Composite materials for grippers and robot arms used for Festo handling systems

IE STUDENTS:
Pelinsu İçil
Nida Enginol
Defne Yağmur Özgün

ME& MAT STUDENTS:
Kemal Çallıoğlu (ME)
Murat Sarp Koçak (ME)
Şeyma Burcu Gülşen (MAT)

FACULTY MEMBER:
Emre Erdem

COMPANY ADVISOR:
Fikret Akyüz

Sabancı Üniversitesi
FACULTY OF ENGINEERING AND NATURAL SCIENCES

ABSTRACT

Instances from our visits to our partners in FESTO

This project, conducted by FESTO company and Sabanci University, ultimately aims to implement a solution for the most feasible robotic arms and grippers, in line with their applicational needs. The implementation of any gripper is a very intricate process due to the numerous criterias involved, but it is very crucial for automation technology companies like FESTO. These companies need to increase the speed and efficiency of their robotic arm operations in order to save time, energy and cost, via selecting very light but still durable materials, having an optimal design and setting smart marketing strategies for their robotic arms and grippers. This project focuses on three main aspects in the path to achieve this goal. The materials aspect will try to find the most suitable materials for efficient robotic arm and gripper systems. The mechatronic design aspect will make the design of the system, including the power supplies and technical drawings. The industrial marketing aspect will research for the costs and marketability of these robotic systems in the field, keeping the above mentioned aspects in mind. Three different engineering groups; Materials, Mechatronics and Industrial Engineering students will simultaneously work on mostly, but not limited to, their respective study areas throughout the project.

OBJECTIVES

This project's main focus can be identified as four main objectives including; design, materials, optimization and marketing aspects. Here, we are aiming to modify only the components that are allowed by the FESTO company. These components are in general determined by the demand of the customers. Such components are the main issues that causes the high weight of the handling system. Therefore in this project we are aiming to reduce by suggesting alternative materials. Basically the Festo company uses aluminum for the component which can be modified. The weight of these components determines the cost, efficiency and the strength of the whole system. The main challenge for the objective of this project is to find out the most optimal composite materials in terms of:

- **Design**
- **Materials**
- **Optimization**
- **Marketing Research**

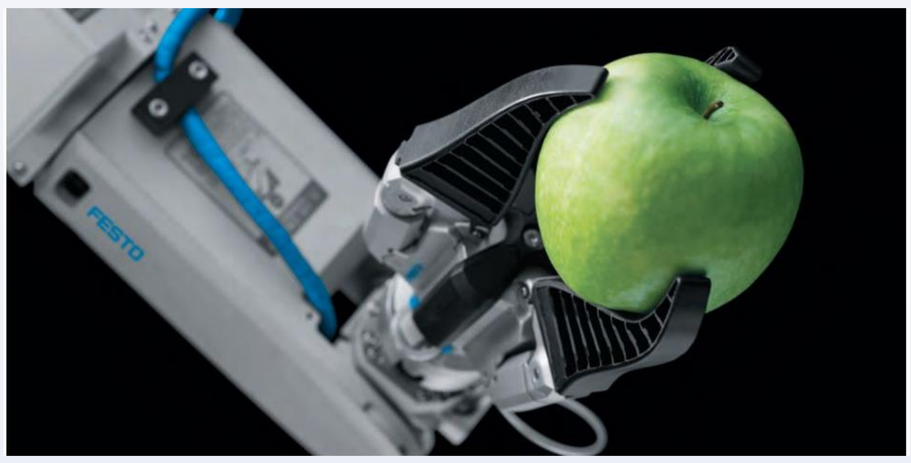
Improvement of the current conventional design, including the optimisation of the selected material in accordance to the load of the robotic arms used in the field currently. Research of lighter robotic arms and grippers that can reliably and economically produced and implemented by the FESTO company. Decreasing the long and short term costs of the production processes and research for cheaper suitable materials. This can be achieved by comparison and market research of different suitable material systems. Taking considerations on eco-friendliness as much as possible, i.e. decarbonization, to decrease the environmental footprint of modern manufacturing processes.

PROJECT DETAILS

In this project cost-effective, lighter and functional materials will be investigated both in research and marketing aspects. By this we will be able to have better, lighter and functional handling system to have better mechanic performance of robot arms and grippers.

More specifically: Handling systems are one of core business of FESTO Company. A pay load is always carried with robots or handlings (Cartesian robot) or a path is moved with a pay load. It is always necessary to have grippers or robot arm to pick parts, materials, tools etc. Robots and handling systems are more or less standardized, based on pay load, strokes, cycle time, accuracy etc. One of the main challenges in this project is how to pick, design of robot arms or gripping method. Additionally, often is the problem is the weight of gripper itself. They are sometimes heavier than the pay load. It causes that we select bigger or heavier robot or handling systems, it means higher cost and less competitiveness. Therefore, it is very important to have less gripper weight in robot and handling applications. We want to study if we can use alternative composite materials for Grippers and Robot arms. Of course in this perspective the cost of both materials and the engineered system is also very important issue.

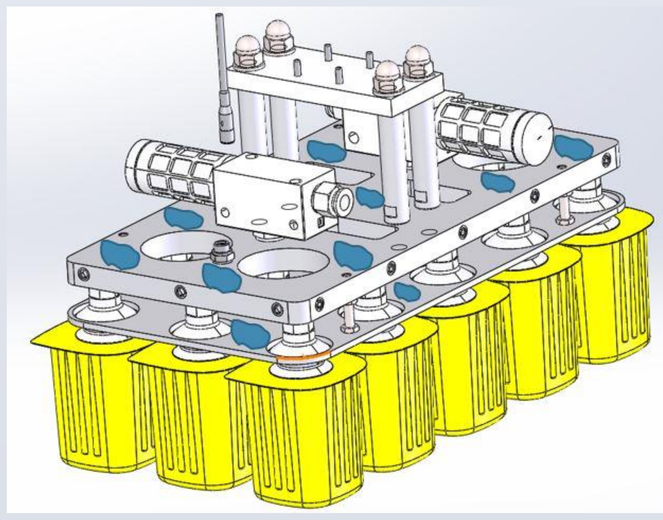
MAIN OBJECTIVE



OPTIMIZATION OF FESTO GLASS VACUUM GRIPPER

- Reducing the total weight in the gripper without changing the original FESTO components.
- Reducing the price by choosing the most cost effective material.
- Material properties will be simulated via ANSYS for stress, shear stress and deformation.
- To reduce the excess material from the plates topological map will be simulated (in progress)
- The plate material was tested for ALIMINUM, elastomer and CARBONFIBER.

- The preleminary results obtained from ANSYS are presented in the tables are given below and Carbon Fiber revealed the most promising data.
- Trying to eliminate low stress points which are non-critical for the performance and the load. The expected areas are shown in blue.



Function of the gripper is to hold a 4x5 plastic water glass

CALCULATION VIA *ANSYS* FOR THE IMPROVEMENT OF FESTO GLASS VACUUM GRIPPER

- *ANSYS* software was used to create a topology optimization, where the material can be removed from the main structure for effective light weighting.
- Topology optimization lets you specify where supports and loads are located on a volume of material and lets the software find the best shape.
  Following values were used:
  - ❖ Load Value: 4100 grams
  - ❖ Plate Geometry: Square with even holes
  - ❖ Geometry Specs: 1 mm thickness and 50 mm x 50 mm plate

	CarbonFiber	Aluminum	Elastomer
Stress	14520 Pa	12211 Pa	10898 Pa
Deformation	2.4887×10^{-6} mm	8.4393×10^{-7}mm	1.1841×10^{-4} mm
Shear Stress	799.08 Pa	6470.1 Pa	5985.5 Pa

CONCLUSIONS

- ✓ Several visits has taken place in FESTO company and the problem was determined.
- ✓ The main problem was determined as the reduction of the weight of the grippers.
- ✓ Specifically FESTO glass vacuum gripper were used as test gripper design (prototype).
- ✓ Three specific materials were chosen to determine their topological comparison.
- ✓ Aluminum, Carbon Fiber and Elastomer were the pioneering materials
- ✓ ANSYS software was used in an highly advanced way to determine critical parameters.
- ✓ From the point of mechatronics, industrial and materials science engineering point of view, in the light of our results we conclude that to find out the optimum/best material is a debating issue for the following reasons:
  - Carbon Fiber is robust but expensive and its strength is direction dependent
  - Research and development of Elastomers are still in progress which needs further investigation for the use of robotics tools.
  - Finally, Aluminum material is the king of all robotic handling operations which is indispensable for now.

https://www.festo.com/