

+41 32 321 62 37
mse@bfh.ch (Secrétariat)

Pour en savoir plus
bfh.ch/fr-mse
bfh.ch/book-mse

Title/degree
Master of Science (MSc)

Mode of study
Full-time study (3 semesters) or part-time study (7 semesters)

Language of instruction
English/German or English/French

Specialisations
The Master of Science in Engineering covers a wide range of specialist skills. These are divided into 14 profiles throughout Switzerland. The MSE can be obtained in ten profiles at Bern University of Applied Sciences:

- Business Engineering
- Civil Engineering
- Computer Science
- Data Science
- Electrical Engineering
- Energy and Environment
- Mechanical Engineering
- Mechatronics and Automation
- Medical Engineering
- Photonics

The profile selected enables candidates to undertake an almost custom-made specialisation, which is completed at one of our research institutions under the close supervision of an advisor.

Master's thesis
The practical focus of the degree programme is of prime importance: students participate in research projects and generally write their master's thesis – which takes an entire semester on the full-time programme and two entire semesters on the part-time programme – in general in collaboration with a company.

Contact
Do you have any questions about the MSE master's degree programme?
We look forward to hearing from you.

032 321 62 37
mse@bfh.ch (faculty office)

More information
bfh.ch/en-mse
bfh.ch/book-mse

Interviews mit Studierenden
Interviews d'étudiant-e-s
Interviews with students

Léo Lapeyre

Why did you decide to do this programme?

I decided to do an MSE since it offers the possibility to earn experimental knowledge from the research laboratory (Plasma Surface Engineering, ALPS), where I was hired on a 50% part-time basis, and at the same time, to follow the solide programme offered by the MSE with the different engineering schools in Switzerland. The freedom given to the students, who can choose the courses they want to follow, must also be underlined, as the students can therefore learn what really interests them. In that way, the curriculum is optimised for their professional plans and their preferences, which offers much more motivation than a classic, strict educational programme.
This combination of theory and practice is, in my opinion, the best way to become a skilful engineer. It gives the opportunity to discover the world of applied research in close collaboration with industrial partners. The learning field is extremely wide and the students' work never becomes boring.

How was your daily schedule during your studies? What did you like best?

The schedule differs from one semester to the other, but a typical day during the MSE would begin with lectures in the morning, whether in Lausanne, Bern, Zurich or Geneva. In the afternoon, I was back at BFH to work on my master projects at the Plasma Surface Engineering Laboratory and on the different tasks related to the lab, apart from the master projects. Being able to progress on both a theory/science level and an experimental one in the same day is what I liked the most during my curriculum. It is very stimulating for the students and gives them a sense of confidence and valorisation.

Did you work during your studies?

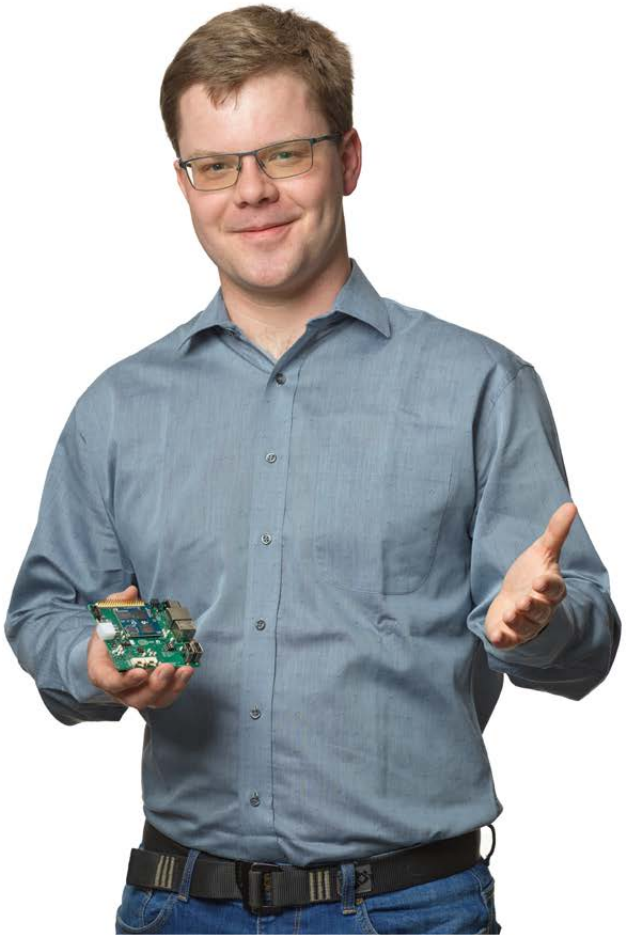
Yes, for the 2 first semesters I was hired at 40% by the PSE lab. My plan was to keep enough time aside for my courses, exercises and exams, which are relatively heavy during the first part of the MSE, and then to move to a 50% contract when the lecture load was lighter, during the last 2 years. The possibility of adjusting the time spent in the lab/classrooms with a certain flexibility is also a strong point of this master. It also makes the students aware of their responsibilities as they have to manage their timetable to fit all the necessary work for the laboratory and the lectures in their week.

What is your career plan after graduation? What is your current occupation? How could you leverage what you have learnt during the program?

I'm currently doing a PhD at Empa (Thun) and I'm planning to continue further in applied research in the field of thin films and material science oriented for energy applications, like batteries. Thanks to the MSE, I began my PhD with already more than 3 years of experience in a research laboratory, which is a not common at the end of a Master. I also oriented the courses I selected for this career plan, which results in a perfectly "tailored" educational plan. Not many curriculums allow to choose between directly joining the industry as an engineer or doing a PhD, with already years of experience (typically not possible with classic masters from universities).

What are your recommendations for future students?

Don't be afraid to do a Master, you will enjoy it and learn many more competences than you could imagine! It will not be easy, but I can assure you that this experience is worth it.



Simon Doppler

Warum haben Sie sich für dieses Studium entschieden?
Ich habe mich für dieses Studium entschieden, um mein Wissen aus dem Bachelor-Studium auszuweiten und zu vertiefen. Für mich war zudem sehr wichtig, dass das Studium sehr praxisorientiert ist.

Wie sah der Studienalltag aus? Was gefiel Ihnen besonders gut an diesem Studium?
Der Studienalltag ist sehr praxisorientiert: Bei vielen Projektarbeiten konnte ich das Wissen aus den Vorlesungen jeweils direkt einfliessen lassen und anwenden. Sehr gut gefallen hat mir auch, dass einzelne Projekte als Teil von einem Grossprojekt während des gesamten Studiums miteinander verbunden waren.

Arbeiteten Sie nebenher (während des Semesters/während der Ferien)?
Ja, ich arbeite Teilzeit als Assistent bei der BFH, in enger Zusammenarbeit mit einem Industriepartner. Diese Zusammenarbeit ermöglicht mir, die Theorie direkt anzuwenden und an aktuellen, angewandten Forschungsprojekten mitzuwirken. Durch die Mitarbeit an einer Produkteentwicklung konnte ich zudem Erfahrungen puncto Industrialisierung sammeln.

Was möchten Sie nach dem Studium machen? Inwiefern können Sie von Ihrem Studium profitieren?
Ich möchte künftig gerne in der Industrie arbeiten. Dabei werde ich sehr vom erlangten Fachwissen im Studium profitieren können, was auch bereits während meiner Anstellung als Assistent bei der BFH der Fall war. Die Firma, die ich während des Studiums kennengelernt habe, wird zukünftig meine Arbeitgeberin sein. So hat der MSE mir nebst fachlichen Kompetenzen und interessanten Projekten auch eine direkte Anstellung bei einem attraktiven Industriepartner ermöglicht.

Welchen Tipp haben Sie für jemanden, der dieses Studium in Betracht zieht?
Sich dafür zu entscheiden! Der Master of Science in Engineering ist ein äusserst vielseitiges und flexibles Studium, in welchem man sehr viel lernen kann. Das Studium fordert durch seine Vielseitigkeit aber auch ein hohes Mass an Selbstorganisation und pflichtbewusstem Handeln. Durch die richtige Wahl des Advisors ist es aber eine fruchtbare Ausbildung.

Zusammenarbeitsformen
Formes de collaboration
Collaboration

Neue Erkenntnisse gewinnen, Synergien schaffen, Praxisnähe erfahren: Die Berner Fachhochschule arbeitet in der angewandten Forschung und Entwicklung eng mit der Wirtschaft und der Industrie zusammen. Dadurch wird die Verknüpfung von Forschung und Lehre gestärkt, und es fliesst neues Wissen in den Unterricht ein. Dies führt zu einer qualitativ hochwertigen und praxisnahen Lehre. Damit Unternehmen bereits heute die Spezialistinnen und Spezialisten von morgen kennenlernen oder sich an eine Thematik herantasten können, besteht die Möglichkeit, Projekt- oder Abschlussarbeiten in Zusammenarbeit mit Studierenden durchzuführen. Als Wirtschaftspartner können Sie Themen vorschlagen. Werden Themen gewählt, bearbeiten Studierende diese alleine oder in kleinen Gruppen in dafür vorgesehenen Zeitfenstern selbstständig. Dabei werden die Studierenden von ihrer Fachperson sowie einer Dozentin oder einem Dozenten der Berner Fachhochschule betreut. Die Rechte und Pflichten der beteiligten Parteien werden in einer Vereinbarung geregelt.

Möchten Sie Themen für studentische Arbeiten vorschlagen und mehr über eine mögliche Zusammenarbeit erfahren? Kontaktieren Sie uns und überzeugen Sie sich vom Innovationspotenzial unserer Studierenden.

bfh.ch/ti/industrie

Acquérir de nouvelles connaissances, créer des synergies, découvrir la pertinence pratique : dans le domaine de la recherche appliquée et du développement, la Haute école spécialisée bernoise travaille en étroite collaboration avec l'économie et l'industrie. Le lien entre la recherche et la formation est ainsi renforcé et l'enseignement profite des nouvelles connaissances. Il en résulte une formation de grande qualité, axée sur la pratique. Pour que les entreprises puissent faire aujourd'hui déjà la connaissance des spécialistes de demain ou aborder un sujet particulier, elles ont la possibilité de réaliser des projets ou des travaux de fin d'études en collaboration avec des étudiant-e-s. En tant que partenaire économique, vous pouvez proposer des thèmes. S'ils sont choisis, les étudiant-e-s les traitent ensuite de manière autonome, seul-e-s ou en petits groupes, dans les créneaux horaires prévus à cet effet. Ils et elles sont encadré-e-s par votre spécialiste ainsi que par un-e enseignant-e de la Haute école spécialisée bernoise. Une convention régit les droits et obligations des parties au projet.

Souhaitez-vous proposer des thèmes pour des travaux d'étudiant-e-s et en savoir plus sur une éventuelle collaboration ? Contactez-nous et laissez-vous convaincre par le potentiel d'innovation de nos étudiant-e-s.

bfh.ch/ti/industrie

Gain new insights, create synergies, experience practical relevance: Bern University of Applied Sciences BFH works closely with business and industry in areas of applied research and development. This strengthens the link between research and education, allowing new knowledge to flow into our teaching, which leads to high-quality and practice-oriented degree programmes. In order for companies to meet our future specialists or to explore a topic, they can carry out projects or theses in cooperation with our students. As a business partner, you can suggest topics. Once these topics are selected, the students work on the projects independently, either individually or in small groups, within designated time frames. They are supervised by both your specialist and a BFH lecturer. The rights and obligations of the parties involved are set out in a written agreement.

Would you like to suggest topics for student projects and find out more about a possible cooperation? Contact us and convince yourself of the innovation potential of our students.

bfh.ch/ti/industry

Studentische Arbeiten | Travaux d'étudiant-e-s | Student projects
Das Modell einer flexiblen Zusammenarbeit mit Industrie und Wirtschaft wird in studentischen Arbeiten erfolgreich umgesetzt:
La flexibilité du modèle de collaboration avec l'industrie et l'économie se concrétise avec succès dans les travaux d'étudiant-e-s:
The model of flexible cooperation with industry and business is successfully implemented in student projects:

Semesterarbeiten, Bachelor-Thesis, Master-Thesis
Travaux de semestre, travail de bachelor, mémoire de master
Semester projects, bachelor thesis, master thesis

Wochen bis Monate
De quelques semaines à plusieurs mois
Several weeks or months

Kostenbeitrag zulasten des Auftraggebers
Frais à charge du donneur d'ordre
Costs are at the expense of the client

Auftragsforschung und Dienstleistungen | Recherche sous contrat et prestations de service | Contract Research and Services
Wir bieten Auftragsforschung und erbringen vielfältige Dienstleistungen für unsere Kundinnen und Kunden (inkl. Nutzung der BFH-Infrastruktur sowie des Forschungsnetzwerkes). | Nous effectuons des recherches sous contrat et fournissons une vaste palette de prestations de services à nos clientes et clients – y compris l'utilisation des infrastructures BFH et du réseau de recherche. | We carry out contract research and provide a wide range of services for our clients, such as exclusive use of the BFH infrastructure and the research network.

Planung, Coaching, Tests, Expertisen, Analysen;
durchgeführt von Expertinnen und Experten
Planification, coaching, tests, expertises, analyses par des expert-e-s
Planning, Coaching, Tests, Expertise, Analysis: done by experts

Wochen bis Monate
De quelques semaines à plusieurs mois
Several weeks or months

Marktübliche Preise
Prix du marché
Prevailing prices

F&E-Kooperationen | Coopérations R&D | R & D Collaboration
Die BFH-TI erbringt Leistungen im Bereich der angewandten Forschung und Entwicklung:
La BFH-TI fournit des prestations de service dans le domaine de la recherche appliquée et du développement:
The BFH-TI provides services in Applied Research and Development:

Kooperationen mit Fördermitteln – mittlere und
grössere Projekte mit:
Coopérations bénéficiant de subventions – projets de moyenne
et grande envergure avec:
Public Aid – medium and large-sized projects with:

Innosuisse, SNF / FNS, EU / UE

Monate bis Jahre
De quelques mois à plusieurs années
Several months or years

Teilfinanziert durch
öffentliche Fördergelder
Financement partiel par
des subventions publiques
Partly public funding

Industriepartner
Partenaires industriels
Industry partners

Eine enge Zusammenarbeit mit Industriepartnern ist uns äusserst wichtig. Zahlreiche Abschlussarbeiten sind in Kooperation mit Firmen aus der ganzen Schweiz entstanden. Wir bedanken uns bei diesen Firmen für die fruchtbare Zusammenarbeit!

bfh.ch/ti/industrie

À nos yeux, une collaboration étroite avec des partenaires industriels est extrêmement importante. De nombreux mémoires se font en partenariat avec des entreprises de toute la Suisse. Nous remercions ces entreprises pour cette fructueuse collaboration !

bfh.ch/ti/industrie

A close cooperation with industrial partners is very important to us. Numerous bachelor's theses have been produced in cooperation with companies from Switzerland. We thank these companies for the fruitful collaboration!

bfh.ch/ti/industry

Cartier Horlogerie, Branch of Richemont International Sa, La Chaux-de-Fonds
Logistikbasis der Armee, Bern
Rychiger AG, Steffisburg
SBB AG, Bern

Liste der Studierenden
Liste des étudiant-e-s
List of students

Im Folgenden präsentieren wir Ihnen die Zusammenfassungen der Abschlussarbeiten* des Jahres 2022.

Die Studierenden haben die Texte – teils mit Unterstützung der betreuenden Dozierenden – selbst verfasst. Die Texte wurden vor Publikation nicht systematisch redigiert und korrigiert.

*Der Begriff «Abschlussarbeiten» ist mit Bedacht gewählt. Zum Zeitpunkt des Druckes handelt es sich um die Abschlussarbeiten von noch nicht diplomierten Studierenden. Nach Erhalt des Diploms entspricht die Abschlussarbeit der Diplomarbeit.

Ci-après, nous vous présentons les résumés des travaux de fin d'études de l'année 2022.

Les étudiant-e-s ont rédigé les textes de façon autonome, parfois avec l'aide des enseignant-e-s qui les encadrent. Les textes n'ont pas systématiquement été relus ou corrigés avant publication.

On the next pages, we present the summaries of the graduation theses of the year 2022.

The texts were written by the students themselves, with some support from their lecturers. They were not systematically edited or corrected before publication.

Grid disturbances caused by electromobility -Results and analysis of field measurements

Degree programme: Master of Science in Engineering | Specialisation: Energy and Environment
Thesis advisor: Prof. Michael Höckel
Expert: Dr. Andreas Beer

Extensive measurement campaigns were carried out in several power grids in Switzerland to analyze the impact of the electromobility on the power quality. Different types of stations were investigated, including Type 2 (onboard charging), CCS (DC), CHAdeMO (DC) and a bus charging station. The results contain the analysis of current harmonic emissions, voltage harmonics, supraharmonics and voltage unbalance.

Introduction

Driven by the global task to reduce fossil fuel consumption, many countries are turning to electromobility. However, the charging infrastructure for electric vehicles is still underdeveloped in most places it will need to grow to meet demand in the coming years. The development of new electric vehicles and charging technologies has raised many questions related to their interaction with the grid. The objective of this work was to determine possible impacts of charging stations on the distribution grid. The focus is on potential power quality disturbances that may occur in the system and should be considered in the design of the infrastructure. This was determined by taking measurements on charging stations in different areas of the Swiss power grid. Subsequently, these measurements were analyzed and evaluated using existing norms and guidelines to identify any particular behavior of the devices. The different behaviors were described in each measurement point with the special characteristics noticed and recommendations are presented as well as overview of the behavior.

Goals

The goal of the work was to provide a better understanding of the impact of EV-Charging stations on the power quality of the grid.

- Perform power quality measurements of EV-Charging stations in different scenarios and of different types of charging stations across Switzerland
- Analyze the effect on the grid and additional load produced by electromobility
- Analyze the emission of current harmonics and compensation effects on the transmission grid
- Analyze the effects of electromobility in voltage quality

Conclusions

The Type-2 charging stations which are the most widespread across Switzerland don't evidence important impact in voltage harmonics. The current harmonic emissions in most stations don't comply with the D-A-CH-CZ for the 15th component, but this harmonic doesn't violate any voltage limits of IEC-50160 in general. The harmonic currents increased when multiple stations were connected, but the currents are relatively small as well as their impact in voltage. If the existing guidelines are followed the impacts in voltage unbalance and flicker are minimal.

The fast-charging infrastructures are recommended to have a dedicated transformer due to the high harmonic currents. The correlation on these station between the voltage harmonics that are close to the limit values is very low, even in some cases compensation (decrease of existing harmonic voltage) was seen, for this reason no harmful effects on the voltage harmonics of the grid were identified. The bus charging station has a big impact in high order harmonics as well as in the supraharmonic region in frequencies around 10 kHz. The current emissions have high values for low order harmonics such as 3rd,7th and 9th. The 3rd causes an increase in the voltage but for the 5th and 7th there were compensations.

The effects on the load situation are handled with exclusive transformers and control systems that regulate the charging power to ensure limits are not exceeded and charging times are optimized. When doing a full charging cycle using on-board chargers, it was noticed that the strategy to reduce the total power by reducing the number of phases connected at nominal current, reduces the harmonic production. It was seen that location is one of the main factors for the harmonic current differences. The charging stations react to the harmonic voltages flowing in the grid and currents are produced. This makes it difficult to identify the source of the harmonic currents. Therefore, it is advised to perform power quality measurements in the sites on a regular basis to overview the interaction of the different elements and use harmonic mitigation filters if required.

Jorge Luis Acuna Espinoza
jorgeae3@gmail.com

Dynamic OCT signal loss in microsecond microsurgery

Degree programme: Master of Science in Engineering | Specialisation: Photonics
Thesis advisor: Prof. Christoph Meier

State-of-the-art treatment for retinal diseases by laser photocoagulation (LPC) leads to collateral damage to all retinal layers. This work investigates the optimal parameters for optical coherence tomography (OCT) based irradiation dosimetry for the new and gentler selective retina therapy (SRT). An experimental treatment setup was built for the improvement of this dosimetry method.

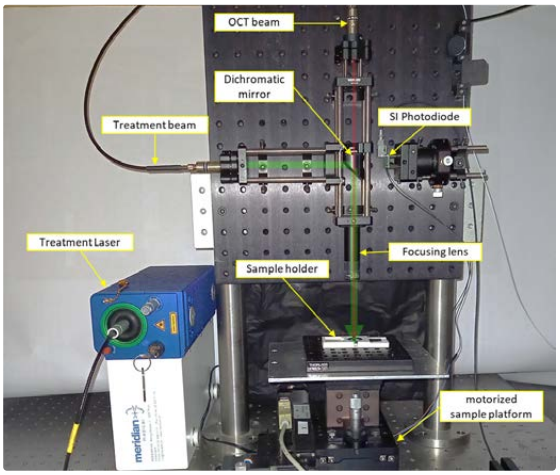
Mylène Amstutz

Introduction

LPC is currently the most common treatment method for retinal diseases. During LPC Long laser pulses (several hundred milliseconds) are absorbed by the retinal pigment epithelium (RPE) which leads to thermal cell destruction. Unfortunately, the heating process leads to collateral damage to all retinal layers including healthy, non-regenerative photoreceptors. The emerging selective retina therapy (SRT) is a gentler method, where laser pulses in the low-microsecond range cause rapid heating of melanosomes. This leads to microbubble formation (MBF) on the melanosome surface without heating the surrounding layers. The consequence is selective RPE cell death while leaving the surrounding tissue intact.

Goal

A remaining challenge in reaching truly selective cell death is the RPE's strongly varying melanin concentration. To avoid insufficient or excessive exposure, the irradiation energy must be closely controlled. This can be achieved with OCT imaging. During SRT, time-resolved OCT Mscans show dynamic signal changes, so-called washouts, that correlate to the size and occurrence of treatment lesions. The goal of this work is to investigate the optimal OCT parameters to reliably detect OCT signal washouts and therefore achieve higher accuracy in the future with this dosimetry method.



The experimental testbench which combines SRT and OCT, that was developed during this master's thesis.

Method

During this master's thesis, an experimental SRT testbench was built, that combines an interchangeable OCT system with the modified MERILAS 532 Short pulse laser (Meridian, Thun, CH) which allows SRT treatment. Additionally, a treatment software was developed that gives full control over all treatment and OCT parameters. A variety of experiments were conducted on ex-vivo porcine eyes to investigate the influence of various OCT parameters on the detectability of signal washouts.

Results

Changes in the OCT spectrometer camera recording speed from 1.5 kHz to 77 kHz did not affect the outcome of the washout detection as long as the Signal to Noise Ratio was high enough. However, the results imply that in combination with the treatment pulse timing, the recording speed could change the detectability of MBF with OCT. Further, a high sensitivity should be preferred over a high axial resolution in an SRT dosimetry OCT system.

Conclusion and Outlook

This work showed, that a simpler and less expensive OCT system could be used for SRT dosimetry control. In the future, the setup could be improved by integrating a scanning head, which would allow cross-sectional OCT imaging of the samples. Furthermore, additional dosimetry methods such as reflectometry and optoacoustic in combination with OCT could allow a deeper investigation of the MBF.

Alterungsoptimierte Batteriebewirtschaftung mithilfe von Open-Source-Simulation

Studiengang: Master of Science in Engineering | Vertiefung: Energy and Environment
Betreuer: Prof. Dr. Andrea Vezzini
Experte: Ueli Kramer (SBB AG)
Industriepartner: SBB AG, Bern

Die SBB hat sich zum Ziel gesetzt, ihre Rangier- und Baustellenlokflotte auf emissionsarme Alternativen umzurüsten, oder durch solche zu ersetzen. In Zukunft werden daher vermehrt auch Loks mit Traktionsbatterien auf dem Schienennetz verkehren. Mithilfe einer im Rahmen dieser Arbeit entwickelten, semi-empirischen Batteriesimulation wurde der Einfluss von unterschiedlichen Betriebsstrategien auf die Alterung von zukünftig eingesetzten Batteriespeichersystemen untersucht.

Ausgangslage:

Dank Loks mit integrierten Batteriespeichersystemen soll in Zukunft ein emissionsarmer Rangier- und Baustellenbetrieb auf nichtelektrifizierten Streckenabschnitten gewährleistet werden. Das derzeitige Antriebskonzept sieht vor, dass die Batteriespeicher der Loks über die Fahrleitung geladen werden können. Durch die Anbindung an das Energieversorgungsnetz der SBB, lassen sich die Speicher, nebst der primären Anwendung als Traktionsbatterien, auch für sekundäre Anwendungen, wie das Schneiden von Lastspitzen, nutzen. Sowohl die primäre als auch die sekundäre Nutzung lässt die Speichersysteme altern. Ziel dieser Arbeit war es, die Alterung durch unterschiedliche Betriebsstrategien zu quantifizieren und zu optimieren. Darüber hinaus wurde der Alterungseinfluss von netzdienlichen Speicheranwendungen, wie dem Schneiden und Glätten des Gesamtlastprofils, analysiert.

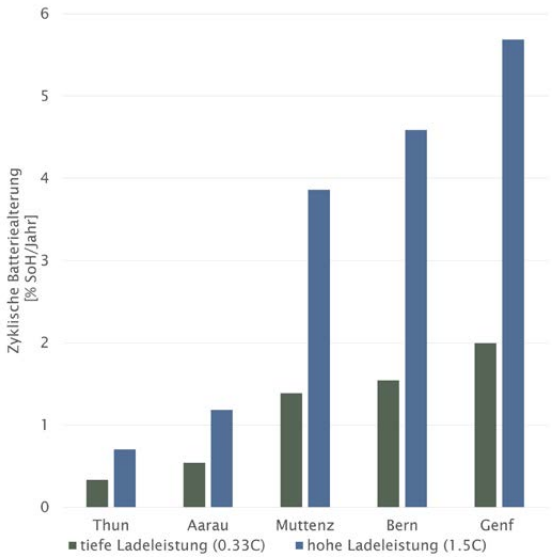
Vorgehen:

Die bestehende Simulationsumgebung wurde mithilfe objektorientierter Programmierung in Python soweit angepasst, dass sich Lithium-Ionen-Batterien unterschiedlicher Zellchemie simulieren lassen. Um die Degradation beschreiben zu können, berücksichtigt die Simulation verschiedene Stressfaktoren, welche die Zellalterung anhand der derzeitigen Batterienutzung beschreiben. Als Grundlage dazu dienen historische Messdaten von unterschiedlichen Zelltypen. Der derzeitige Rangierbetrieb konnte anhand von aufgezeichneten Messdaten auf den Fahrzeugen nachvollzogen werden. Ausgehend von den Messdaten wurden Lastprofile für zukünftige Speichersysteme erstellt, wobei zwischen nichtelektrifizierten und elektrifizierten Streckenabschnitten unterschieden wurde. Mithilfe der Lastprofile und der Simulationsumgebung konnte die Alterung der Speichersysteme, unter Berücksichtigung unterschiedlicher Bewirtschaftungsstrategien, simuliert werden.

Resultate:

Die Simulationsumgebung wurde weiterentwickelt und erlaubt die Simulation von unterschiedlichen Lithium-Ionen-Zelltypen. Der modulare Aufbau und die öffentliche Verfügbarkeit des Quellcodes erlauben einen Einsatz der Simulationsumgebung in unterschiedlichen Projekten. Bei der Simulation der einzelnen Bewirtschaftungsstrategien zeigte es sich, dass eine tiefe Ladeleistung und eine Reduktion des Ladezustands (SoC = State of Charge) der Speicher bei abgestellten Fahrzeugen einen positiven Einfluss auf die Alterung des Speichers haben. Beides liesse sich bei den Speichern gemäss der derzeitigen Flottennutzung betrieblich realisieren. Der netzdienliche Speichereinsatz würde zu zusätzlicher Speicherdegradation und damit zu weiteren Kosten führen. Anhand der Simulationsergebnisse lassen sich diese Kosten dem Nutzen, der für das SBB-Energienetz entsteht, gegenüberstellen.

Marco Beyeler
marco-beyeler@gmx.ch



Zyklische Batteriealterung an Standorten mit unterschiedlicher Nutzung (NMC-Zellen)

Isolated gate driver power supply with integrated PCB capacitive coupling communication

Degree programme: Master of Science in Engineering | Specialisation: Energy and Environment
Thesis advisor: Prof. Dr. Sébastien Mariéthoz
Expert: Dr. Silvio Colombi

This thesis is part of a bigger project which focuses on the development of an isolated multilevel AC/DC converter for medium voltage AC and low voltage DC grids. In addition to the sizing of the power electronics, there are insulation limits that must be respected to ensure a correct and safe operation. In order to power and control this converter power module boards, an isolated system has been developed.

Riccardo Coiro
riccardo.coiro@gmail.com

Context

The AC/DC converter consists of cell inverters mounted in cascade in the medium voltage AC part to ensure the desired voltage. These cells will be connected to modules with an AZCS (Active Zero Current Switching) topology that will ensure isolation and transfer the power to the low voltage DC network. The idea is to develop an interface that both guarantees the isolation and transmits the power and the control signals to the control boards of the power modules.

Goal

The aim of this project is to develop a prototype of an isolated driver that allows the simultaneous transmission of power and the command signals.

Starting point

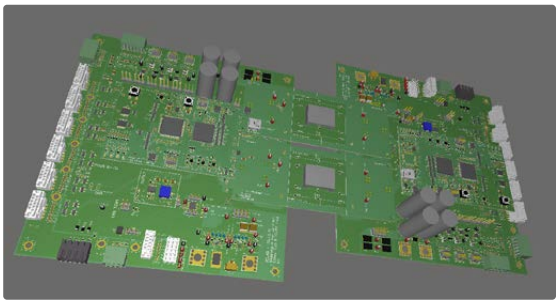
In order to develop the isolation system needed to transmit the signals and the power, it was initially necessary to complete the construction of the AZCS modules developed in the BFH power electronics laboratory. Then a first prototype of the isolated power supply was redesigned to supply the control boards for the AC/DC converter power electronics. Eventually, the isolated communication channel had to be integrated into the power supply through capacitive elements integrated on the PCB.

Implementation

First of all, the operation of the AZCS converter was analysed, in order to complete its hardware. Therefore, the control board for the IGBT power modules was developed. Then, a safety standard zone was conceived to carry out the commissioning and the measurements of the losses of each power element of the AZCS converter.
Based on an existing prototype of an isolated DC/DC converter, it was possible to resize it by redesigning a 500kHz planar transformer to transfer adequate power, 12V/50W, to supply the control boards of the AZCS converter. The transformer was designed to isolate two areas with potential differences of 14.5kV. It included a shield that contained the high electric fields, which was exploited to create an isolated communication channel through capacitive elements integrated on the PCB. Afterwards, it was possible to implement a prototype that consisted of two PCBs interconnected through the transformer with integrated isolated communication. On the two PCBs there was the Layout of the DC/DC converter with a control board (uC+FPGA) that could control the transfer of the power and manage a communication protocol. In order to make the communication channel immune to interference from power electronics, a RLC band-pass filter using the integrated capacitive elements was implemented. The communication protocol applied is of the OOK type.

Results

The development of the AZCS converter has been successful. So far, it has been possible to run initial tests up to a maximum RMS current flowing through the converter of 60A with total losses equal to 1.375% of the rated power estimated during the test of 42kW. An isolated driver prototype has been built and validated by transferring 12V/8W of power at the frequency of 500kHz simultaneously trasmitting a signal with a BaudRate of 25MBit/s under a common mode transient voltage perturbation of 2.85kV/us.



Isolated Driver Prototype Board

Experimental test bench for GaN multilevel topologies

Degree programme: Master of Science in Engineering | Specialisation: Energy and Environment
Thesis advisors: Timothé Delaforge, Prof. Dr. Sébastien Mariéthoz
Expert: Alain Lacarnoy (Schneider Electric)

In this thesis, a multilevel topology was studied. After optimizing the layout, the prototype was built and commissioned. Two different topologies are mounted back-to-back in order to make experimental comparisons. Some specificities of this type of converter were investigated, such as the precharge, the voltage balancing or the discharge.

Eric Rudolf Donzé
erdonze@gmail.com

Context

The recent improvements in semiconductors, especially in GaN and SiC components, offer new opportunities to make high efficiency converters in the small and medium power range. The multilevel topologies were used to exceed the voltage limits of traditional components in high voltage technique, whereas today, we try to merge them with new transistors technologies to take up new energy challenges.

Goal

The aim of this project is to develop a test bench with two different multilevel topologies in order to investigate their behaviour in operation and compare them experimentally .The first converter is a „Flying Capacitor“, a prototype that already existed in the PELaB. The second one is a „Stacked Multicell Converter“, this prototype had to be developed.

Starting point

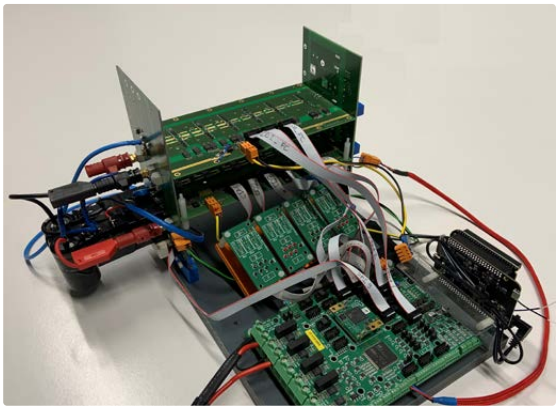
In a previous project, the flying capacitor converter was studied and a new layout was developed. The stacked multicell converter was designed using an optimization software from PELab. For the sake of having a common basis for comparisons, the prototypes use the same GaN technology and the same power rating.

Implementation

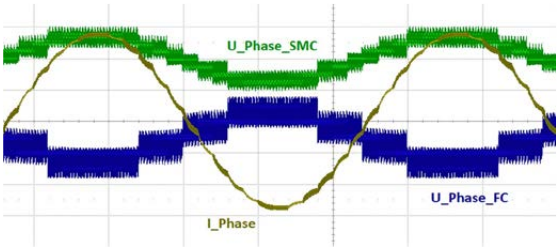
Investigation of SMC operation and control was done on simulation software. Then, to achieve a high efficency converter, an optimal layout was proposed to the commutation cells with the GaN FET to dramatically reduce parasitics. All safety rules were respected to design the SMC PCB board. The FPGA modulator was adapted to SMC special switching pattern to have a correct control on the converter. Finally, the two topologies were put back-to-back to loop the power between the converters so the supply provides only the losses and no need for a load. The security and start/stop processes were validated, just like the voltage balancing, which is specific to these converters. A full investigation was led on the converters over a large domain of operation. Main task was to fine tunning the filters to improve the regulation of the converter and also to resolve EMI problems.

Results and outlook

The objectives were accomplished. The converters work in safe operation, the validation of the new layout is done and the voltage balancing on the two topologies is efficient. Loss analysis was performed allowing comparisons of experimental results with simulations. Futher tests will be done at higher power.



Test bench prototype



Voltage and current waveforms of the test bench

MDB/ICP Firmware for GNU Taler Cashless Payment Device

Degree programme: Master of Science in Engineering | Specialisation: Industrial Technologies
Thesis advisors: Prof. Dr. Christian Grothoff, Prof. Andreas Habegger
Expert: Rico Zoss (Wabtec)

GNU Taler is a free software payment system centered on data protection and fraud elimination. A MDB/ICP cashless payment peripheral allows users to use their wallet at any compatible Point-of-Sale systems such as vending machines.

Motivation

The acceptance of new technologies depends to a large extent on how easy they are to use and the ubiquity of opportunities to use them. A viable cashless payment device that is compatible with all vending machines worldwide is a significant milestone, both for widespread adoption and for quickly demonstrating the power of the payment system.
Current cashless payment systems provide extensive tracking of users by recording enormous amounts of data about their transactions. GNU Taler is technically designed in such a way that both tracking of user information and fraud are impossible. This makes GNU Taler digital cash without the possibility of hiding criminal activity.

Objectives

The primary goal of this thesis is to develop a standalone MDB/ICP (Multi Drop Bus/Internal Communication Protocol) — the communication standard for vending machine peripherals, firmware for a cashless payment device based on open hardware and free software. The firmware must be compliant with the MDB/ICP specification and provide a way to exchange data between the vending machine and a custom application.

GNU Taler MDB/ICP interface

The second goal of this work is to build a demonstrator of the GNU Taler MDB/ICP Cashless Device so that it can be set up at BFH and presented at exhibitions and trade shows.
The test setup must provide a QR code and NFC-based payment interface for the existing GNU Taler wallet application and be compatible with the existing GNU Taler infrastructure, including the taler-mdb vending integration for MDB/ICP compliant vending machines.

Results

This thesis attempted to build a fully self-designed embedded system and identified the remaining issues to achieve that goal. It also created a MDB/ICP Cashless Payment Device based on existing commercial open-hardware modules with a custom made MDB/ICP interface.
This system is based entirely on widely community and vendor supported open-source projects, such as Buildroot and the Linux kernel. It also allows any Linux-based application requiring a MDB/ICP interface to be implemented very easily, by providing access to a serial port.
A self-contained demo, based on a commercial MDB/ICP enabled coffee machine and the existing BFH GNU Taler infrastructure was also set up.

Outlook

The next step will be to finalize the fully self-designed embedded system for MDB/ICP Cashless Payment Device by solving the challenges this thesis identified. On the software side, extending the firmware to support data logging from the MDB/ICP bus and providing support for different kinds of devices (other than the Cashless Payment Device) are on the roadmap, along with maintenance of the software to remain aligned with development of the GNU Taler infrastructure.

Simon Didier Doppler

simon.doppler@
alumni.unistra.fr

Analysis of an Electromagnetic Levitation Actuator with the Application of Open Source FEM

Degree programme: Master of Science in Engineering | Specialisation: Energy and Environment
Thesis advisors: Prof. Dr. Stéphane Félix, Prof. Dr. Sébastien Mariéthoz
Expert: Dr. Martin Veenstra

In this master thesis an electromagnetic levitation actuator is analysed. The purpose of the actuator is to be used to teach control systems. Through the conceptual analysis possible physical principles are identified. The principle to obtain levitation through generated magnetostatic fields is analysed using the Finite Element Method (FEM).

Felix Alexander Grimm

Initial Situation

In a previous project, a simplistic levitation device was used in the practical exercises of the control systems class at the BFH University of Applied Sciences. This device was adjusted in small steps to improve performance and handling without considering the stator design. This consideration requires the development of a new device, whereby physical limits can be better exploited to achieve an increase in performance compared to the existing device. In addition, a development of a new actuator allows the incorporation of new functionalities. Hence, the meaning functionality is either of technological or didactical nature. This means from a technical aspect, the levitating component can move in different ways, e. g. the translation or the rotation around fixed axes in space. In the sense of a didactic aspect, the actuator is a device to support the learning process of the students who conduct the exercise.

Conceptual Analysis

The goal of the conceptual analysis is to identify possible physical principles to obtain electromagnetic levitation, which can be used in a control exercise class. In a first step, principles are reviewed and conducted in experiments. In a second step, existing levitation actuators are presented to gain insights between functionality and physical structure. A morphological matrix is used to categorize the actuator functionalities with their possible solution principles.

FEM Analysis

The goal of the FEM analysis is the investigation of magnetostatic fields. Different candidates are selected. On the one hand side, the purpose of the candidates is to investigate aspects of the actuator's layout. On the other hand, it is investigated how FEM must be handled with respect to an electromagnetic design. For this reason, the application of FEM is done in the software tools Elmer (open source) and Comsol (commercial). Further, the FEM analysis of the actuator is conducted along analytical analysis and experiments.

Results

Concepts

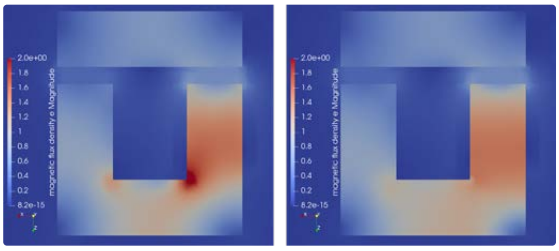
From the findings of the conceptual analysis the inclusion of four different electromagnetic principles is proposed. The principles are electrodynamic levitation, diamagnetic levitation, levitation through the magnetic bound state and electromagnetic levitation through the application of magnetostatic fields. Actuator concepts of the first three principles are proposed through the literature review and the conducted experiments. The added didactic value, to use several principles, is twofold. It enables teaching the control exercise in a stepwise degree of difficulty. Cross-linked knowledge can be achieved through the inclusion of more than one electromagnetic principle in the exercise.

Simulations

The simulated candidates achieve the following four results: - The verification of Biot-Savart law for a closed single current carrying loop (circular, triangular and square-shaped). - The obtained force, energy and inductance values from a gapped UI-Cored coil with linear (permeability) and non-linear (BH-Curve) material settings. - The placement and geometrical variation of magnetizable material in the stationary and levitated part respectively. - The magnetic forces between two opposing permanent magnets.

Conclusion

The analyses lay the foundation to design a levitation actuator which is to be used to teach control systems.



B-Field distribution by an equal current excitation. Simulated with Elmer. Permeability setting left and BH-Curve right.

Solar-powered water pumping systems: Developing a course for technicians in Ghana

Degree programme: Master of Science in Engineering | Specialisation: Energy and Environment
Thesis advisor: Prof. Dr. Andrea Vezzini

As the emerging market for solar-powered water pumps grows, a need for trained technicians arises. This master thesis addresses the issue by creating a course covering the skillsets required to plan, install, operate, maintain, inspect, troubleshoot and repair solar-powered water pumping systems.

Motivation

Solar-powered water pumps offer a promising alternative to fossil-fuel and grid-powered water pumps in locations where water distribution and grid electricity are a challenge. As these systems gain popularity with small-scale farmers and are implemented as solutions for communal water supply, a lack of trained technicians is becoming evident. To address this shortfall and avoid incorrectly executed installations in the field, a course aimed to train technicians is needed.

Objective and development

This master thesis covers the development and implementation of a course for solar-powered water pumping systems. The focus lies on systems suitable for small-scale farmers and for rural water supply with a power range of 0.5 to 2 HP. This course is designed to help technicians learn all the skills needed to plan, install, operate, maintain, inspect, troubleshoot and repair solar-powered water pumping systems. It aims to provide technicians with a broad foundational knowledge of the different types of solar water pumps and their various use cases, their components and the external equipment they use and includes teaching the underlying physics that determine how hydraulic systems behave.

Technicians are also schooled on client instruction to ensure the system's longevity through proper use and maintenance by the end clients.
The course will be carried out once and then handed over to a training center that can conduct the course on its own to enhance autonomy on a local level.
The specific know-how is contributed by the BFH-spinoff ennos ag. The company has several years of experience in the field through the development, sale and after-sales support of their own surface solar water pump, the sunlight pump.

Results and outlook

The course was carried out in a technical training center in Ashaiman, Ghana. The technicians that took part in the course had a professional background as solar installation technicians. They successfully completed the two-week course and have shown competency in theory and practice in a final exam.
In parallel to the course, the content was filmed and will be part of an online learning platform that provides a learning resource for technicians unable to attend the course in person.
The project included training the local teachers and equipping their training center with a designated course book, a lesson plan, as well as the required materials and tools needed for them to offer the course on their own in future installments.

Sebastian Kevin Ossian Hope

Solar-powered water pumping systems - Class of 2022

Students installing a solar water pump for residential use

The influence of reports on management decision making

Degree programme: Master of Science in Engineering | Specialisation: Business Engineering and Production
Thesis advisor: Prof. Dr. Stefan Grösser
Expert: Ing. Adrian Stettler

Internal reports are frequently used in companies. However, the real impact of reports on real decision-making is still uncertain. Moreover, reports are often adapted to the situation and needs of companies. The aim of this study is to analyse which graphical elements are most efficient in helping decision-makers in the decision-making process.

Claudio Giorgio Oscar Keller

Introduction

Managers are faced every day with large amounts of data that, relying on their competences, knowledge and intuition, they use to take decisions. Here, the visualization of this data plays an important role. In fact, the interpretations by decision makers can be highly influenced by the type of visualization. A tool that is useful for decision-makers is the management report. It should give the necessary information to evaluate, decide, and implement actions. However, creating effective and efficient reports is not that simple. Efficient is understood here as the response time; the lower the report readers need to draw their conclusions, the higher the efficiency. Effectiveness is the metric that evaluates the correctness of the answers; the lower the number of wrong answers, the higher the effectiveness. To understand which graphical elements enable the decision-makers to take the right actions in the shortest time, it has been analysed, with the help of an eye-tracking methodology, the gaze and the behavior of a group of people while looking at reports' elements. Gaze is where the reader is looking. Behavior is how the reader is looking at an element.

Objective

Due to the importance of reports for management decision making, in this study the design elements, like tables, bar charts, line charts, pie charts, have been analysed to understand which was more efficient. Research said that tables are preferred when specific information is shown and not to understand trends (Eisl et al., 2013), while diagrams provide better view of data over time (Reardon et al., 2019). Changing over time and trends are also easy to understand with line charts (Archambault et al., 2015), while to show proportion of a whole, divided in a small number of components, seems to be better to use pie charts (Siirtola et al., 2019). In detail, the following question was posed: "Which elements are more efficient to help decision makers to take good decisions?".

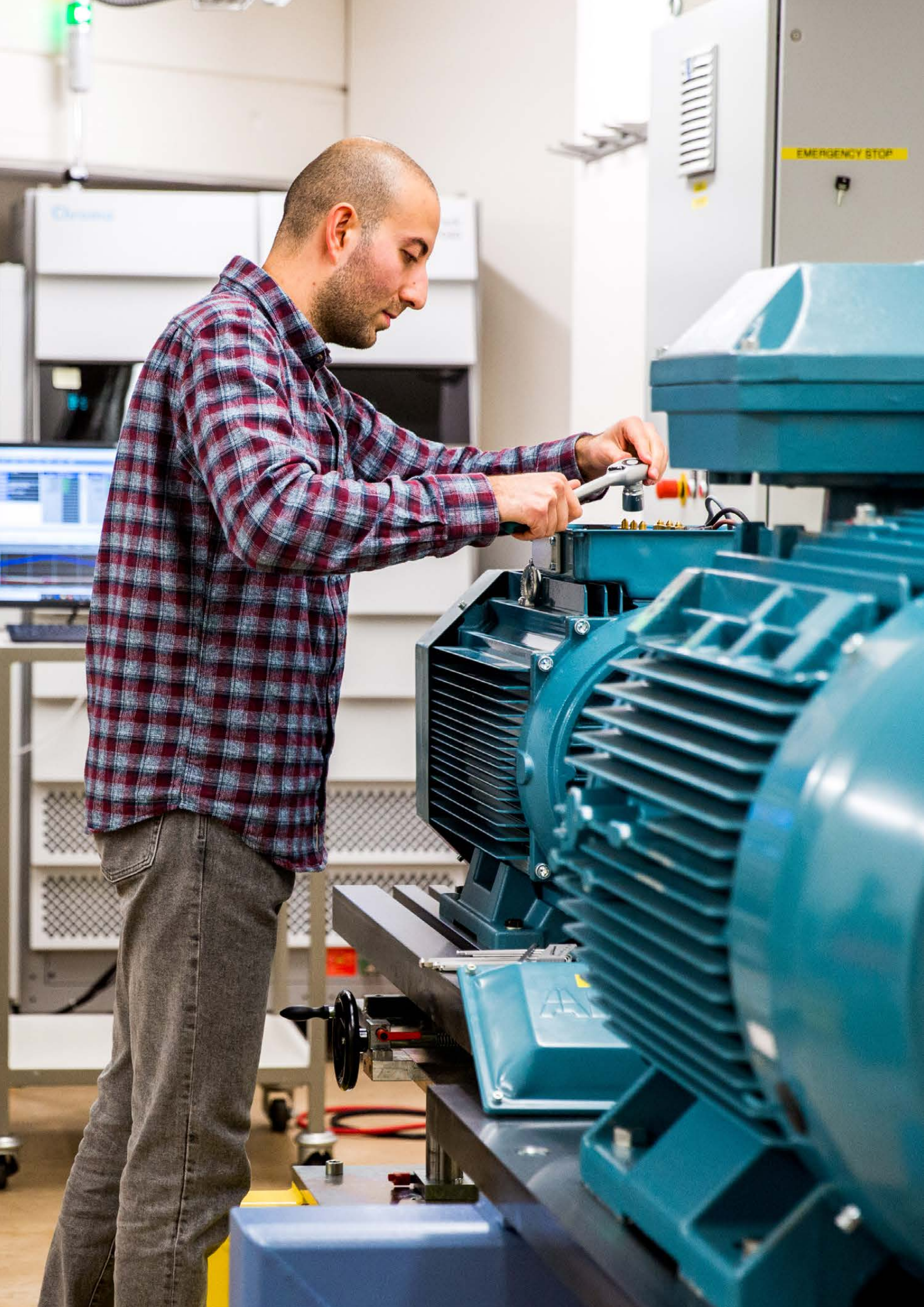
Methodology

30 people were confronted with a case study of a syringes manufacturing company. Graphs and tables regarding production processes were shown to the participants through the eye-tracking system and they were asked to answer questions. For each question, two stimuli were created to test which one was the best. There was only one correct answer for each question. The time spent to reply and the answers' correctness were combined to create a data set for a correlation analysis and a Fisher's Exact Test. These two tests were made to evaluate the following hypotheses:

- H1: Tables are better than diagrams to represent accurate and detailed data
- H2: Diagrams provide a better understanding of trends than tables
- H3: Lines graphs are better than bar graphs to represent data trends
- H4: Bar graphs are better than pie charts to compare multiple categories of data
- H5: Pie charts are better than bar charts to represent the distribution or proportion of a small number of different categories of data

Results

The two tests allowed to conclude that it is not possible to reject the Hypothesis H1, H2, H3 and H5 because a positive association and correlation exists at a level of significance lower than 0.05. Instead, H4 is rejected because the p-value was .481, therefore it is not possible to prove the existence of a correlation. These results highlight that in most cases the decision-making process is influenced by the elements that are presented into reports. In fact, the reaction time of decisions and the correctness of the actions is highly dependent on the way the data are presented. Therefore, it is crucial to chose the right elements to show data and to optimise and to tailor reports to each type of company according to their real needs.


EMERGENCY STOP

High piezoelectric response AlScN thin films deposited by reactive HiPIMS for MEMs devices

Degree programme : Master of Science in Engineering | Specialisation : Energy and Environment
Thesis advisor : Prof. Dr. Thomas Nelis

High piezoelectric response materials find a significant interest in the context of MEMs and watchmaking industries: piezoelectric thin films make use of the mechanical movement from MEMs to generate extra electric energy and use it in additional sub-systems, namely an hybrid technology between mechanical and electric device. This energy harvesting allows for a new type of engineering and leads to significant innovations in the field of MEMs, removing the need of a battery.

Léo Arthur Lapeyre
076 408 86 39
leo.lapeyre02@gmail.com

Introduction

Implementation of piezoelectric materials in micro-mechanical devices extend the engineering possibilities, as sub-systems can be implemented and powered by the energy conversion from the piezoelectric thin film. As the sub-system depends on the efficiency of the mechanical-electric conversion from the thin film, namely the piezo response, the general goal is to reach high thin film quality, high density and high crystallinity to maximize the piezo response and extend the engineering possibilities as far as possible. To this, High Power Impulse Magnetron Sputtering (HiPIMS), a state of the art physical vapor deposition (PVD) technique providing superior film quality and fine tuning of film properties, is employed.

Process optimization

Many parameters can be adjusted in the plasma discharge to modify the samples properties. In this work, the most important one was the choice of the nitrogen flow, which determines weither the coating is going to be a metal or a ceramic material. Another process optimization was to combine the HiPIMS system with microwave (MW) electron cyclotron resonnance (ECR) plasma sources. This solution remains actually unexplored in the litterature and shows promising results, which could lead to a publication in thin films research journals. As observed on Fig. 1, these parameters have a strong influence on coating's atomic structure.

Thin films properties

For appreciable film quality, the crystalline network should be dense and oriented in the (002) direction. Fig.1 shows the X-ray diffractogram of three different films, with the blue line corresponding to a deposition with optimized parameters. The sharp and narrow peak from the blue signal line at 2 Theta = 36 ° translates a strong preferiential orientation of the atomic structure in the desired piezoelectric phase. From this result, it is expected to observe a significant increase in piezoelectric coefficient for this material. As XRD analysis of oriented films requires a solid understanding of the technique and deep analysis characterizing atomic structure was a major part of this work. On Fig.2, the AlScN layer (550 nm) presents non-columnar and high density structure.

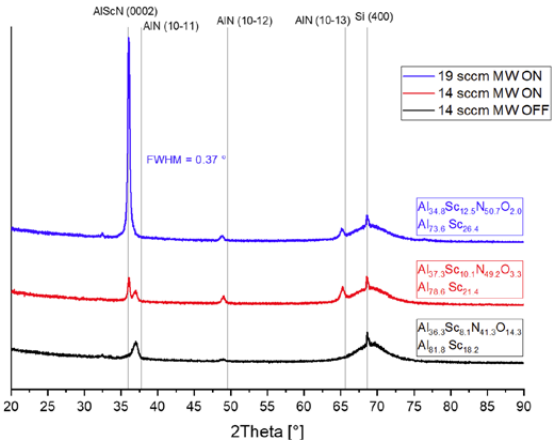


Fig.1 X-ray diffractogram of AlScN thin films. Blue line shows coating processed with optimized parameters.

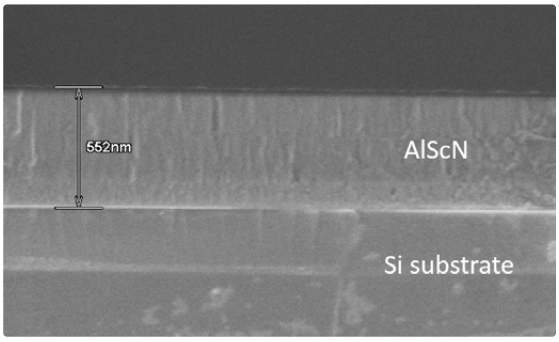


Fig.2 SEM cross sectional topography of AlScN thin film over Si substrate.

Bern RTOS - A real-time operating system for microcontrollers written in Rust

Degree programme: Master of Science in Engineering | Specialisation: Industrial Technologies
Thesis advisor: Prof. Roger Weber
Expert: Daniel Kühni (Inetronic AG)

Microcontroller performance and connectivity is ever increasing and so is the complexity of embedded systems. A larger code base naturally leads to more software defects that can cause a fault or can be exploited. As opposed to C/C++ the Rust programming language is memory-safe, eliminating most common run-time bugs by design. Based on Rusts safety principles a fail-safe real-time operating system (RTOS) has been developed in this thesis.

Embedded Rust ecosystem

Rust is a programming language with memory-safety and thread-safety guaranteed at compile time. By mitigating software defects from runtime to compile time Rust might challenge to role of C/C++ on microcontroller based embedded systems. Especially as the complexity of microcontroller applications increases. The embedded Rust ecosystems already provides community driven hardware abstraction layers (HAL) and a real-time framework (RTIC). However, missing is an RTOS which is fail-safe, can be easily integrated in a project and provides an intuitive application programming interface (API).

A new RTOS from the ground up

In previous projects the requirements for the kernel were defined based on the analysis of existing RTOS written in Rust or C. The core components of the kernel i.e. scheduler and synchronization primitives were then implemented and tested on a microcontroller. This thesis introduced the concept of threads and processes to microcontrollers. Processes run in isolation from each other preventing software faults from spreading across the entire system. Process memory and stack boundaries are enforced in hardware. A violation of these boundaries results in immediate termination of the thread. The kernel handles message passing between threads in different processes. In addition, usability was increased significantly by adding message queues, memory allocation, system logs and event tracing.

Espresso machine example application

In the second part of the thesis Bern RTOS was put to the test on a real-world use case: an espresso machine. The goal was to implement an integration test of many kernel components and to evaluate the API usability.
First, the machine was upgraded with custom made electronics including a touch screen and additional sensors to measure water pressure, flow and temperatures at multiple points. The application emulates a typical RTOS use case where many loosely coupled tasks are executed on the same microcontroller. There is a real-time critical aspect with the temperature control and actuators which must run in a deterministic manner. A high background load is caused from updating the graphical user interface with live sensor measurements. A dynamic and unknown system load was created by a TCP/IP connection which interacts with a computer storing machine state and measurements in a database.

Outlook towards an open source RTOS

The espresso machine application demonstrates that Bern RTOS provides the fundamental features to develop a real-time application. It also shows that Rust can be used effectively for microcontroller applications. The text size of the complete example application is with 286 kB (7 kB Bern RTOS, 219 kB GUI) comparable to an implementation in C/C++ . Yet, guaranteeing memory-safety and thread-safety at compile time. The run-time costs for Bern RTOS are low. In case of the espresso machine the kernel uses 2% of the total CPU execution time.
The Bern RTOS code base is open-source (MIT license) and further development continues as a community project. **bern-rtos.org**

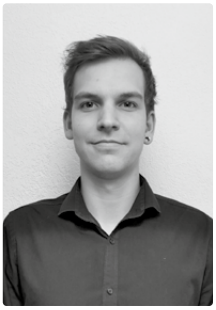
Modified espresso machine used in the example application.

Stefan Lüthi
bern-rtos@luethi.tech

Cobotic Solution for Watch Bracelet Assembly

Degree programme: Master of Science in Engineering | Specialisation: Industrial Technologies
Thesis advisor: Prof. Dr. Sarah Dégallier Rochat
Expert: Yvan Chkouropadsky
Industrial partner: Cartier Horlogerie, Branch of Richemont International Sa, La Chaux-de-Fonds

The Industry 4.0 revolution is in full swing bringing new automation possibilities through technologies such as Cobotics. With this in mind, Cartier Horlogerie has decided to launch a project aimed at renewing the production process for watch bracelets. For now, most of the stages of production are carried out by hand. This is a very monotonous, unrewarding work, which is suitable for automation. A system that is both flexible and highly precise is required.



Lucas Manuel Renfer

Initial Situation

Cartier Horlogerie is still producing luxury watches mainly using manual processes. Reason for this are the comparably complex and small parts, as well as small lot sizes and a large product portfolio, which make traditional automation economically difficult. The answer for a cost-effective automation is a workplace that can easily be set-up and changed over between different products/processes. With this equipment/workplace, small lot- sizes of various products can be treated. Quick and simple change-over between products ensure efficient production despite small lot sizes.

Workplace

The workstation is equipped with an UR5e robot that is mounted on a linear axis to increase its reach (thus providing access to a larger workspace). To execute the various tasks, different parts (targets) must be recognized. In the case of this project, the camera is directly mounted to the robot arm. In this way, the regions on and around the workstation can be detected. This provides great flexibility to the user, as they are not tied to fixed locations.

The lexibility is further enhanced by the integration of a tool changer, which allows the use of various tools to perform the required tasks.

User Interface

The user interface must be as simple and easy to use as possible in order to reduce training as well as mistakes. The basis is a no-code blockly-like programming environment that is intuitive to use. By combining blocks, a complex program to define movements of the robot or vision algorithms for object detection, can be created in a few minutes. This tremendously reduces the required time. Personnel with little training can carry out small changes.

Results

The flexibility of the workplace is increased tremendously compared to more traditional automation systems. The creation of programs – for the detection as well as handling of parts – is much faster and requires little practice. Very complex tasks still require a certain amount of time, but are greatly supported by the graphical interface. The integrated tool changer enables more complex tasks to be performed without interruption.

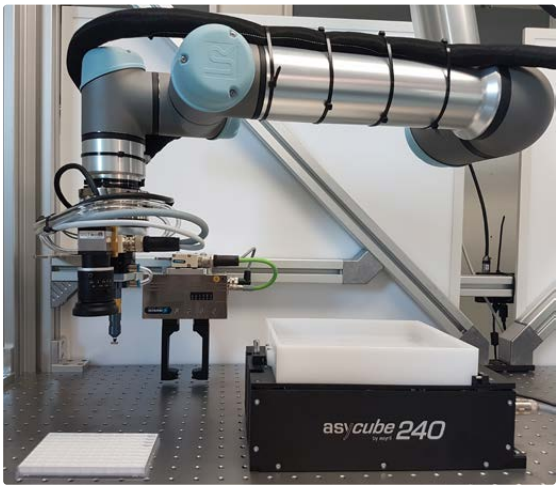


Figure 1: UR5e robot performs an example task. The links are placed in a pallet, which can be exchanged automatically.

Figure 2: Detection of links with developed method creator.

Künstliche Intelligenz optimiert zirkuläre Nahrungserzeugung

Studiengang: Master of Science in Engineering | Vertiefung: Energy and Environment
Betreuer: Prof. Dr. Andrea Vezzini
Experte: Viktor Hangartner

Für eine moderne Lebensmittelproduktion erlernt ein Softwareagent selbstständig eine Strategie, um ein System namens „Aquaponik“ zu verbessern. In dieser Masterarbeit wurde eine Computersimulation entwickelt, welche eine Lernumgebung für einen „Reinforcement Learning“ Algorithmus ermöglicht. Mit den Messdaten der realen Anlage wird zudem die Simulation verbessert, wodurch schliesslich die Sicherheit des Systems erhöht, und der Anlagenbetreiber alarmiert wird.

Einleitung und Forschungsziel

Ein Drittel der heutigen Weltbevölkerung hat keine sichere Versorgung mit sauberem Trinkwasser. Auf der anderen Seite werden mindestens 70 % des weltweiten Süsswasserverbrauchs von der Landwirtschaft benötigt und dennoch sind Schätzungen zufolge eine Milliarde Menschen unterernährt. Um diesem Missstand entgegenzuwirken, braucht es Lösungen wie die der Aquaponiksysteme. Diese Masterarbeit beschäftigt sich mit der Frage, ob das maschinelle Lernen diese automatisierte Nahrungserzeugungsmethode weiter verbessern kann. Untersucht wird, ob die Sicherheit des Systems erhöht und der Verbrauch von Ressourcen reduziert werden kann.

Untersuchungs- und Umsetzungsmethodik

Mit einer Simulation wird das System nachgebildet. Dort lernt der Agent anschliessend, wie er die Anlage optimieren kann und ob gleichzeitig die Grenzwerte - zum Wohl der Fische sowie auch der Pflanzen - mit den Sensordaten eingehalten werden können. Dabei wird der PPO (Proximal Policy Optimization) Algorithmus verwendet. Das Ray.RLlib Framework dient als Grundgerüst für den Aufruf der Lernumgebung und die damit verbundenen Interaktionen.

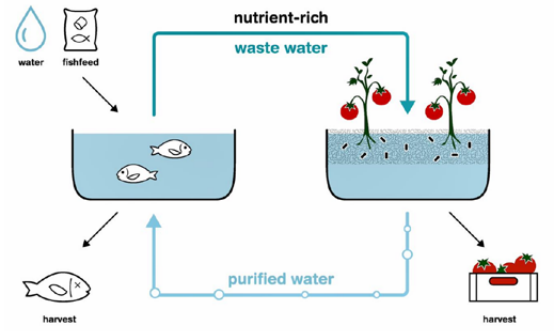
Ergebnisse und Ausblick

Eine bestehende Anlage ist mit Wasserqualitätssensoren erweitert worden und die daraus gewonnenen Daten werden in einer Datenbank abgespeichert. Des Weiteren wird mittels Grafana-Dashboard visualisiert, auf welchem auch die Alarmierung stattfindet. Das Konstrukt welches die Interaktion der Komponenten ermöglicht, ist so erstellt und kann nun für weitere Lernzyklen sowie eine Erhöhung der Simulationskomplexität verwendet werden. Die Wahl des Agenten wiederum ist dank Framework sehr flexibel und er kann ebenso mit Parameteranpassung und mehr Rechenzeit weiter optimiert werden.

Persönliches Fazit

Eine Simulation zu implementieren, welche ein Aquaponiksystem möglichst unter realen Bedingungen nachbildet, ist die grosse Herausforderung. Grund hierfür ist die Mischung aus organischen Lebewesen und Systemkomponenten, welche viele Zusammenhänge beinhalten, die sich mathematisch nicht einfach modellieren/abbilden lassen. Dank der Skalierbarkeit der Aquaponik ist sie sowohl für die Selbstversorgung als auch für die Massenproduktion denkbar und bietet viele Vorteile für das Zusammenleben von Mensch und Natur. Die Optimierung durch künstliche Intelligenz verspricht weitere Erfolgsaussichten für diese bereits nachhaltige Lösung.

Daniel Schlecht
work@alindro.ch



Wasserkreislauf der Aquaponik mit den Hauptelementen der Simulation.

Übersicht von Temperatur und pH Sensoren im Dashboard mit dem aktuellen sowie auch zeitlichen Ablauf der Messdaten.

Automated Decision Making System for Processing Large PDF Files

Degree programme: Master of Science in Engineering | Specialisation: Information and Communications Technologies
Thesis advisors: Dr. Souhir Ben Souissi, Prof. Andreas Habegger

Preparing a patient history for a medical expertise involves the analysis of huge amounts of records of various origins. To date, the entire case file - up to 5‘000 pages - is printed, then analyzed and sorted by hand to create a chronological dossier containing only the relevant pages which amount to about 10% of the entire case file. An Automated Decision Making (ADM) System should now be developed to assist in compiling patient‘s medical history.

Lukas Alexander Studer

Approach

A selection of common case files are analyzed by hand to determine the structure and available information within the PDF files. Based on this analysis, following Metrics characterizing a page are defined and the approach for extracting them is established: Relevance (is the page relevant, should it be included?), Keywords (keywords summarizing the page), Coherence (which pages form an in of itself coherent document), Pagination (page number and number of pages), Date (when was the page created?), Duplicates (which pages are duplicates of one another?) Persona (who was involved in the correspondence?).

Forensic Image Hashes

A prediction on the Relevance of a page is made based solely on the visual aspect using gray scale images of the PDF page. However, the image is reduced to a forensic image hash to reduce the complexity of the classifiers and to maintain the privacy of patient records in case external infrastructure is used. A hand full of common classifiers are compared to evaluate the expedience of forensic image hashes in a classification environment using supervised learning.

In addition, an analysis of the similarity of the image hashes for pages of the same class and pages of different classes is performed to gain insights into the data set and to provide context for the resulting model.

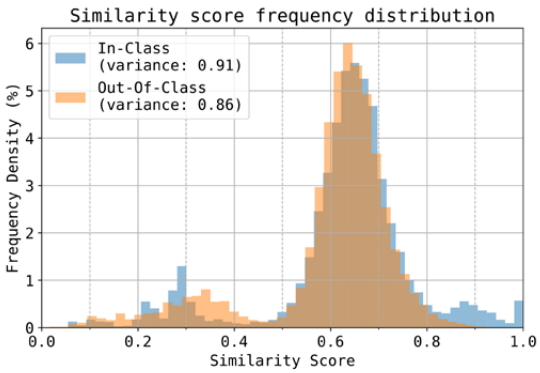
Name	Recall	Percision	Accuracy	MCC	F1
RandomForest	0.820	0.871	0.833	0.689	0.823
Lin. SVC	0.818	0.817	0.818	0.635	0.817
AdaBoost	0.835	0.836	0.837	0.671	0.836
NNSimple	0.865	0.871	0.868	0.735	0.866
NNComplex	0.874	0.877	0.877	0.751	0.875

Performance values for relevance prediction of different classifiers based on 1024 bit average hashes

Forensic image hashes are further used to detect Duplicates, as is the common use case for forensic image hashes. For this purpose, each page is compared with one another and assessed based on the similarity of the forensic image hash. Only in cases where the hash similarity is ambiguous is an additional comparison of the text performed.

Results

The extraction of the Coherence, as well as the characteristic Date and the Pagination of pages was possible through the use of embedded text and meta information without the need for machine learning. Preliminary results of the detection of Duplicates and suggestions on the Relevance of pages using forensic image hashes proved to be highly successful with accuracies of up to 99% and 87% respectively. This proves that forensic image hashes can be used to detect page duplicates and classify pages using supervised learning. Further, with the overlapping frequency distribution of the similarity score, it can be said that the model is not trivial and is not based on a threshold. The forensic image hash therefore preserves the essence of the page, which can be used as a basis for predictions. However, the extraction of Keywords and correspondences between Personas was found to be generally unsuccessful.



Frequency distribution of the similarity score in-class and out-of-class samples based on 1024 bit average hashes


SONY

Radiale und 3D-Mikrobearbeitung von Werkstücken mittels UKP-Laser

Studiengang: Master of Science in Engineering
Betreuer: Prof. Dr. Torsten Mähne, Prof. Dr. Beat Neuenschwander
Experte: Ernst Wilhelm Böckler (SCANLAB GmbH)

Mittels Ultrakurzpulslasern (UKP) ist es möglich Oberflächen hochpräzise und schonend zu bearbeiten. Dabei hat die Strategie zur Strukturierung grossen Einfluss auf die benötige Prozesszeit. Ziel dieser Arbeit war es eine neuartige radiale Bewegungstrajektorie zu evaluieren und zu implementieren. Diese ermöglicht es kreisförmige Werkstücke mit bisher unerreichten Geschwindigkeiten zu bearbeiten.

Dominic Joshua von Bergen
dominic@von-bergen.com

Ausgangslage

An der Berner Fachhochschule forscht das Institute for Applied Laser, Photonics and Surface Technologies (ALPS) an der Oberflächenstrukturierung mit Ultrakurzpulslasern. Der Einsatz solcher Laser, welche im Femto- und Pikosekundenbereich arbeiten, ermöglicht es, Material präzise und schonend abzutragen. Dabei ist die Trajektorie (Abb. 1), welche gefahren wird, von grosser Bedeutung. So ist die Lünette einer Uhr eine beispielhafte Anwendung für eine radiale Bewegungsform. Bis anhin war es nur möglich lineare Bewegungen zu fahren.

Aufgabenstellung

Das Ziel dieser Arbeit war die Erforschung radialer Bearbeitungstrajektorien. Dabei ging es darum diese in der Steuerungssoftware zu implementieren und zu analysieren, für welche Strukturen diese tatsächlich effektiv sind. In einem weiteren Schritt sollte das 2D-Scansystem durch eine optische z-Achse zu einem 3D-System ausgebaut werden.

Realisierung

Zunächst wurde die spiralförmige und die kreisförmige Trajektorie definiert und umgesetzt. Dabei galt es diese in die in C++ implementierte Steuerungssoftware zu integrieren. Modellierungen und Messungen der beiden Strategien haben gezeigt, dass die Spirale der kreisförmigen Trajektorie in Bezug auf die Prozessgeschwindigkeit überlegen ist. Basierend auf dieser Erkenntnis wurde entschieden, mit der Spirale im Fokus weiterzufahren. Diese wurde schrittweise weiter optimiert. So wurden bidirektionale Scanverfahren in Scan- wie auch in Cross-Scan-Richtung entwickelt. Auch neue Methoden, um Prozessparameter (z.B. den Schleppverzug) zu berücksichtigen, mussten entworfen werden. In einem letzten Schritt wurde eine optische z-Achse in das System integriert, welche es ermöglicht die Fokuslage des Lasers dynamisch zu steuern.

Ergebnisse

Radiale Trajektorien wurden erfolgreich in die bestehende Software integriert. Dabei konnte die spiralförmige Strategie optimiert werden, wodurch die Prozesszeit weiter verkürzt wird. Durch die erforderliche Neustrukturierung der Software wurde auch der Weg bereitet, um künftig mit wenig Aufwand weitere Trajektorien zu implementieren. Vergleiche der neuen Trajektorie und der konventionellen linearen Bewegung haben gezeigt, dass radiale Bewegungen für gewisse Strukturen einen deutlichen Geschwindigkeitsvorteil bringen. So dauert ein Durchgang über eine Uhrenlünette, wie in der Abb 1. dargestellt, nur noch 2.3 s anstelle von 7 s. Dies entspricht einer Verbesserung von rund 300 %. Die Integration einer optischen z-Achse mithilfe eines ExcelliShifts ermöglicht es nun den Fokus entlang einer gewölbten Oberfläche nachzuführen. Dadurch können auch unebene Werkstücke (Abb.2) über die ganze Fläche bearbeitet werden.

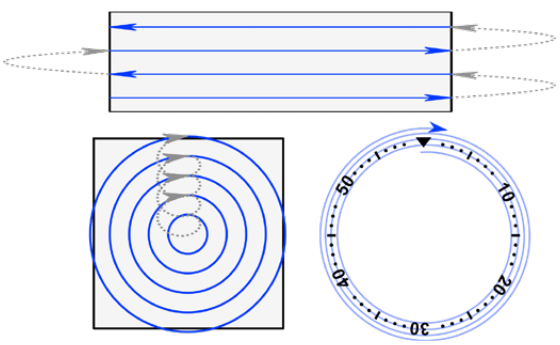


Abb. 1: Trajektorien (oben: linear, unten links kreisförmig, unten rechts spiralförmig über Lünette)

Abb. 2: Testmuster auf gewölbter Oberfläche (oben: ohne Fokusnachführung, unten: mit Fokusnachführung)

Shoefitting für Kampfstiefel

Studiengang: Master of Science in Engineering | Vertiefung: Industrial Technologies
Betreuer: Prof. Dr. Axel Fuerst
Experte: Dr. Michael Jäger (armasuisse)
Industriepartner: Logistikbasis der Armee, Bern

Ein passender Schuh ist essentiell um ihn den ganzen Tag tragen und auch weitere Distanzen zurücklegen zu können. Dies gilt auch für die Kampfstiefel der Schweizer Armee. Bei der Erstausrüstung besteht keine Möglichkeit für eine individuelle Beratung wie in einem Fachgeschäft. In dieser Arbeit wird eine Methodik inklusive Prototyp entwickelt, die mit einer hohen Wahrscheinlichkeit den passenden Schuh bestimmt.

Ausgangslage

Zweimal pro Jahr starten die Rekrutenschulen der Schweizer Armee. Zu Beginn müssen alle neuen Angehörigen der Armee in kürzester Zeit ausgerüstet werden. Dies umfasst auch die Ausgabe der Kampfstiefel. Im momentanen Prozess werden die Füsse von Hand durch einen Mitarbeiter ausgemessen. Dies bedeutet in einem ersten Schritt das Messen der Fusslänge mit einem Messapparat für das Längenmass. Im zweiten Schritt wird der Ballenumfang des voluminöseren der beiden Füsse mit einem Messband gemessen. Anhand einer Tabelle wird der passende Schuh, Schuhgösse und Breite, ermittelt. Dieser Messprozess hat eine Zykluszeit zwischen 30 und 50 Sekunden.
Nach dem Erhalten der Kampfstiefel werden diese von den Rekruten anprobiert und falls diese nicht passen umgetauscht. Aufgrund der hohen Anzahl an ausgegebenen Schuhen kann keine individuelle Beratung erfolgen. Das bedeutet, dass der ermittelte Schuh möglichst immer passen sollte.

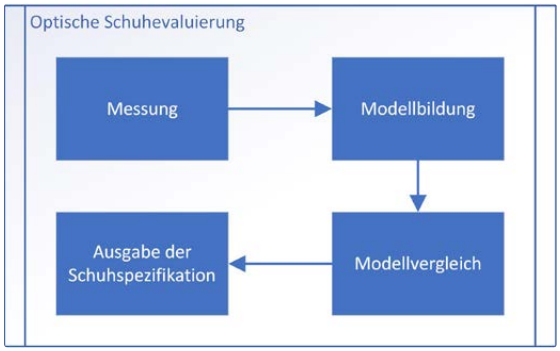
Ziele

In diesem Projekt soll die Fussmessung inklusive der Grössen- und Breitenbestimmung verbessert werden. Die Verbesserung sollte in einer Reduktion der Zykluszeit und im besten Fall auch in einer Steigerung der „First-Match“ Quote erfolgen.
Das Ziel ist es, die momentan manuell durchgeführten Messungen mit einer automatisierten optischen Messmethodik zu ersetzen. Dazu wird ein digitales Fussmodell erstellt und mit den Datenmodellen der Schuhe abgeglichen, um den bestmöglichen Schuh zu ermitteln. Dadurch sollen weniger Schuhe während der Anprobe, respektive dem Eintragen, umgetauscht werden. Dies resultiert in einer Kosten und Aufwandersparnis.
Ein reibungsloser Ablauf und ein perfekt passender Schuh steigert auch die Kundenzufriedenheit. Das bedeutet, dass die Angehörigen der Armee mit dem Schuh und der Arbeit der Logistikbasis der Armee zufrieden sind.

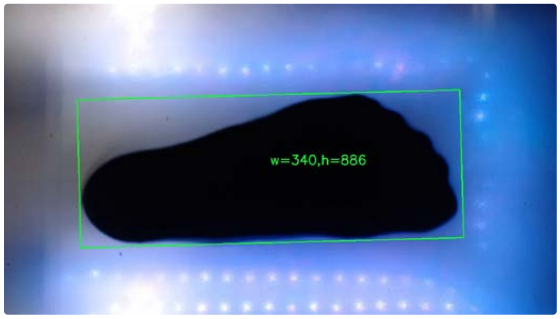
Simon Walther

Ergebnisse

Die erarbeitete Methodik basiert auf der Verwendung von zwei Kameras. Pro Fuss wird ein Bild des Umrisses von unten gemacht. Aus den Fotos wird ein Modell des Fusses erstellt, welches das Extrahieren der für die Schuhzuweisung erforderlichen Charakteristiken erlaubt. Der Prototyp inklusive Applikation ermöglicht ein schnelles Zuweisen der passenden Schuhe in einer guten Qualität.
Die Abbildung unten links zeigt den schematischen Ablauf der optischen Schuhevaluierung. Unten rechts ist der erkannte Fuss zur Modellbildung abgebildet. Daraus wird das Fussmodell erstellt.



Ablauf der optischen Schuhevaluierung



Erkannter Fuss für die Modellbildung

In-Line Sealing Inspection

Degree programme: Master of Science in Engineering | Specialisation: Mechatronics and Automation
Thesis advisor: Prof. Dr. Gabriel Gruener
Expert: Matthias Höchemer (CSEM SA)
Industrial partner: Rychiger AG, Steffisburg

In-line quality control is very important in automatic production systems. For Rychiger AG, one such task entails detecting leaks in coffee capsule seals. This work demonstrates that a system that uses a visible-spectrum camera and deep-learning–based defect detection works quite well. Shape-from-shading algorithms achieve even better feature extraction for more robust results at the cost of process speed.

Simon Raphael Werner
079 254 44 43
simon.werner95@gmail.com

Motivation

Rychiger AG manufactures advanced filling and sealing machines for coffee capsules. The process runs very stably. Rarely, defective coffee capsules are produced. In particular, coffee particles in the sealing seam can lead to leaking capsules, which need to be sorted out. On behalf of Rychiger, different technologies for in-line sealing inspection were analysed. The most appropriate method was implemented and evaluated.

Method Evaluation

A wide variety of non-destructive test technologies are available to ensure sealed seam tightness. Vacuum, acoustical, capacitive, and optical technologies were studied in collaboration with sensor manufacturers. It was then decided to continue with industrial cameras operating in the visible spectrum. These cameras can be used to detect a wide range of defects. A Cognex smart camera D900 was selected. The focus was set on processing the images using deep-learning defect detection due to its recent success.

Implementation

Five supervised and unsupervised defect-detection models were implemented, evaluated, and compared with the commercial Vidi software from Cognex:

1: Unsupervised anomaly detection using convolutional autoencoder (Tsai and Jen, 2021)
2: Unsupervised anomaly segmentation via deep feature reconstruction (Shi et al., 2021)
3: Adapting pretrained features for anomaly detection (Reiss et al., 2021)
4: Unsupervised defect detection using patch features in memory bank (Roth et al., 2021)
5: Mixed supervised learning (Bozic et al., 2022)

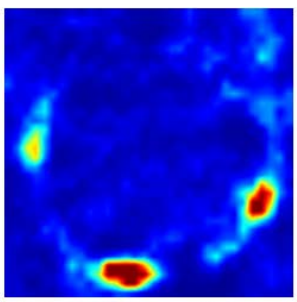
Supervised learning uses labelled, defect-free and defective samples. Unsupervised learning only requires defect-free samples, thus detecting deviations as anomalies. This means less effort to train the system, but the false-positive rate tends to be higher. In addition, a setup was created that enables generating shape-from-shading images, which enables improved feature extraction.

Results

Supervised learning outperforms unsupervised methods. Better results are achieved with shape-from-shading images. An implementation of the deep-learning approaches is not yet necessary, as Cognex's Vidi tools achieve good results. To detect small defects (few pixels) Cognex's tools are not suitable. Here, method 4 or 5 could provide a solution. Shape-from-shading shows potential and is recommended for future Rychiger projects.

Coffee capsule: Coffee particles in the sealing seam

Surface FX image of coffee capsule



Predicted defect map: Detected by supervised deep-learning model

Voting Without a Trace

Degree programme: Master of Science in Engineering | Specialisation: Information and Communications Technologies
Thesis advisor: Prof. Dr. Reto Koenig
Experts: Prof. Jacques André Augustin (EFREI Paris)Dr. , Karola Marky (University of Glasgow)

Voting is one of the main pillars that allows citizens to elect their representatives and express their opinions in a democratic society. However, our voting protocols haven't evolved with the technological improvements in sensing and forensics, and so start losing protection against attacks concerning anonymity. This work demonstrates these weaknesses and proposes solutions to regain protection against de-anonymization.

Context

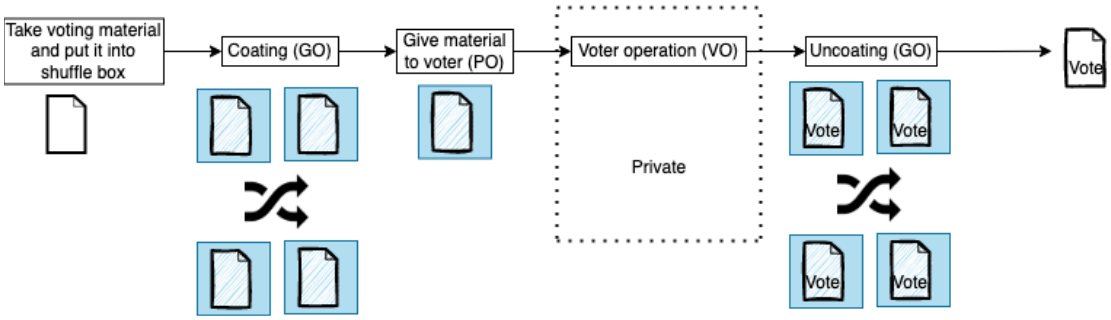
Voting is part of democracy's rituals, where members of the society are allowed to express their volition. Each voter leaves a mark on its ballot by expressing its volition. Unfortunately, though, oblivious to the voter, any current voting process itself leads to individual markers, so that track-marking along the voting process becomes unavoidable. While this has always been the case, it's only with the great advances in sensing storage and forensics that backtracking a marked ballot to its origin (i.e. the voter) is becoming more accessible (i.e. cheaper). This results in an attack vector for complete de-anonymization of voters after having cast their ballots. Thus, this renders any guarantee of the preservation of anonymity void for any current voting process.
In e-voting, the aspect of anonymity is tackled using various techniques such as mixnets or homomorphic tallying. The drawback of those solutions is that there are long-term secrets involved (permutations within the mixnet, decryption key ...). They create an attack vector that can be used to act against people in the future, regarding a mark on a specific vote in the past. Members of the society and parties must have confidence in the entire voting process to be able to accept any voting outcome. This requires the whole process to be verifiable individually and universally (i.e. end-to-end verifiable). The introduction of a new voting protocol, especially if it requires non-trivial steps or devices, has to be understood and approved by the public in order to be trusted. Therefore, the use of mathematics and technologies that require specialized knowledge (such as cryptography) must be reduced to the bare minimum.

Layered Architecture for Voting

To enable verifiable traceless voting, I propose a new approach. Inspired by the double envelope voting, I revisit and extend the well-known multilayer approach. Nowadays, each covering (coating) or uncovering of an envelope (uncoating) is performed per ballot, i.e., one local operation per ballot.
I propose the introduction of a global operation for coating and uncoating, where those two operations are each performed on all ballots at the same time and location, leading to a hidden shuffling. I claim that this results in a voting approach, where the tracing link between the individual markers and the vote is broken. This results in voting without a trace.
This requires the voter to cast and verify its vote on the ballot without having to remove or even touch the opaque coating. For this purpose, I propose a new physical ballot and an appropriate procedure. This allows end-to-end verifiable voting without a trace, where targeted attacks on vote privacy are detectable with a very high probability.

Paul-Henri Guy Maurice Zimmerlin

paulhenri.zimmerlin@gmail.com



Voting Protocol with Layered Architecture

Infoveranstaltungen
Séances d'information
Information events

Interessiert Sie ein Studium an der Berner Fachhochschule?
Wir öffnen unsere Türen: Erfahren Sie alles zu unseren Bachelor- und Master-Studiengängen, Zulassungsbedingungen, Studienbedingungen und unserer Schule. Führen Sie persönliche Gespräche mit Studierenden und Dozierenden und besuchen Sie unsere Labors in Biel und Burgdorf. Mit einer Weiterbildung auf Master-Stufe gehen Sie in Ihrer Karriere einen Schritt weiter. Unsere umfassende, interdisziplinäre Palette von Modulen ermöglicht Ihnen, Ihre Kompetenzen auf verschiedensten Gebieten zu erweitern und zu ergänzen. Informieren Sie sich in einem persönlichen Beratungsgespräch.

Jetzt informieren und anmelden:
bfh.ch/ti/infoveranstaltungen

Vous intéressez-vous à des études à la Haute école spécialisée bernoise ?
Nous vous ouvrons nos portes : obtenez des informations exhaustives sur nos filières de bachelor et de master, sur les conditions d'admission et d'études, et sur notre école. Discutez avec des étudiant-e-s et des enseignant-e-s et visitez nos laboratoires à Bienne et à Berthoud. Avec des études de master, vous posez un nouveau jalon dans votre carrière. Notre vaste gamme de modules dans diverses disciplines vous permet d'étendre vos compétences dans les domaines les plus variés. Informez-vous dans le cadre d'un entretien de conseil personnel.

Informations et inscription :
bfh.ch/ti/seances-information

Are you interested in studying at Bern University of Applied Sciences?
If so, we invite you to attend our open house events. They will give you insights into our bachelor's and master's degree programmes, our admission requirements, our study regulations and our university. You will have the opportunity to talk with students and professors and to visit our laboratories in Biel and Burgdorf. Completing your continuing education with a master's degree takes your career one step further. Our comprehensive, interdisciplinary range of modules allows you to expand and complement your skills in a wide variety of areas. Find out more in a personal counselling interview.

Further information and link to register:
bfh.ch/ti/information-events

Alumni*ae BFH
Alumni BFH
Alumni BFH

Alumni BFH vereint die ehemaligen Student*innen sowie die Alumni-Organisationen der BFH unter einem Dach. Als Alumni*ae sind Sie Teil eines lebendigen Netzwerkes und profitieren von attraktiven Leistungen und Benefits. Sie erhalten regelmässig den Newsletter «Alumni aktuell» und können der Community von Ehemaligen auf Facebook und LinkedIn beitreten und sich so aktiv vernetzen.

Ihr Mehrwert als Alumni*ae der BFH
Als ehemalige Student*innen sind Sie wichtige Botschafter*innen für die Berner Fachhochschule. Nach Abschluss Ihres Studiums werden Sie (kostenlos) ins fachübergreifende Alumni-Netzwerk des Dachverbands Alumni BFH aufgenommen. Wir bieten Ihnen:
- Newsletter «Alumni aktuell» (4x jährlich)
- Attraktive Angebote und Vergünstigungen
- Vielfältige Veranstaltungen der Alumni-Organisationen
- Alumni-BFH-Community auf LinkedIn und Facebook
- Karriereportal mit Jobplattform und Kursangebote rund ums Thema «Bewerben»

Als Alumni*ae sind Sie exklusiv zum grossen Netzwerk-Abend Alumni BFH eingeladen, welcher jährlich mit über 300 Ehemaligen in Bern stattfindet. Ausserdem können Sie an vielseitigen Events der Alumni-Organisationen und am Sportangebot der Universität Bern teilnehmen. Daneben erhalten Sie Vergünstigungen und Rabatte auf ausgewählte Dienstleistungen und profitieren vom attraktiven FH-Schweiz-Leistungsangebot sowie vom Weiterbildungsangebot der BFH.

Mehr Informationen zu Alumni BFH und den attraktiven Leistungen unter: bfh.ch/alumni

Alumni BFH réunit sous un même toit tous les ancien-ne-s étudiant-e-s et les organisations d'alumni de la BFH. Membre d'Alumni BFH, vous faites partie d'un réseau dynamique et profitez de prestations attrayantes. Vous recevez régulièrement l'infolettre « alumni à l'heure actuelle » et avez la possibilité de rejoindre la communauté sur Facebook et LinkedIn.

Vos avantages
En tant qu'ancien-ne étudiant-e, vous êtes une ambassadrice ou un ambassadeur important-e de la Haute école spécialisée bernoise. Une fois vos études achevées, vous rejoignez (gratuitement) le réseau interdisciplinaire de l'association faitière Alumni BFH et bénéficiez de précieux avantages :
- Infolettre « alumni à l'heure actuelle » (4 fois par année)
- Offres attrayantes et prix préférentiels
- Vaste palette de manifestations proposées par les diverses associations d'alumni
- Alumni BFH Community sur LinkedIn et Facebook
- Portail Carrière, plateforme d'emplois et offre de formations pour vous aider à postuler à un emploi

En outre, vous recevez en exclusivité une invitation à la grande soirée de réseautage qui se tient une fois par année à Berne, réunissant quelque 300 ancien-ne-s étudiant-e-s. Vous pouvez également participer aux différents évènements des associations d'alumni et profiter de l'offre sportive de l'Université de Berne. De plus, vous bénéficiez de prix préférentiels et de rabais pour certaines prestations et avez accès à l'offre intéressante de FH Suisse ainsi qu'aux formations continues de la BFH.

Plus d'informations sur Alumni BFH et l'offre de prestations : bfh.ch/alumni

Alumni BFH unites former students and BFH alumni organisations under one roof. As a member, you are part of a lively network and benefit from attractive services. You regularly receive the informative newsletter "Alumni aktuell" and can join the community on Facebook and LinkedIn

Your benefits as a BFH alum
As a former student, you are an important ambassador of Bern University of Applied Sciences. After completing your studies, you are admitted (free of charge) in the multidisciplinary umbrella organisation Alumni BFH. Our offer:
- Newsletter "Alumni aktuell" (quarterly)
- Attractive offers and discounts
- A wide range of events set up by the alumni organisations
- The Alumni BFH community on LinkedIn and Facebook
- A career portal with a job platform and courses to help you with your job applications

As an alum, you will be exclusively invited to the great Alumni BFH networking night, which takes place annually in Bern with over 300 former students. In addition, you can participate in the many events offered by the alumni organisations and make use of the sports facilities of the University of Bern. You also receive discounts and special offers on selected services and can benefit from the attractive offers of FH Schweiz and the BFH continuing education programme.

More information on Alumni BFH and its attractive services: bfh.ch/alumni

Berner Fachhochschule
Master of Science in Engineering
Quellgasse 21
2502 Biel

Telefon +41 31 848 50 46

mse@bfh.ch
bfh.ch/mse

Haute école spécialisée bernoise
Master of Science in Engineering
Rue de la Source 21
2502 Bienne

Téléphone +41 31 848 50 46

mse@bfh.ch
bfh.ch/fr-mse

Bern University of Applied Sciences
Master of Science in Engineering
Quellgasse 21
2502 Biel

Telephone +41 31 848 50 46

mse@bfh.ch
bfh.ch/en-mse