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

Demonstration

Link!

01
Problem and solution

Lærke Holst

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
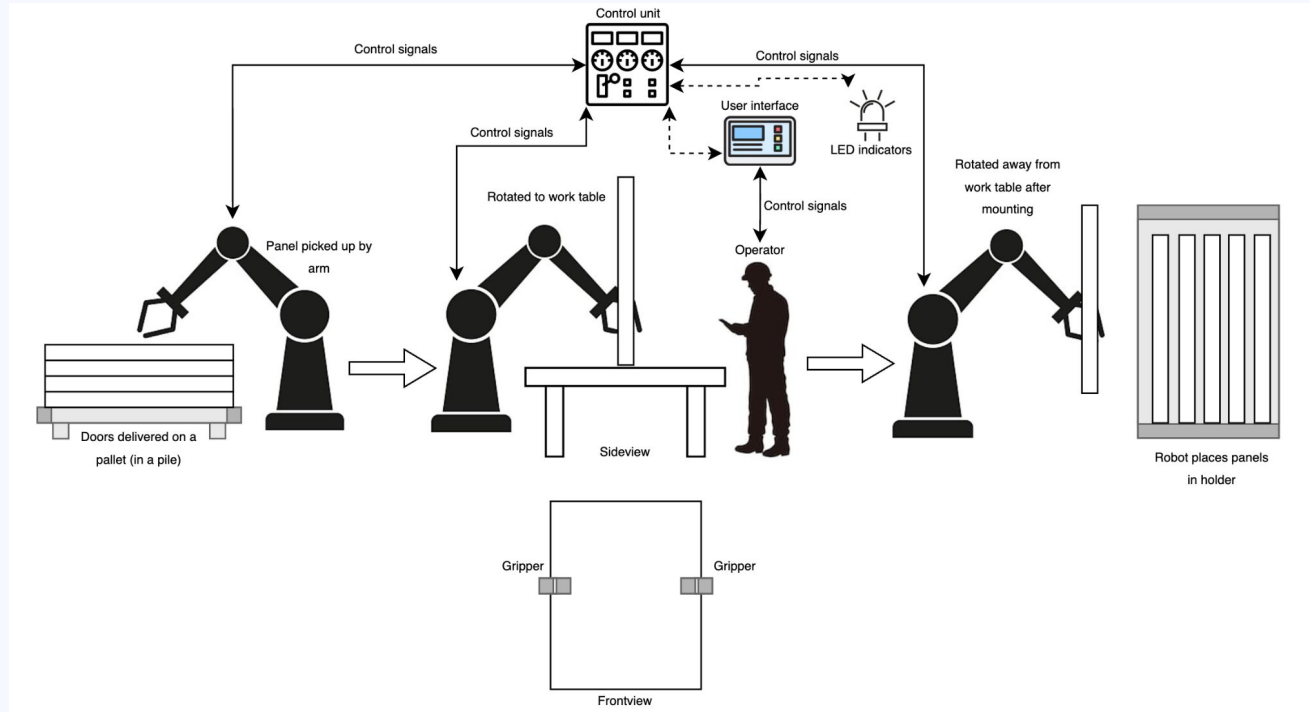
Improved ergonomics, stability, and assembly quality.
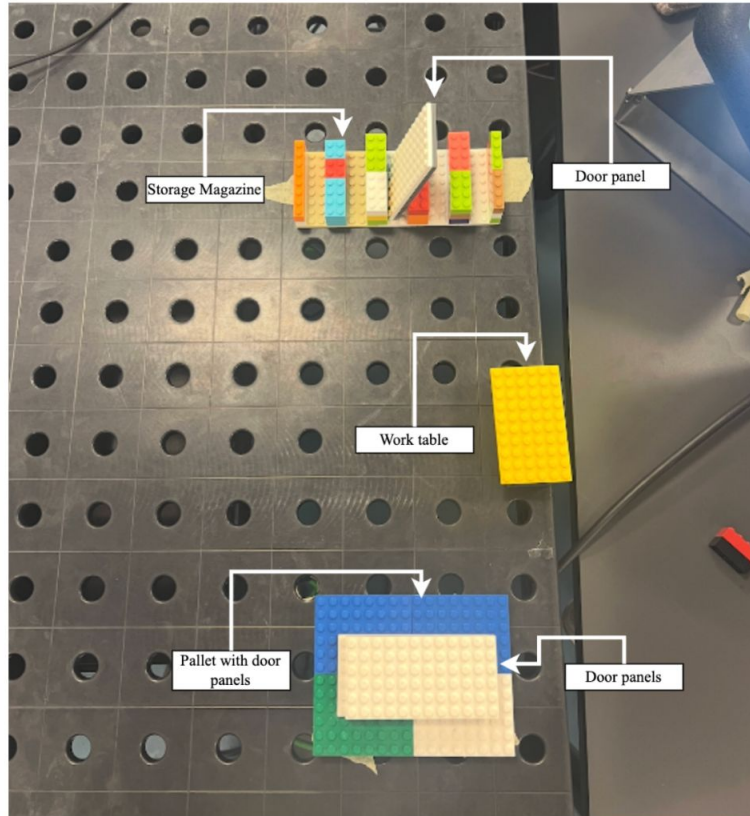
02
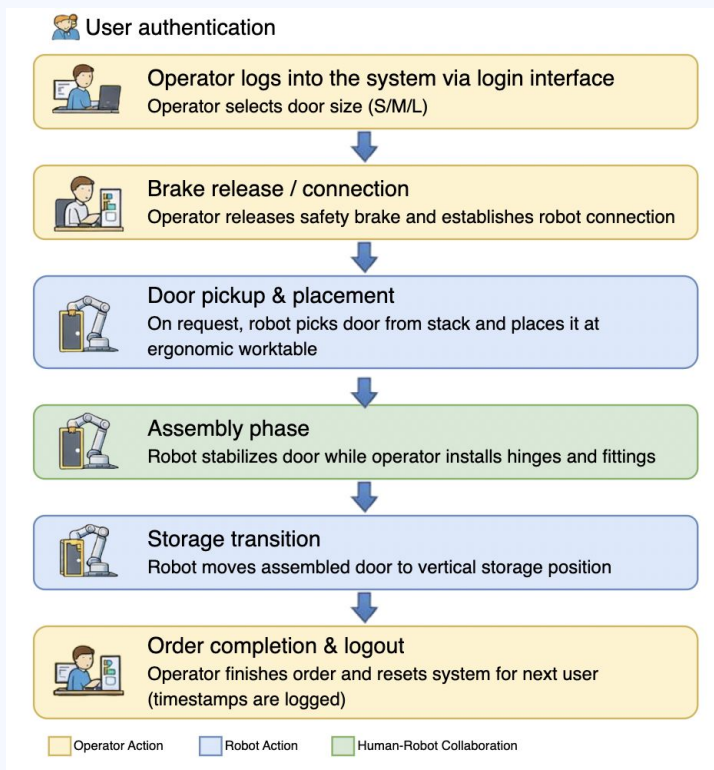# Design and implementation

Ida Ankerstjerne

Concepts

Setup

Control and flow logic

The overall process follows the main steps:

🧑‍💻 User authentication

Operator logs into the system via login interface
Operator selects door size (S/M/L)

Brake release / connection
Operator releases safety brake and establishes robot connection

Door pickup & placement
On request, robot picks door from stack and places it at ergonomic worktable

Assembly phase
Robot stabilizes door while operator installs hinges and fittings

Storage transition
Robot moves assembled door to vertical storage position

Order completion & logout
Operator finishes order and resets system for next user (timestamps are logged)

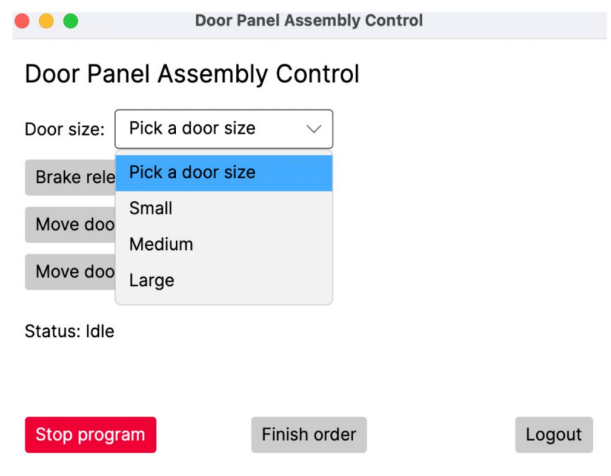☐ Operator Action   ☐ Robot Action   ☐ Human-Robot Collaboration

03
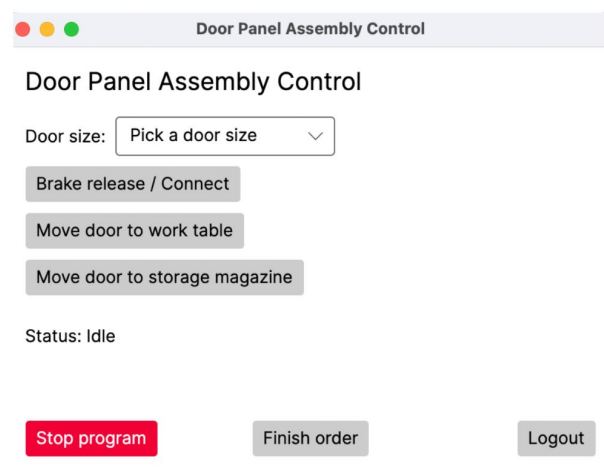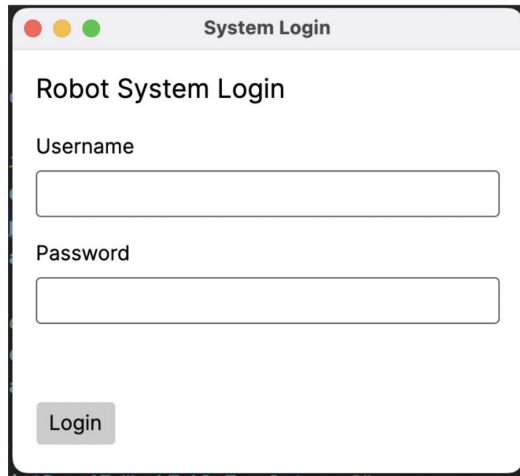
GUI, database and test

Sophie Hauritz

Graphical User Interface (GUI)

Purpose

- The GUI acts as the Operator control panel for the robot.
- Enables collaboration instead of full automation.
- Prevents unintended motion via 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 URScript TCP.
- Door size maps to grip width/force.
- Login validated against salted password hashes.
- SQLite used for logging order 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

Order Logging

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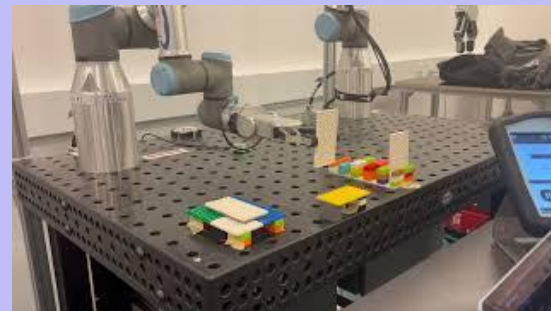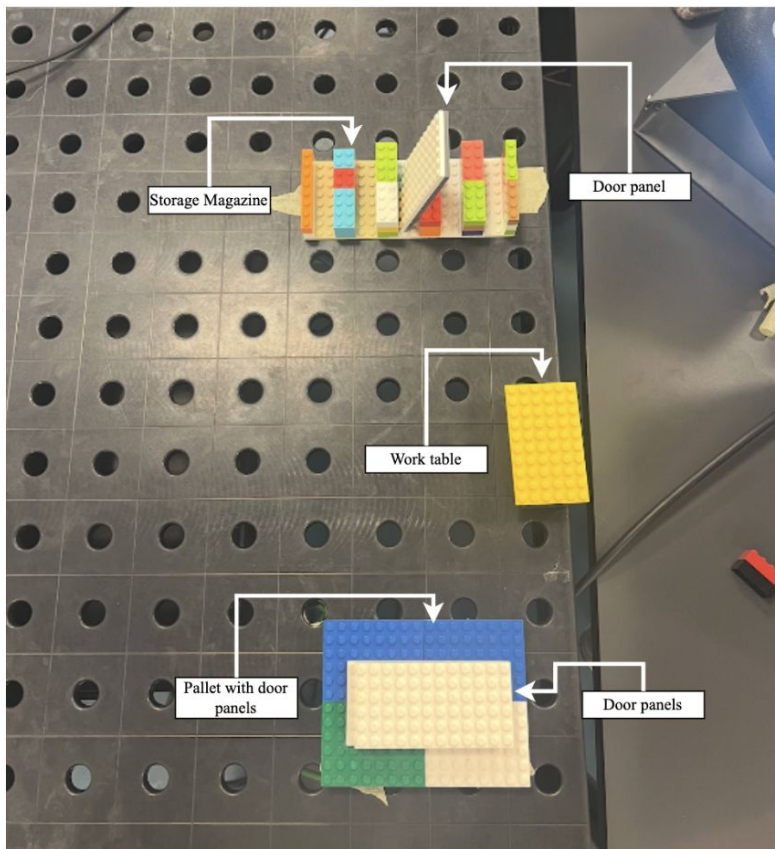- Measures cycle time for each order

Table:	📊 OrderLogs				
	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

Tech

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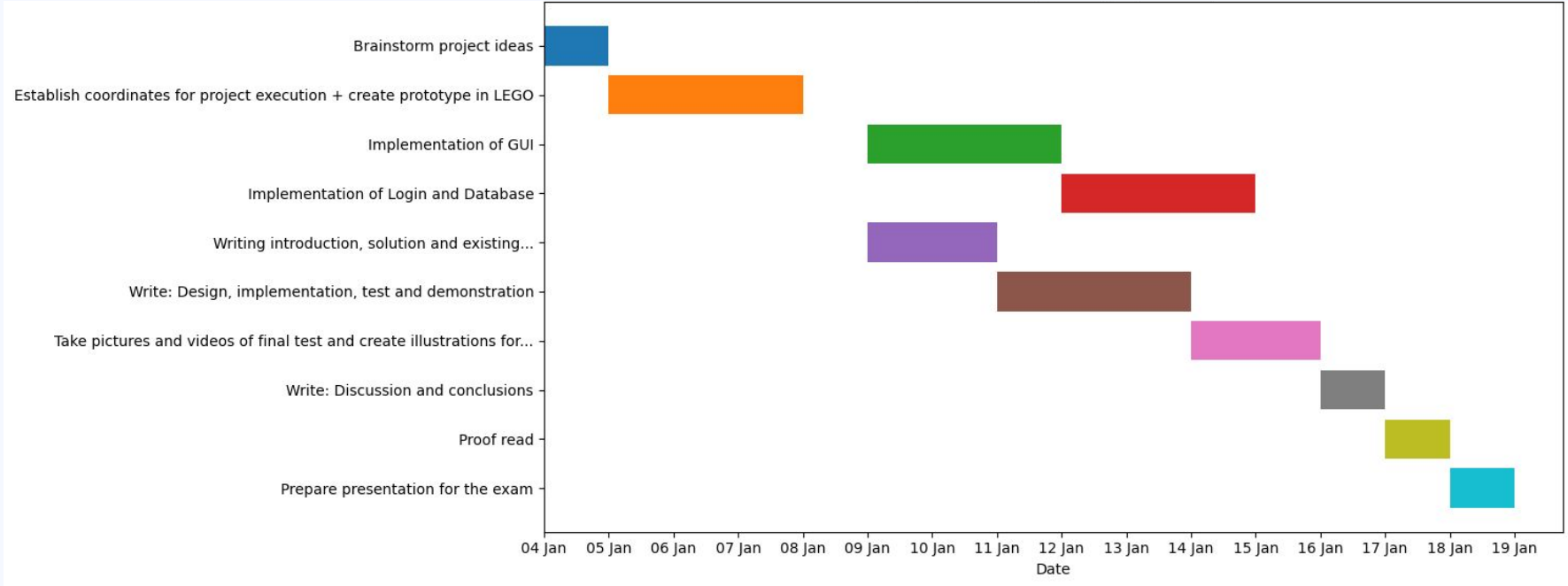- Scalable toward MES/ERP in future

Test

Storage Magazine

Door panel

Work table

Pallet with door panels

Door panels

Initial test

Final test

04

Goals and limitations

Lærke Holst

Milestone

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?