TEAM 13

Autonomous Wheelchair with Obstacle Avoidance, Remote Surveillance, and Room-to-Room Navigation

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COE CIE 4 EE ME

Problem Statement

Manual wheelchairs lack integrated sensor fusion from onboard vision and inertial sources, real-time obstacle detection, dynamic A*-based path planning, and remote monitoring capabilities. This deficiency forces mobility-impaired users to depend on caregivers for navigation in complex indoor environments, increasing collision risks and reducing autonomy.

Constraints

- Lighting Conditions
- Dynamic Obstacle Handling
- Delay Time
- User Weight Capacity

Specifications

- Battery usage & capacity (24 V, ≥ 12 Ah)
- High-strength frame (FoS > 2)
- Frame rate (≥ 20 FPS)
- Power consumption (< 550 W)
- Wheel diameter (≥ 30 cm)
- Compute throughput (> 25 TOPS)
- RAM (8 GB)
- CoM height (< 60 cm)
- Response (≤ 1 % SS error; ≤ 5 % overshoot)
- Total weight (< 60 kg)
- Motor torque (≥ 20 N·m)
- Obstacle detection accuracy (> 90 %)

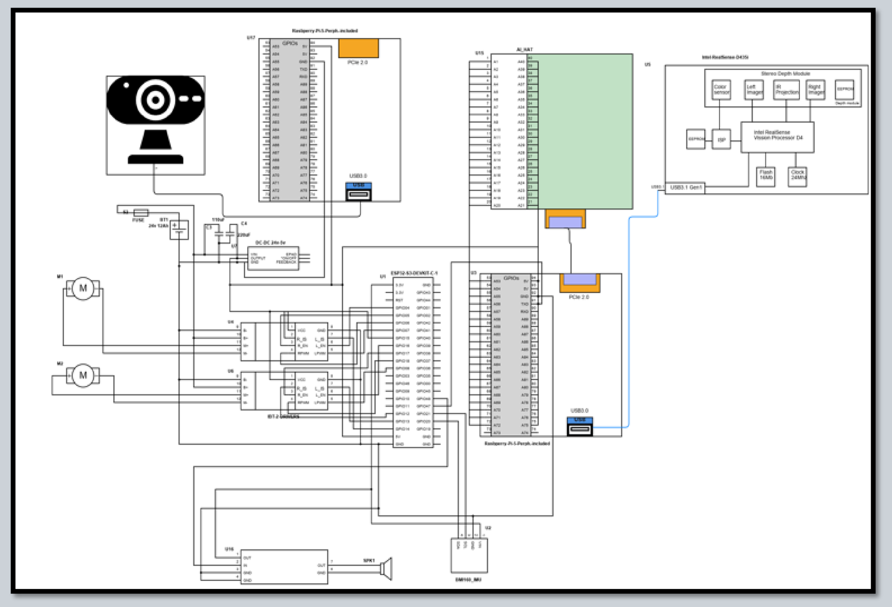
Prototype Design & Manufacturing

Mechanical Design

We started the design process by designing a 3D model of the wheelchair's frame with accurate dimension measurements. This 3D frame model was used later to conduct the stress analysis and verify the Factor of Safety.

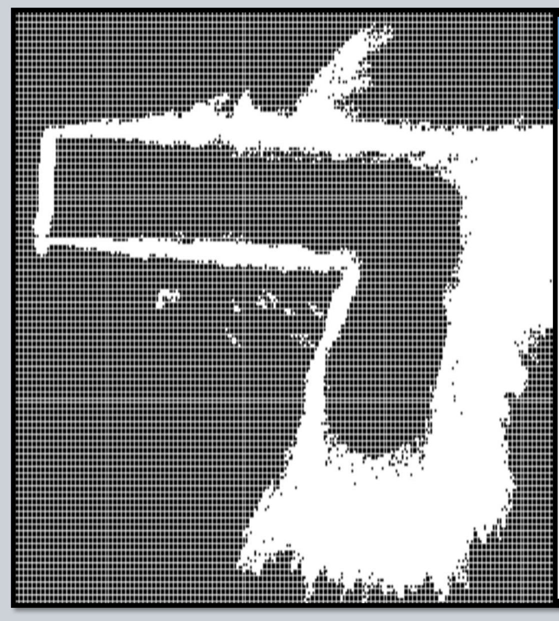
Adding the seat and the system components

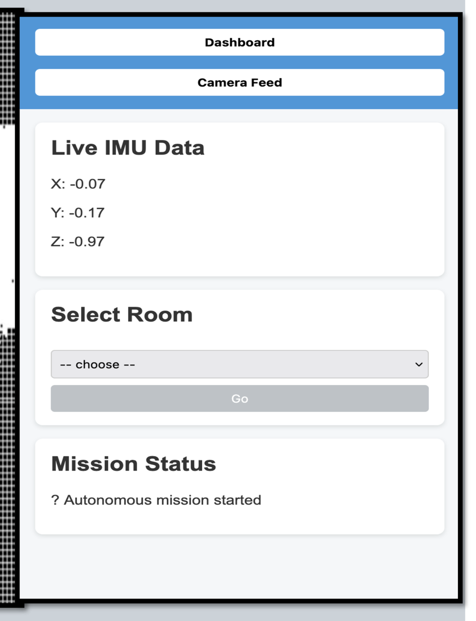
Electrical Circuit Design



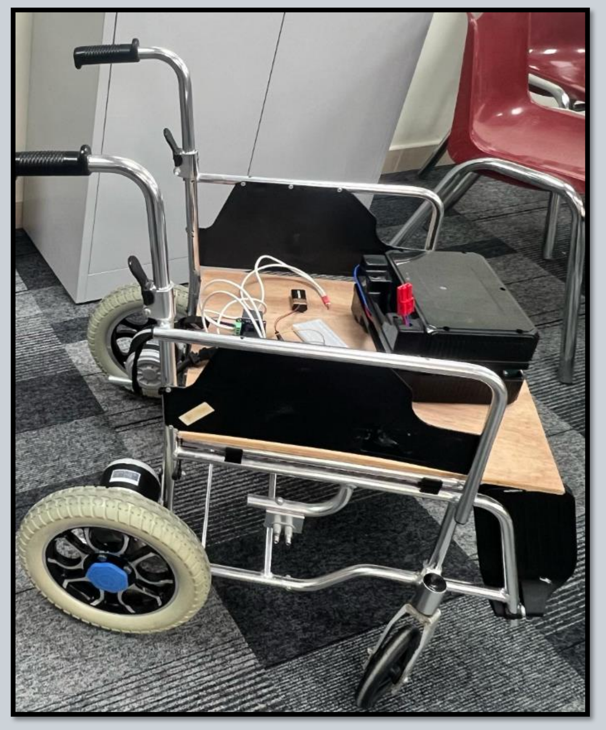
Computer Engineering

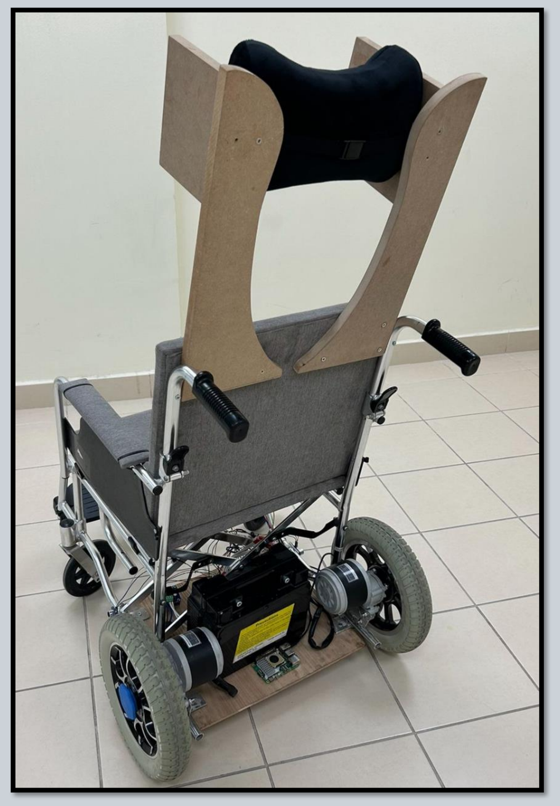
RTAB-Map/ROS 2D map of KFUPM Bldg 42 3rd floor powers sensor-fusion A* navigation; dashboard enables room-goal selection and live cam feed.





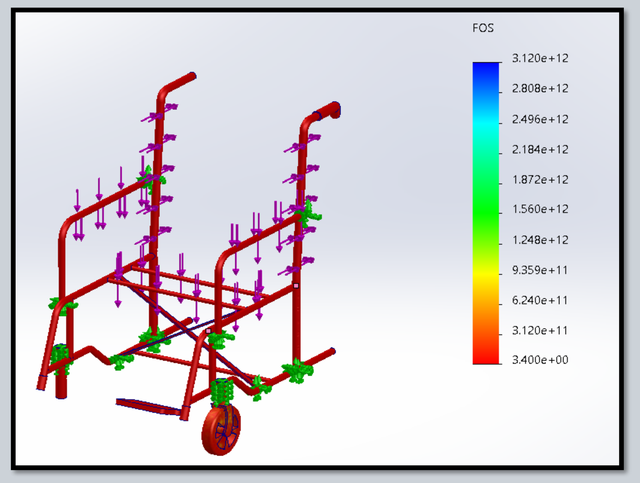
Final Prototype building



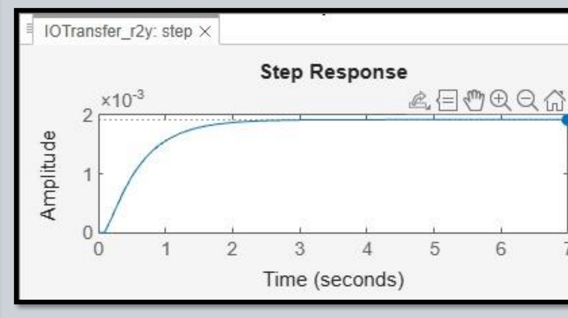


Testing / Validation

Targeted Specification	Validation Method
1. High-strength Frame (FoS <2)	• SolidWorks to evaluate stresses. • The FoS was found to be 3.4
2. Frame rate (≥ 20 FPS)	FPS ➔ $\frac{1000}{N}\sum_{i=1}^{N}\Delta t_i$
3. System Response (≤ 1 % SS error; ≤ 5 % overshoot)	• MATLAB Simulation

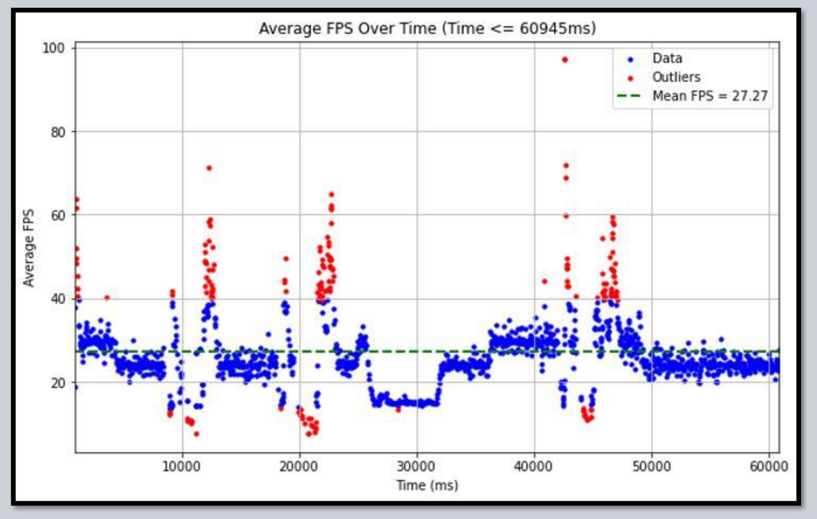


Stress Analysis



System Response Validation

FPS >= 20



Conclusion

Our prototype achieves safe, fully autonomous room-to-room navigation with live remote monitoring, restoring independent mobility and easing caregiver workload. These outcomes echo recent research showing that smart wheelchairs using multi-sensor autonomy enhance user safety and reduce caregiver burden. Future work will refine the interface and validate performance across larger, more diverse environments.