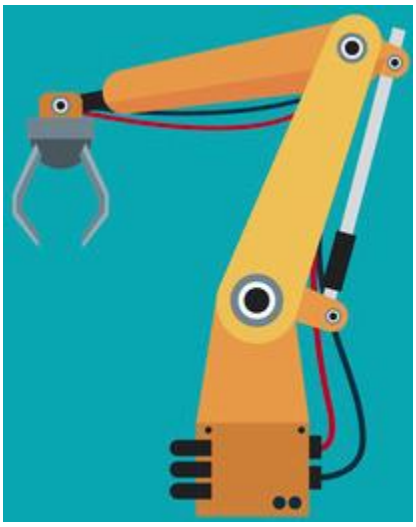
Robotic Flange Assembly



Initial Project & Group Identification Document

Interdisciplinary Project:	**Group 18**
SPONSORED BY	**Siemens**
Prepared for:	**Senior Design I**
Prepared by:	**Antonio Buda, Alana Icenroad,**
	Cassidy Lyons, Viviana Gonzalez

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Project Description

The following text describes the Robotic Flange Assembly project as stated in the document titled:

“Flanges are often used to attach pipes carrying fluids and gases to various power plant equipment and systems. Flanges are typically round rims welded to the end of pipes with a sequence of holes for threaded fasteners to attach two pipes together. A gasket is usually placed in between two flanged pipe ends to maintain a seal. The assembly of flanges are manually intensive processes requiring careful control so as to maintain a proper seal.

The goal of this project is to develop a scaled prototype robotic flange assembly assistant to demonstrate and better understand the opportunities associated of the system. Benefits of the proposed system include reduced manual effort and improved quality. [1]”

The project, sponsored by Siemens, is interdisciplinary and requires the combined efforts of Mechanical, Electrical, and Computer engineering expertise. The predefined project description shall serve as a baseline as we focus on developing our own unique description of the project. In this early stage as we (the ECE components) integrate ourselves with the Mechanical Engineers (a group of 6), our primary focus is on discovering the root problem we are tasked to solve. We aim to clearly define our roles and to accurately portray the benefits of the proposed system.

Project Narrative

Motivation to pursue the Robotic Flange Assembly interdisciplinary project stemmed from a need to satisfy a deep curiosity and longtime fascination with robotics. The chance to manipulate a robotic limb is an incredible opportunity, especially for a group of college students. Before we can imagine what it takes to automate a flange assembly, we must carefully study the mechanics of the manual process.

As engineers, we ask ourselves how the process of flange assembly can improve, and we must identify as many shortcomings as possible to ensure we do not carry over any imperfections. During the initial phase of our data gathering, it appears that human error plays a larger role in the pitfalls of flange assembly than does the design aspect.

Flanges, gaskets, and fasteners are three components we have come to read a lot about while exploring nature of our ambitious task at hand. Fasteners can be at the root of failure if they are insufficiently tightened. A too loose fastener will not provide adequate support while a too tight fastener can impose stress on pipes. This is why fasteners must be tightened to a specified torque. Gaskets help to prevent leakage and serve as a seal. Careful installation and proper use should provide a stable design. When engineers select a material

that is designed to fill a certain space, a gasket can provide a margin of error to the fasteners being tightened. Flanges must be handled with care to ensure they are not damaged before installation. It is important that proper installation is initially achieved to avoid damage that may occur with less than perfect attempts. While little can be done about flanges becoming warped over time, there does exist ample opportunity for improvement by simply taking precautionary actions.

The most exciting conclusion to draw is the notion that by minimizing the exposure to human error, many failures can be circumvented. The motivation that began as simple intrigue now presents itself as the chance to make a meaningful difference. We are inspired to challenge our intellectual limits and to work alongside other disciplines to achieve our goals.

Group Identification

Named Member	Role	Degree Major
Antonio Buda	ECE student member	Electrical Engineering
Alana Icenroad	ECE student member	Computer Engineering
Cassidy Lyons	ECE student member	Computer Engineering
Viviana Gonzalez	ECE student member	Electrical Engineering
Rodrigo Duran	ME student member	Mechanical Engineering
Fernando Gil	ME student member	Mechanical Engineering
Justin Connolly	ME student member	Mechanical Engineering
Reed Snowden	ME student member	Mechanical Engineering
Juan Meneses	ME student member	Mechanical Engineering
Juan Barajas	ME student member	Mechanical Engineering

Named Contributor	Role	Expertise
Jerry Feller	Siemens Sponsor Liaison	Siemens Representative
Eduardo Lopez Del Castillo	Project Advisor	NASA Engineer Adjunct Faculty Member (UCF)
Mark W. Steiner	Initial POC, project coordinator	Professor and Director of Engineering Design Mechanical and Aerospace Engineering

Requirements Specification

- Must be able to tighten two bolts on the flanges simultaneously
- Must provide more efficiency and consistency than work done by the human hand
- Must be able to hold two flanged pipes together securely and evenly while the bolts are tightened
- Must meet all standards specified by the European Sealing Association guidelines (tightening and fitting)
- Must be reproducible (financially and mechanically)
- Must have clear code that's reproducible for software engineers
- Must withstand specified load limits

Estimated Project Budget and Financing

Estimated Project budget and financing is $1200, generously provided by Siemens, our sponsor. As a group, we have an ideal overhead budget of approximately $400.00 for the ECE team members.

Description	Quantity	Estimate Cost	Actual Cost
Power Supply	1	$50.00	$50.00
Dual Motor Drive	1	$15.00	$15.00
Microcontroller	1	$25.00	$25.00
PCB	2	$50.00	$100.00
Motion Sensors	5	$5.00	$25.00
Circuit Components	10	$15.00	$150.00
Miscellaneous	10	$20.00	$200.00

Block Diagram

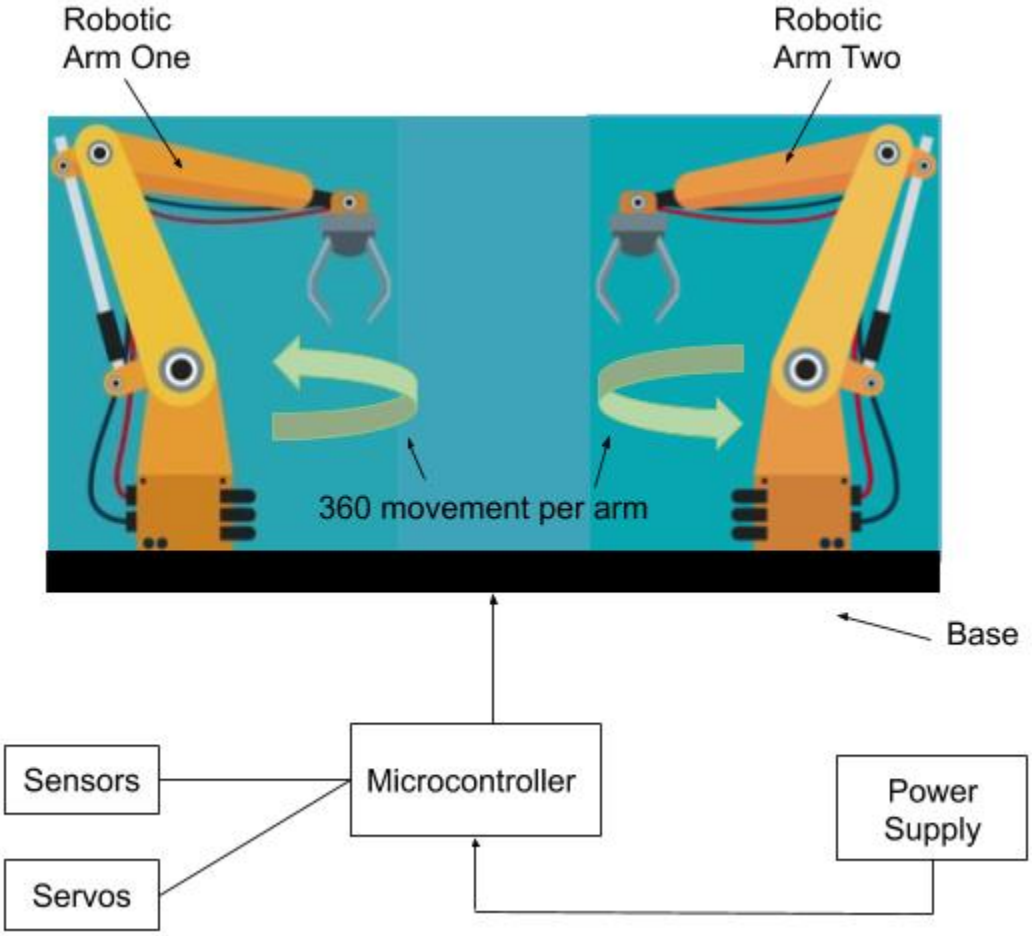


Figure 1 - Initial Block Diagram

Initial Project Milestones

Initial milestones as defined by the requirements of Senior Design I is to have a complete design plan for the product system with well-defined roles for each student member, a detailed timeline that serves as a blueprint to be relied upon throughout Senior Design II.

Senior Design I Task List	**Due Date**
Project Ideas	08/24/18
Project Selection	09/14/18
Assign Member Roles	09/28/18
Initial Divide & Conquer	09/14/18
Final Divide & Conquer	09/28/18
60-page Submission	11/02/18
100-page Submission	11/16/18
Final Document	12/03/18
Senior Design II Task List	**Due Date**
Order & Test Parts	01/07/19
Build Prototype	TBA
Testing & Redesign	TBA
Finalize Prototype	TBA
Peer Presentation	TBA
Final Report	TBA
Final Presentation	TBA

List of Acronyms

Acronym	Full Text
ECE	Electrical and Computer Engineering
ME	Mechanical Engineering
POC	Person of Contact
MCU	Microcontroller
ESA	European Sealing Association
FSA	Fluid Sealing Association
ECE	Electrical and Computer Engineering
ME	Mechanical Engineering

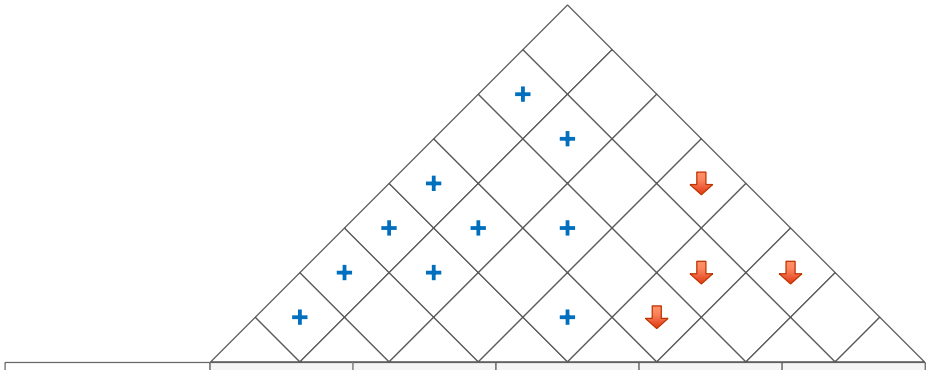
Marketing and Engineering Requirements

		Efficiency	Sensitivity	Weight	Quality	Dimension	Portability	Performance	Cost
		+	+	-	+	+	-	+	-
Efficiency	+	↑↑							
Sensitivity	+		↑↓						
Weight	-			↑↓					
Quality	+				↑↑				
Dimensions	+					↑↓			
Portability	-						↑↓		
Performance	+							↑↑	
Cost	_								↑↓
Target for Engineering Requirements		> 70%	<20%	TBD	> 70%	TBD	TBD	> 80%	<= $1200

Marketing Engineering

↑ = Positive correlation
↑↑ = Strong positive correlation
↓ = Negative correlation
↓↓ = Strong negative correlation
+ = Increases the requirements
- = Decreases the requirement

House of Quality



	Demonstrate Opportunities of Automated Process	Simultaneous Tightening of Bolts	A Carousel Arrangement	Perform Necessary Calculations	Programmed Sequence
Scaled Prototype Robotic Flange Assembly					◉
Two Robotic Arms		○	◉		
Platform Capable of Rotating the Robotic Arms	◉		○		
Ensure Bolted Flange Connection Integrity	◉				○
Improved Quality	◉				
Reduced Manual Effort	◉	○			◉
Uniformly Tighten Threaded Fasteners to a Specified Torque		○		✦	◉
Optimize Gasket Sealing		◉			
Simulated Environment	◉		✦		◉

◉ Strong
○ Medium
✦ Weak

For this section, the software “EdrawMax2” [2] was utilized in order to format and populate it as shown.

Lecture

[1] L.Wei EEL4914 Microsoft Word document titled “2018-19 I-Design Projects 8_07 update.docx” College of Engineering and Computer Science, University of Central Florida Orlando, FL, Aug. 9, 2018.

Software

[2] Shenzhen Edraw Software Co., LTD. [Web-Based]. Nanshan District, Shenzhen City, Guangdong Province, 2004-2018. Available: https://www.edrawsoft.com/edraw-max.php [Accessed 14 Sept. 2018]