Human Robot Collaboration For Ergonomic Door Panel Assembly

Sofie, Sophie, Lærke og Ida

Agenda

01

Problem and solution

02

Design and implementation

03

GUI, database and tests

04

Goals and limits

01
Problem and solution

Lærke Holst

Demonstration

Link!

Problem and solution

Problem

Ergonomic Problem

Manual handling of heavy door panels causes ergonomic strain.

Industrial Constraint

High product variability limits the use of full automation.

Solution

Proposed Solution

A collaborative robot supports lifting and positioning.

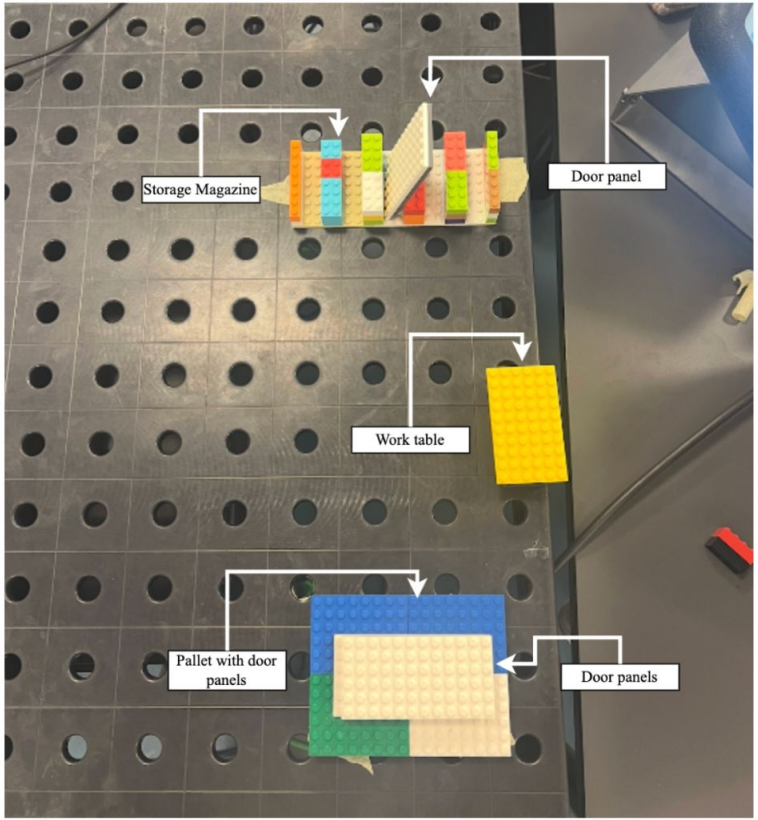
Expected Benefits

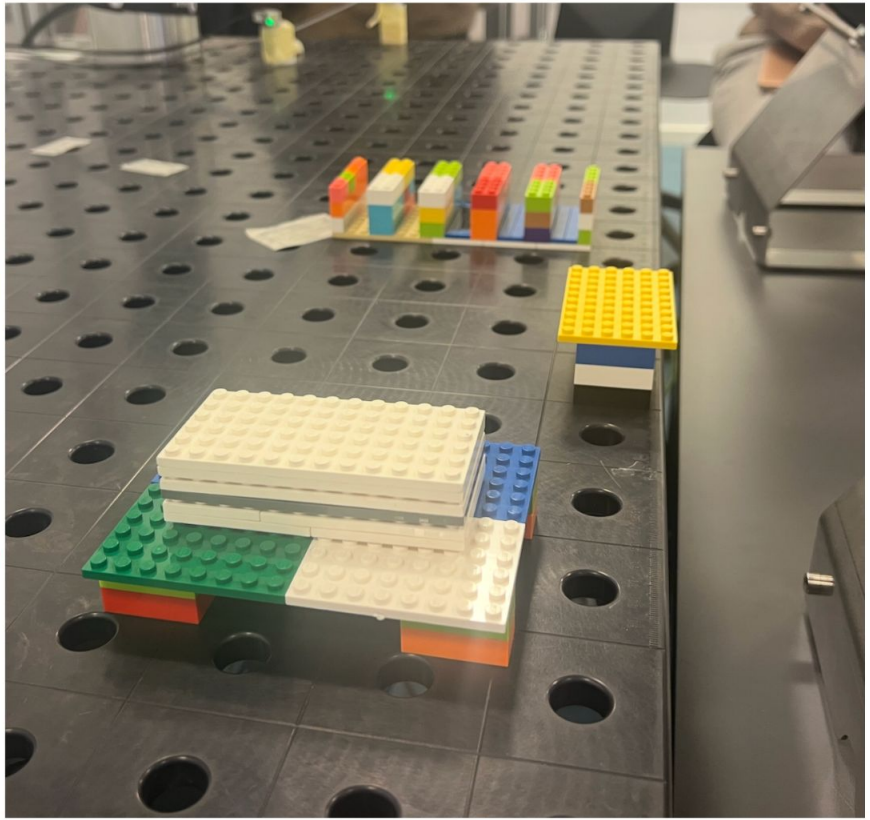
Improved ergonomics, stability, and assembly quality.

02
Design and implementation

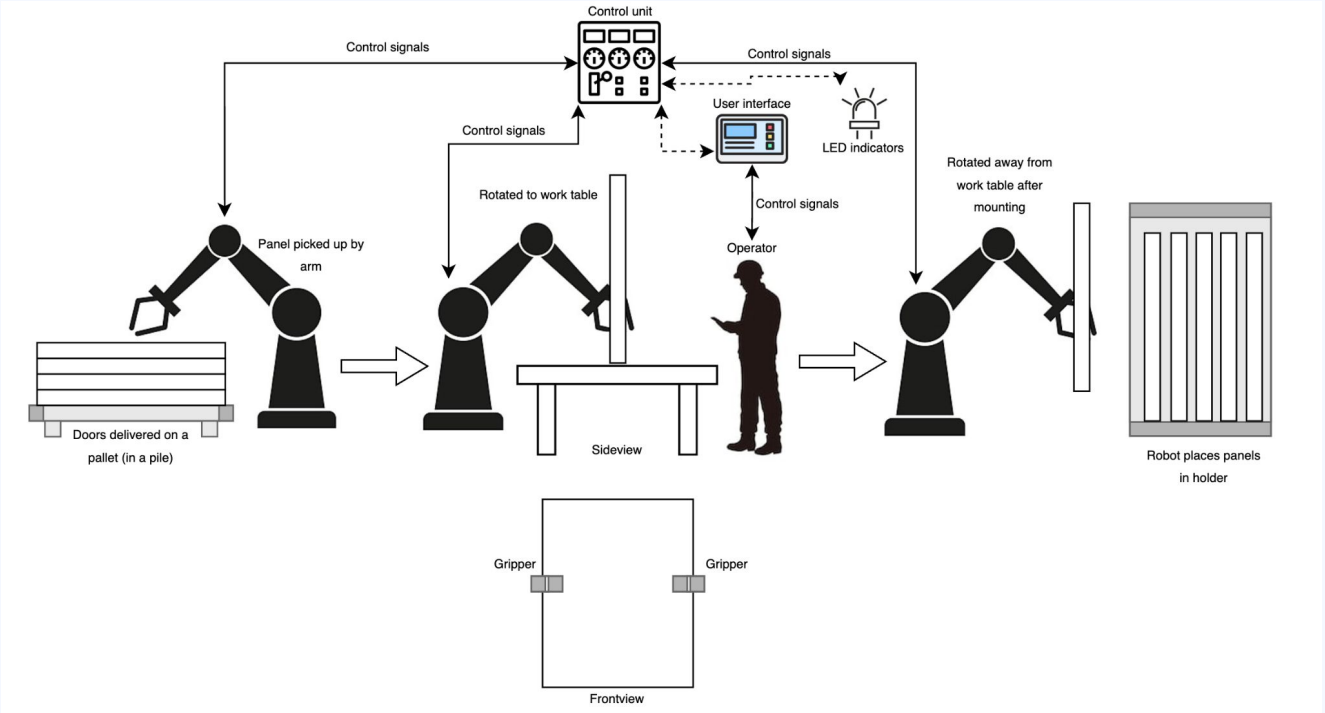
Ida Ankerstjerne

Setup

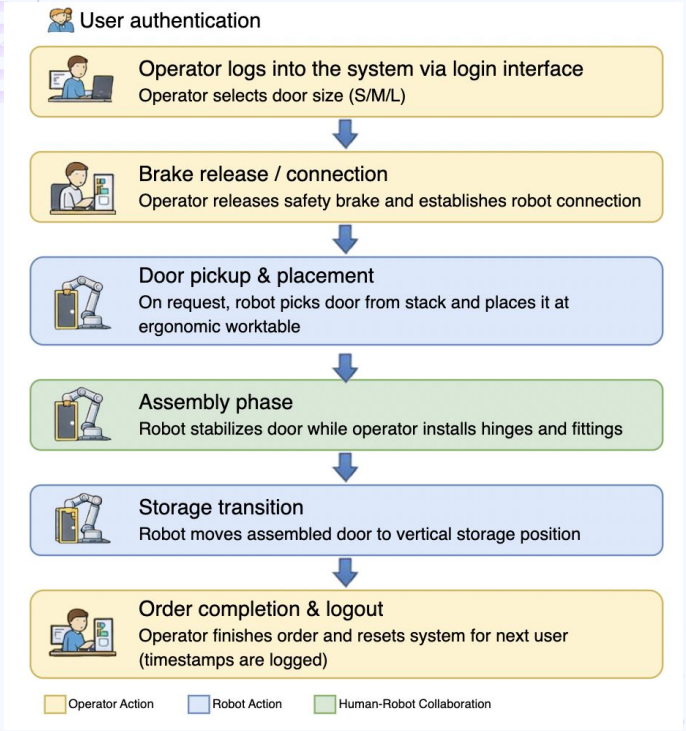

Storage Magazine
Door panel
Work table
Pallet with door panels
Door panels



Concepts


Control unit
Control signals
Control signals
Control signals
User interface
LED indicators
Rotated away from work table after mounting
Rotated to work table
Control signals
Operator
Panel picked up by arm
Doors delivered on a pallet (in a pile)
Sideview
Robot places panels in holder
Gripper
Gripper
Frontview

What is this topic about?



The overall process follows the main steps:

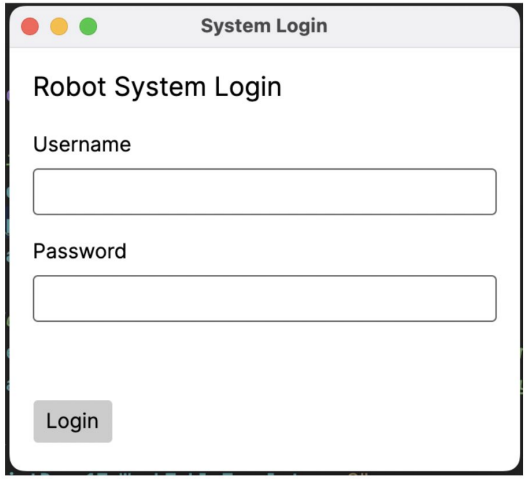
1. User authentication: the operator logs into the system through a login interface.
2. Parameter selection: the operator selects the door size (small/medium/large), which determines the gripping width and force used by the robot.
3. Brake release/connection: the operator establishes the connection to the robot controller and releases the safety brake.
4. Door pickup and placement: on request, the robot retrieves a door from the stack and places it at the ergonomic workstation.
5. Assembly phase: the robot stabilizes the door while the operator installs hinges and fittings.
6. Storage transition: when assembly is complete, the operator commands the robot to move the finished door to a vertical storage position.
7. Order completion: the operator marks the order as finished, which records a timestamp and closes the operation.
8. Logout: the operator logs out, resetting the interface to the idle state for the next user.

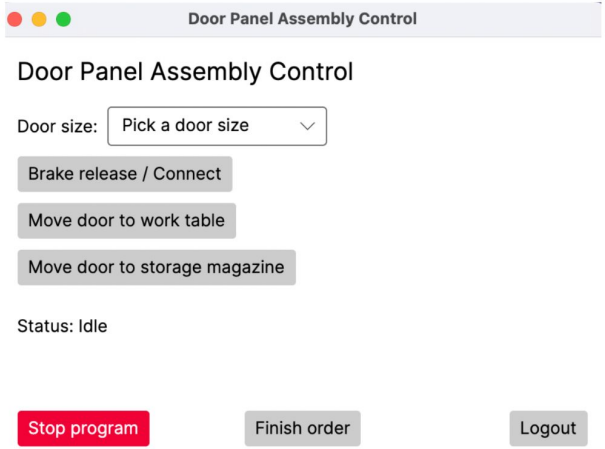
03

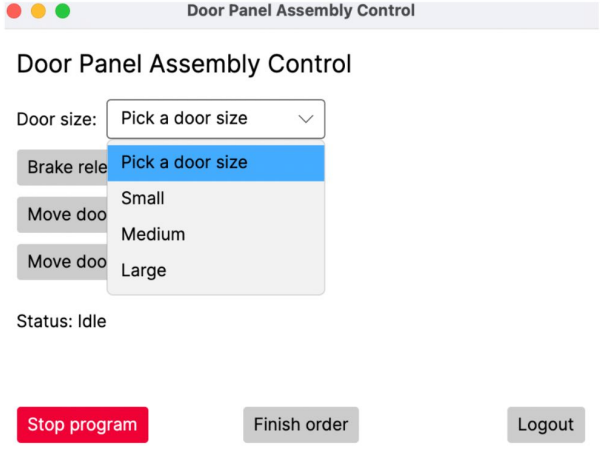
GUI, database and test

Sophie Hauritz

Graphical User Interface (GUI)







Purpose

- The GUI acts as the Operator control panel for the robot.
- Enables collaboration instead c full automation.
  Prevents unintended motion vic confirmation buttons.
- Login restricts access to authorized users.
- Door size affects robot gripper settings.

User Flow

- Login with username + password.
- Select door size (S/M/L).
- Trigger robot actions step-by-step.
- Stop button for safety interruptions.
- Status text shows current system state.

Tech

- Built in Avalonia (.NET).
- XAML for layout, C# for logic.
- Event handlers send URScrip TCP.
- Door size maps to grip width/force.
- Login validated against salte password hashes.
- SQLite used for logging orde users.

Safety & Trace

- Identifies operator.
- Logs timestamps for each order.
- Supports accountability + documentation.
- Operator stays in charge, robot handles physical strain.

Database (SQLite)

Authentication

- Stores users + roles (admin/user)
- Login restricts access to system
- Passwords stored as salted + hashed
- Prevents unauthorized robot control

Table: Accounts

	Username	Salt	SaltedPasswordHash	isAdmin
	Filter	Filter	Filter	Filter
1	Laerke	BLOB	BLOB	1
2	Sophie	BLOB	BLOB	1
3	Sofie	BLOB	BLOB	0
4	Ida	BLOB	BLOB	0

Traceability

- Tracks who did what and when
- Useful for quality + documentation
- Supports bottleneck analysis
- Enables future scheduling/delivery estimation

Table: OrderLogs

Filter ...

	Id	Username	DoorSize	StartedAt	FinishedAt
	...	Filter	Filter	Filter	Filter
1	1	Sophie	Small	2026-01-15 11:01:55.349606	2026-01-15 11:02:26.776203
2	4	Ida	Medium	2026-01-15 11:09:19.427963	2026-01-15 11:09:43.173335
3	5	Laerke	Large	2026-01-15 11:10:23.25267	2026-01-15 11:10:44.580694
4	6	Sofie	Small	2026-01-15 11:10:59.054394	2026-01-15 11:11:20.427787

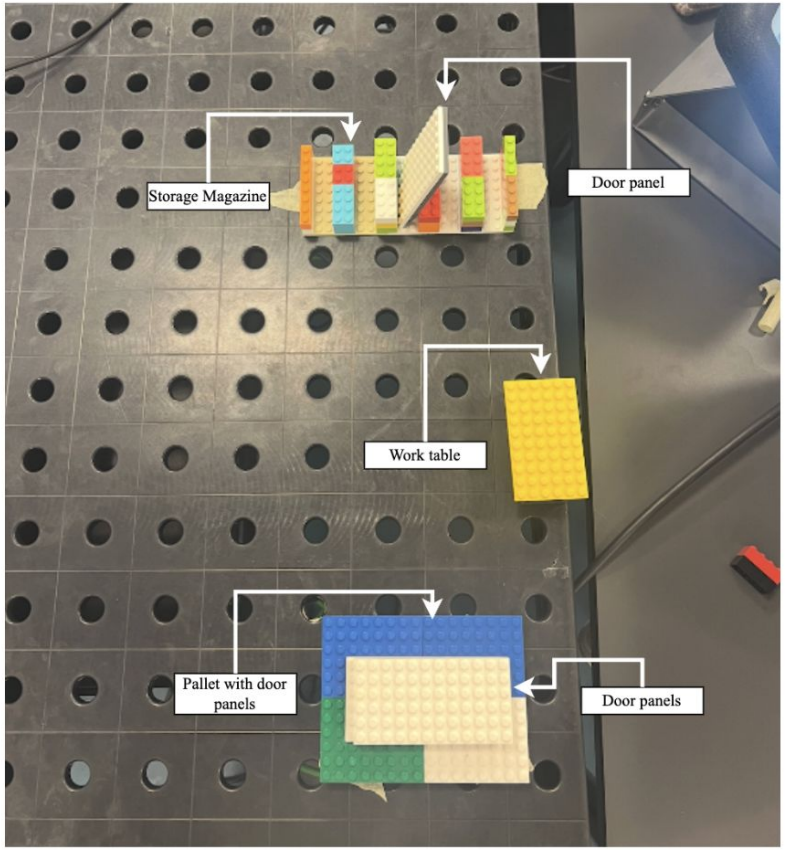
Order Logging

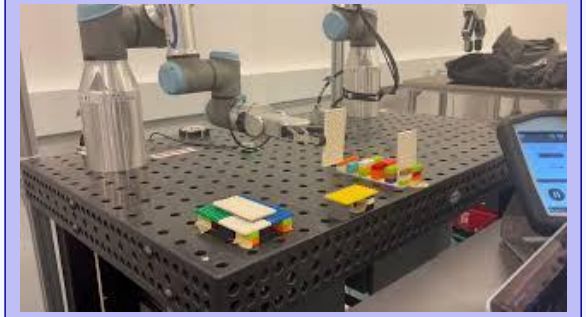
- Logs start + finish timestamps
- Triggered via GUI buttons
- Links actions to specific operator
- Measures cycle time for each order

Tech

- SQLite used as local MVP DB
- EF Core maps objects to tables
- Simple to deploy (no server needed)
- Scalable toward MES/ERP in future

Test





Initial test

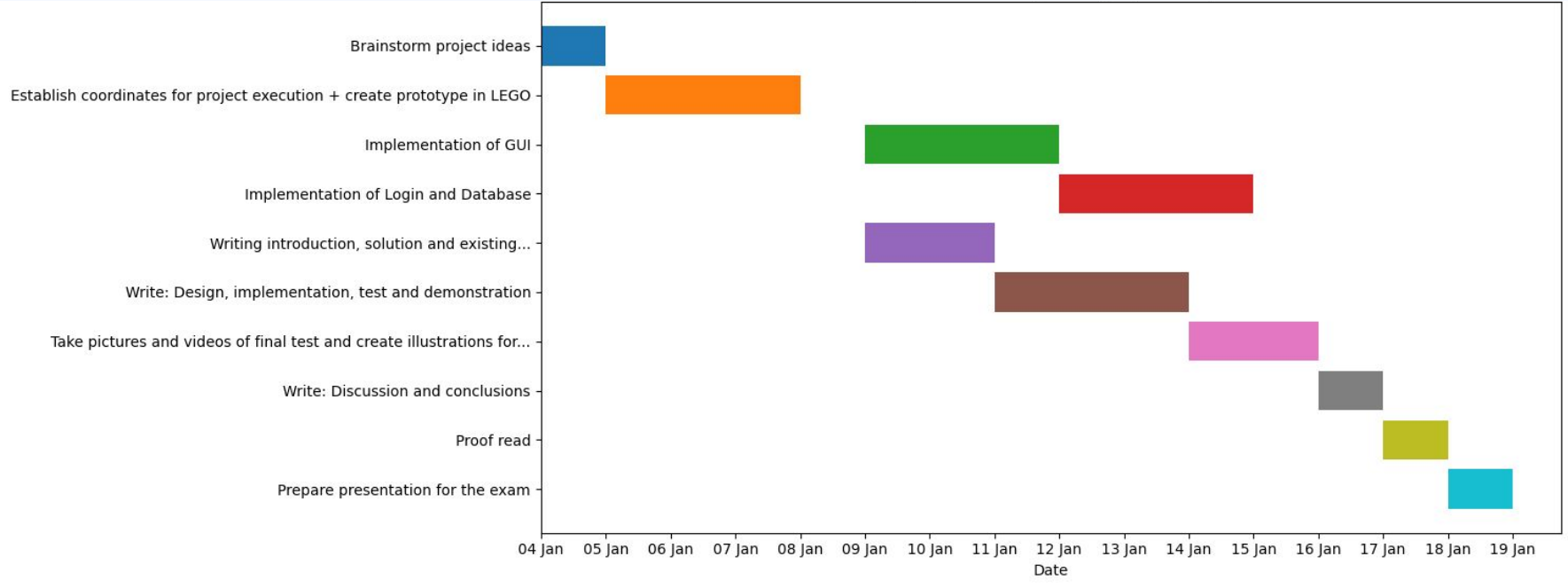
Final test

04

Goals and limitations

Lærke Holst

Milestone


Brainstorm project ideas
Establish coordinates for project execution + create prototype in LEGO
Implementation of GUI
Implementation of Login and Database
Writing introduction, solution and existing...
Write: Design, implementation, test and demonstration
Take pictures and videos of final test and create illustrations for...
Write: Discussion and conclusions
Proof read
Prepare presentation for the exam
04 Jan
05 Jan
06 Jan
07 Jan
08 Jan
09 Jan
10 Jan
11 Jan
12 Jan
13 Jan
14 Jan
15 Jan
16 Jan
17 Jan
18 Jan
19 Jan
Date

Limitations

1. Restricted Automation

The workflow relies on predefined sequences and manual input, with limited adaptability to varying components.

2. Simplified Hardware Setup

LEGO-based doors, factory layout, and workstation are used instead of real industrial components.

3. Minimal Sensor Integration

The system lacks sensors for automatic detection, positioning, and state feedback.

4. Basic User Interface

The GUI contains a limited number of buttons and does not support advanced configuration or dynamic input.

Future improvements

01 **Increased Automation**

Introduce adaptive control logic to reduce reliance on predefined sequences and enable more autonomous operation.

02 **Advanced User Interface**

Expand the GUI with additional controls, dynamic input, and configurable workflows for improved usability.

03 **Sensor & Vision Integration**

Integrate sensors and camera-based recognition to enable automatic detection, positioning, and state feedback.

04 **Industrial-Grade Setup**

Replace the LEGO-based prototype with real components to increase realism, robustness, and scalability.

Thank you for your time!

Any further questions?