Aalto University
School of Engineering

Mechatronics project

MEC-E5002

12.1.2021

Mechatronics project

Course personnel:

- **Petri Kuosmanen, Professor, Teacher in charge**
- **Panu Kiviluoma, Senior University Lecturer**
- **Project instructors**
- **Laboratory personnel**
  - Jouni Pekkarinen
  - Antti Sinkkonen
  - Jarno Järvinen



Learning outcomes

After completion of the course the student is able to

- **design and build a new mechatronic product or test equipment according to task description.**
- **work systematically in a multidisciplinary team**
- **analyze different alternative solutions to make motivated decisions on basis of this**
- **choose the essential methods, practices and components to design and build a mechatronic machine.**

Mechatronics project

Lectures: Tue 14…16

- **When needed, check the schedule in MC**

Project

- **Approx. 4-5 person team**
- **Research topic**

Circus + Conference

- **Circus Thu April 8th**
- **Conference TBA**

Highlights of the mechatronic project 2020

Mechatronic Circus

https://www.aalto.fi/en/industrial-internet-campus/mechatronic-circus-2020

The 5th Baltic Mechatronics Symposium April 17, 2020

https://www.aalto.fi/en/industrial-internet-campus/the-5th-baltic-mechatronics-symposium-april-17-2020

Mechatronics students claim top three prizes in development project competition

https://www.aalto.fi/en/news/mechatronics-students-claim-top-three-prizes-in-development-project-competition

https://www.tekniikkatalous.fi/videot/video-teekkareiden-keksinnon-varjopuoli-laitteesta-mahdollisuus-saada-pahoja-terveysongelmia-nyt-jatkokeksinto-vahentaa-riskeja-6719928?utm_source=Teta_Uutiskirje&utm_medium=email&utm_campaign=Teta_Uutiskirje

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https://www.aalto.fi/fi/uutiset/nanopaperin-valmistuksesta-letunpaistoon-opiskelijoiden-rakentamat-laitteet-ihastuttivat

https://www.tekniikkatalous.fi/tiede/tutkimus/sydamen-heikentymisen-voi-havaita-suoraan-sangylla-makaavasta-ihmisesta-opiskelijat-jatkoivat-professorinsa-tyota-6719920?utm_source=Teta_Uutiskirje&utm_medium=email&utm_campaign=Teta_Uutiskirje

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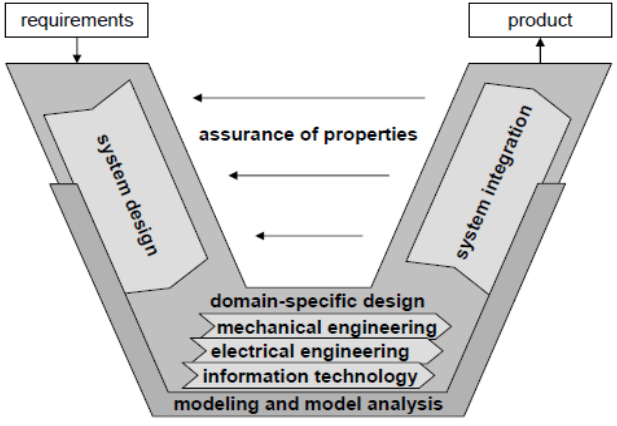
http://www.tekniikkatalous.fi/tekniikka/opiskelijat-kehittivat-automaattisen-soppatykin-patentti-haussa-katso-video-6639702

http://www.sahkoala.fi/opiskelu/Ajankohtaista_opiskelu/fi_FI/mekatroniikan_sirkus_esitteli_teollista_internetia/

Assessment

Peer assessment

- **Other projects**
- **Own project**
- **Own team**
- **Own learning**

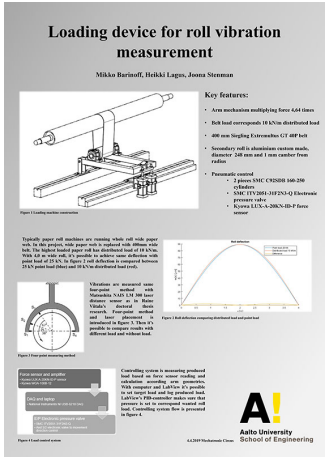


Scientific paper & presentation

Circus appearance

Project outcome


Multi-material mixer and extruder for 3D printing
Jimi Lehtola, Oliver Tallavaara, Pradeep Tajhya, Arturo Pellicer
WHAT ARE WE DOING?
We are working on a multi-material extrusion system for large scale 3D prints using non-conventional materials. KUKA robot was utilized as a ready start up platform where to build on an additional extrusion mechanism. Up to date, it has been tested with an epoxy resin. However, the extrusion of new non-conventional materials is planned, thus making sense our project as the creation of a platform for future projects.
SYSTEM COMPONENTS
Mechanical elements:
• Linear actuator (24V DC, gr 40:1)
• Casted aluminium mixer
• Printed mount(s) PLA/ABS
• One use static mixer nozzle
• 200 ml cartridges
• Non-reactive SMC pipes
• Stainless steel SMC Fittings
• KUKA robot
Electronics control:
• BALLUFF power supply (24V DC)
• BECKHOFF PLC controller
• Potentiometer 24V 8A max
• On/OFF-On switch
HOW ARE WE DOING IT?
Extruding two different materials need a plunging mechanism and mixing them before extrusion. The two materials are plunged through two cartridges using a linear actuator, keeping the materials separated before the mixing head. Increasing the stroke length of actuator and the length of the plunger allows to extrude materials through longer cartridges. The speed of the actuator movement was controlled to have desired rate of extrusion of the materials.
BALLUFF


Loading device for roll vibration measurement
Mikko Barinoff, Heikki Lagus, Joona Stenman
Key features:
• Arm mechanism multiplying force 4,64 times
• Belt load corresponds 10 kN/m distributed load
• 400 mm Siegling Extremultus GT 40P belt
• Secondary roll is aluminium custom made, diameter 248 mm and 1 mm camber from radius
• Pneumatic control
• 2 pieces SMC CRSDBI 160-250 cylinders
• SMC ITV2051-31F3N3-Q Electronic pressure valve
• Kyowa LUX-A-20KN-ID-P force sensor
Aalto University
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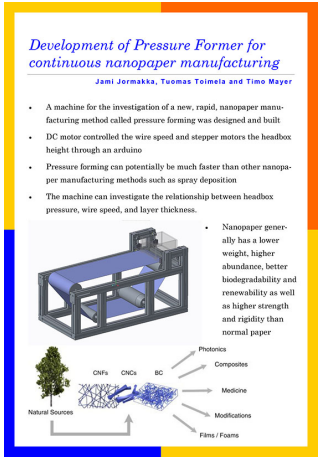
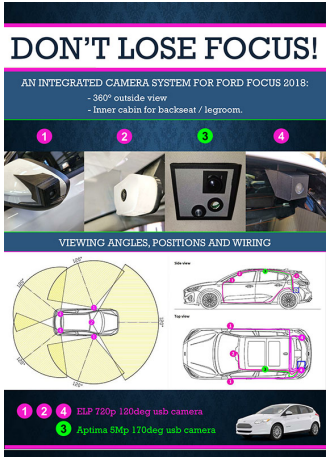
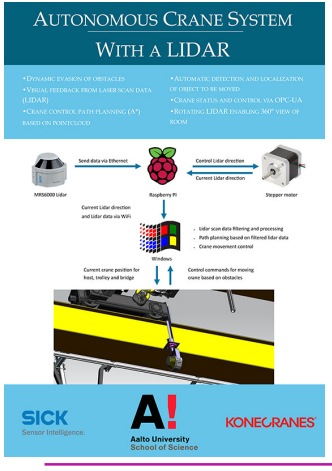
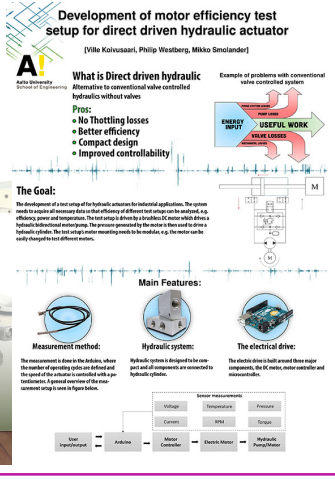
GRANULAR JAMMER
THE UNIVERSAL GRIPPER
PROJECT ANAKONDA
Iiro Vuorinen
Jesse Miettinen
Patrick Frilund
WHY?
The granular jammer can be used to lift large variety of objects with different shapes. No need for manual labor to attach chains or ropes between the object and the hook. Fast and easy.
HOW?
The pouch of the granular jammer is hanging freely in the air.
Granular jammer is lowered on the object and the pouch forms to the shape of the object.
Vacuum is sucked into the pouch and the pouch full of the granular particles hardens to the shape of the object.
The object can be lifted now. Works for objects with different shapes. Cool!

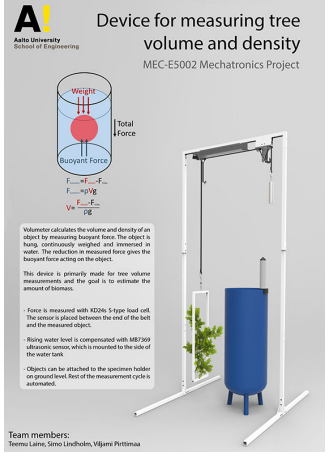

Development of Pressure Former for continuous nanopaper manufacturing
Jami Jormakka, Tuomas Toimela and Timo Mayer
• A machine for the investigation of a new, rapid, nanopaper manufacturing method called pressure forming was designed and built
• DC motor controlled the wire speed and stepper motors the headbox height through an arduino
• Pressure forming can potentially be much faster than other nanopaper manufacturing methods such as spray deposition
• The machine can investigate the relationship between headbox pressure, wire speed, and layer thickness.
• Nanopaper generally has a lower weight, higher abundance, better biodegradability and renewability as well as higher strength and rigidity than normal paper
Natural Sources
CNFs
CNCs
BC
Photonics
Composites
Medicine
Modifications
Films / Foams


DON'T LOSE FOCUS!
AN INTEGRATED CAMERA SYSTEM FOR FORD FOCUS 2018:
- 360º outside view
- Inner cabin for backseat / legroom.
VIEWING ANGLES, POSITIONS AND WIRING
1 2 4 ELP 720p 120deg usb camera
3 Aptima 5Mp 170deg usb camera


AUTONOMOUS CRANE SYSTEM
WITH A LIDAR
• DYNAMIC EVASION OF OBSTACLES
• VISUAL FEEDBACK FROM LASER SCAN DATA (LIDAR)
• CRANE CONTROL PATH PLANNING (A*) BASED ON POINTCLOUD
• AUTOMATIC DETECTION AND LOCALIZATION OF OBJECT TO BE MOVED
• CRANE STATUS AND CONTROL VIA OPC-UA
• ROTATING LIDAR ENABLING 360° VIEW OF ROOM
Send data via Ethernet
Control Lidar direction
MR560000 Lidar
Raspberry Pi
Stepper motor
Current Lidar direction and Lidar data via WiFi
Current Lidar direction
Lidar scan data filtering and processing
Path planning based on filtered lidar data
Crane movement control
Windows
Current crane position for host, trolley and bridge
Control commands for moving crane based on obstacles
SICK
Sensor Intelligence.
Aalto University
School of Science
KONECRANES


MEC–E5002 - Mechatronics Project
Team
LiMotronix
Siemens Sinumerik 840d sl CNC control system is widely used for machine tools and other production machine applications, such as laser machining and handling systems. Siemens Simotics L-1FN3 linear motor is typically used for high-performance machine tools and production machines.
Inverted pendulum is a classical testing application for the different control systems and methods. Inverted pendulums are usually implemented with cart, belt, rotating DC motor and with simple microcontroller control.
Our Challenge:
"Can a G-code program be used in feedback control loops to self-stabilize an inverted pendulum...?"
Ilkery Konce
Tomas Tyn
Aishwarya Dharamsi
SIEMENS
Aalto University


Development of motor efficiency test setup for direct driven hydraulic actuator
[Ville Koivusaari, Philip Westberg, Mikko Smolander]
What is Direct driven hydraulic
Alternative to conventional valve controlled hydraulics without valves
Pros:
• No Thottling losses
• Better efficiency
• Compact design
• Improved controllability
Example of problems with conventional valve controlled system
ENERGY INPUT
USEFUL WORK
VALVE LOSSES
The Goal:
The development of a test setup of for hydraulic actuators for industrial applications. The system needs to acquire all necessary data so that efficiency of different test setups can be analyzed, e.g. efficiency, power and temperature. The test setup is driven by a brushless DC motor which drives a hydraulic bidirectional motor/pump. The pressure generated by the motor is then used to drive a hydraulic cylinder. The test setup's motor mounting needs to be modular, e.g. the motor can be easily changed to test different motors.
Main Features:
Measurement method:
Hydraulic system:
The electrical drive:
Sensor measurements
Voltage
Temperature
Pressure
Current
RPM
Torque
User Input/Output
Arduino
Motor Controller
Electric Motor
Hydraulic Pump/Motor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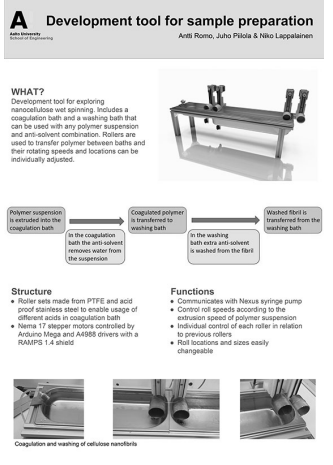
Device for measuring tree volume and density
MEC-E5002 Mechatronics Project
Weight
Total Force
Buoyant Force
Volumeter calculates the volume and density of an object by measuring buoyant force. The object is hung, continuously weighed and immersed in water. The reduction in measured force gives the buoyant force acting on the object.
This device is primarily made for tree volume measurements and the goal is to estimate the amount of biomass.
- Force is measured with KD24s S-type load cell. The sensor is placed between the end of the belt and the measured object.
- Rising water level is compensated with MB7369 ultrasonic sensor, which is mounted to the side of the water tank
- Objects can be attached to the specimen holder on ground level. Rest of the measurement cycle is automated.
Team members:
Teemu Laine, Simo Lindholm, Viljami Pirttimaa


Development tool for sample preparation
Antti Romo, Juho Piitola & Niko Lappalainen
WHAT?
Development tool for exploring nanocellulose wet spinning. Includes a coagulation bath and a washing bath that can be used with any polymer suspension and anti-solvent combination. Rollers are used to transfer polymer between baths and their rotating speeds and locations can be individually adjusted.
Polymer suspension is extruded into the coagulation bath
In the coagulation bath the anti-solvent removes water from the suspension
Coagulated polymer is transferred to washing bath
In the washing bath extra anti-solvent is washed from the fibril
Washed fibril is transferred from the washing bath
Structure
• Roller sets made from PTFE and acid proof stainless steel to enable usage of different acids in coagulation bath
• Nema 17 stepper motors controlled by Arduino Mega and A4988 drivers with a RAMPS 1.4 shield
Functions
• Communicates with Nexus syringe pump
• Control roll speeds according to the extrusion speed of polymer suspension
• Individual control of each roller in relation to previous rollers
• Roll locations and sizes easily changeable
Coagulation and washing of cellulose nanofibrils

Project topics 2021

1. Elasto-magnetic sensors for accurate load weight measurement
2. Re-think Beauty
3. Tunnel flow control system for combi thruster
4. Nanopaper dewatering device
5. Remote control of moving platform with ROS
6. Device for material technology
7. Semi-Active suspension system’s Hardware In the Loop testing
8. Coupling with adjustable torsional stiffness

Project application

- **DL Sunday Jan 17th at 23.55**
- **pdf (max 1 sheet)**
- **MyCourses**

Name

Background

- Studies, work experience, hobbies, special interests, …

Skills

- Mechanical, electrical, software, manufacturing, programming, control, communication, team/project work, …

What would you like to learn on this course/project

3 most interesting project ideas (in order)

- Reasons and motivation, your contribution, your vision

Home assignment

Find a scientific article related to *Mechatronics research and/or design*

Read the additional material in MyCourses related to scientific writing

- **DL Fri Jan 22nd at 12.00**
- **pdf (max 1 sheet)**
- **MyCourses**

Report (max 1 page):

- Reference data of the article
- Was the article organized according to the guidelines (IMRAD)? (Why/why not?)
- Did you get some new ideas about scientific writing or mechatronics? Was it useful to read the article? Please explain.
- Did this raise some questions about scientific writing?