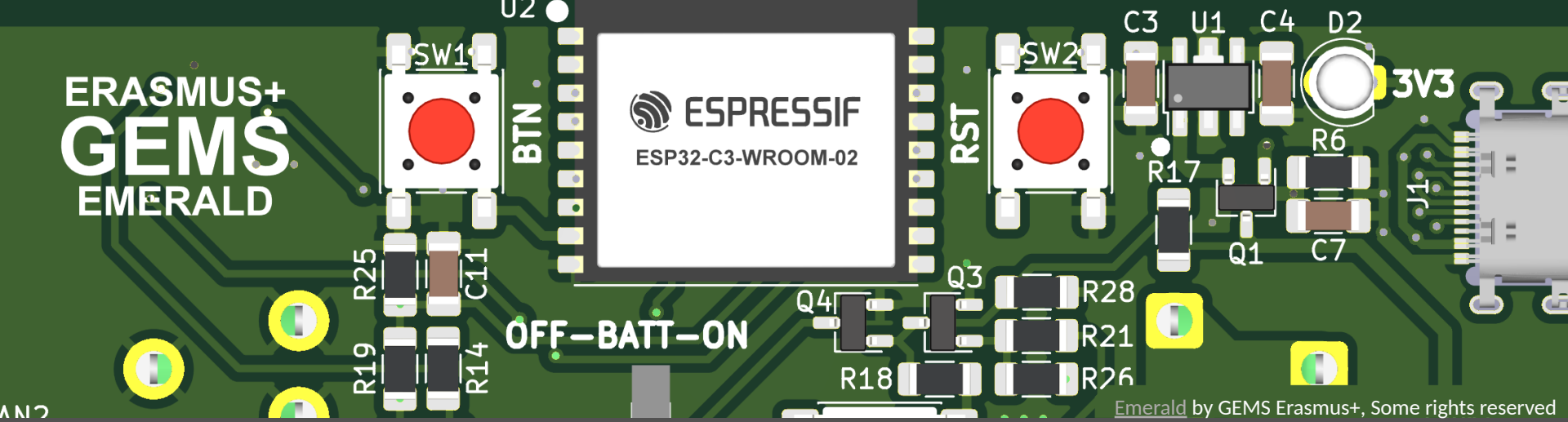


Mobile robot with differential drive

Building Robots: System Integration

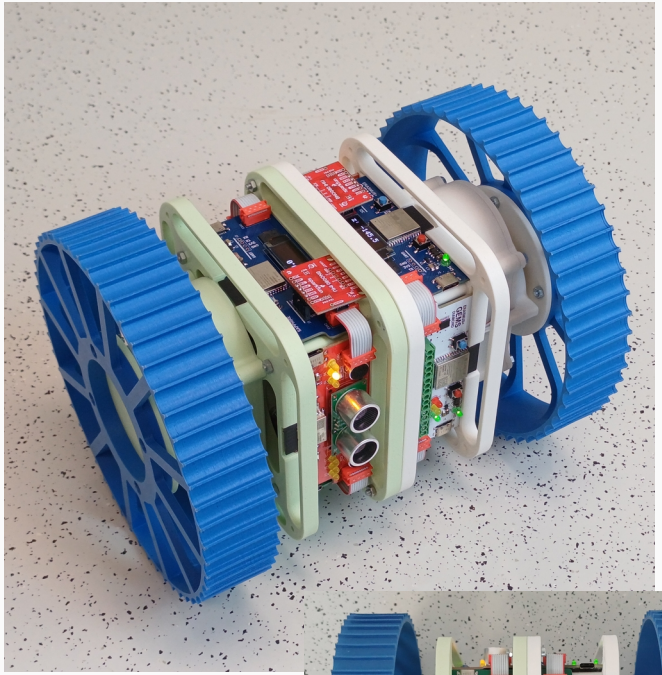
Gašper Škulj

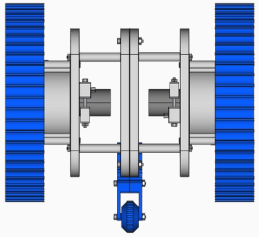
University of Ljubljana, Faculty of mechanical engineering

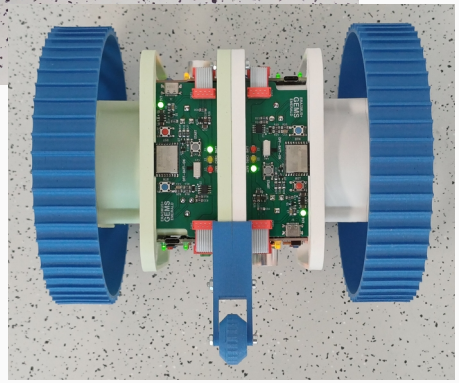
About

1. Mobile robot
2. Structure
3. Forward kinematics
4. Inverse kinematics

Mobile robot



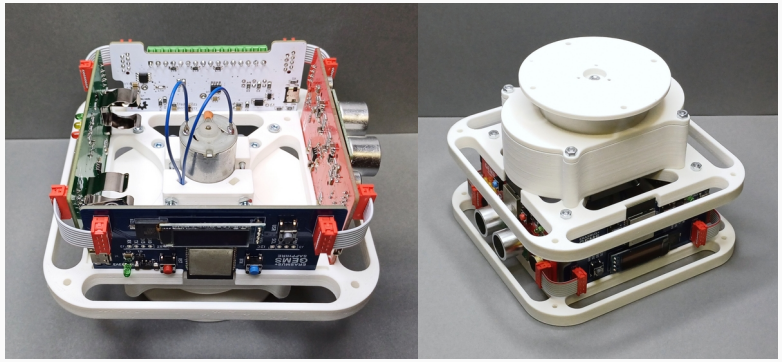


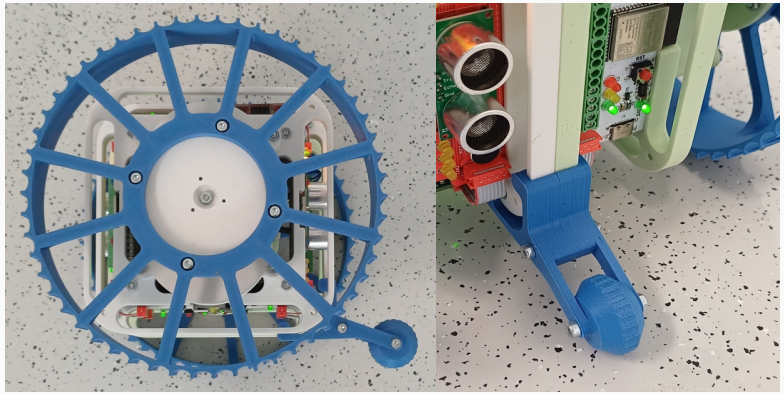


Robot type

1. Mobile robot → movement (to different location)
2. Wheels → ground → ~flat
3. 2 drive wheels → Differential drive (+ support → 3 point contact)

Structure



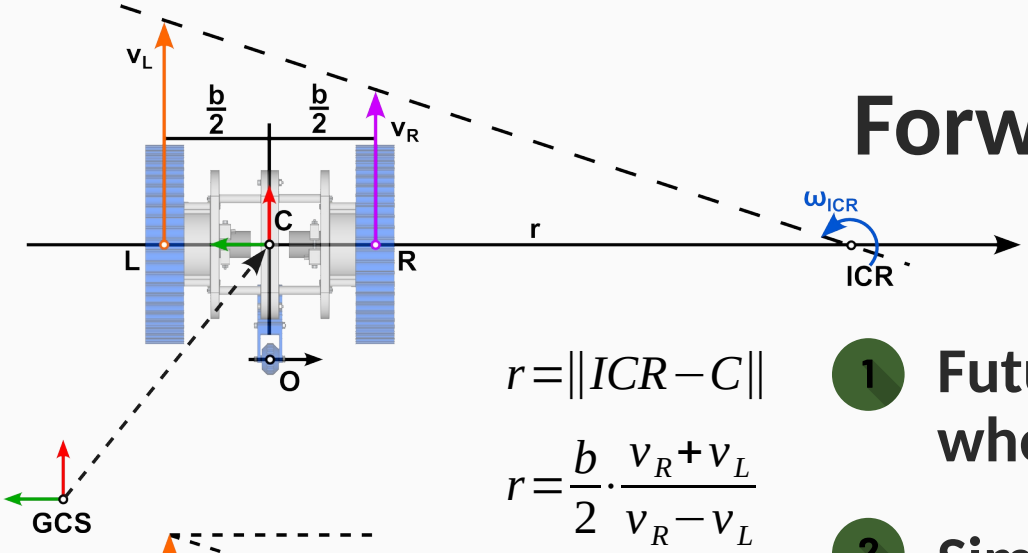


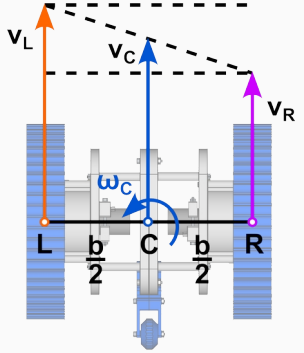
GEMS Mobile Robot

1. Modular: PCB modules → servo motor → Mobile Robot
2. Educational → slow and robust (big 3D printed wheels)
3. Autonomy → Emerald PCB module with battery

Kinematics

Forward kinematics





$$r = \|ICR - C\|$$

$$r = \frac{b}{2} \cdot \frac{v_R + v_L}{v_R - v_L}$$

$$v_C = \frac{v_R + v_L}{2}$$

$$\omega_C = \frac{v_R - v_L}{b}$$

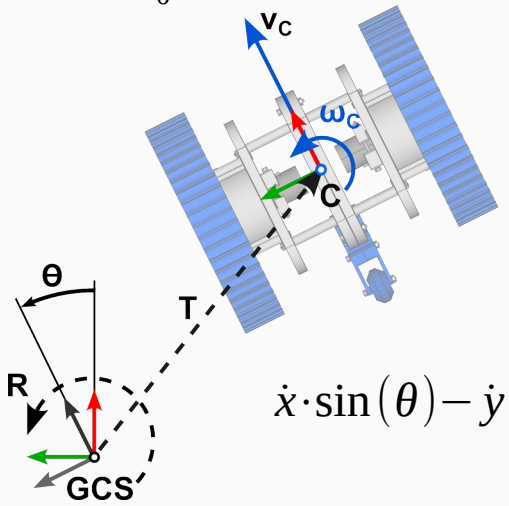
1. Future position derived from wheel speeds
2. Simple → similar triangles linear and rotational speed
3. ICR - Instant center of rotation

Forward kinematics

$$x(t)=\int_0^t v_c(t)\cdot\cos(\theta(t))\,dt$$

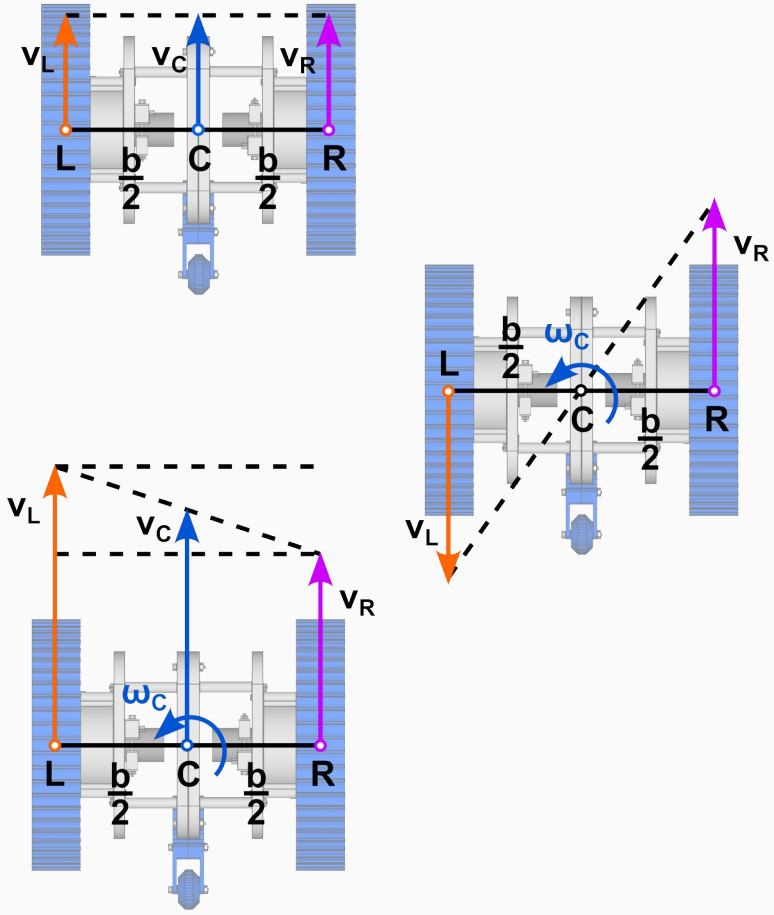
$$y(t)=\int_0^t v_c(t)\cdot\sin(\theta(t))\,dt$$

$$\theta(t)=\int_0^t \omega_c(t)\,dt$$



$$\dot{x}\cdot\sin(\theta)-\dot{y}\cdot\cos(\theta)=0$$

1. Non-holonomic system: cannot move freely in all directions
2. Assumptions: flat and no slip
3. Integration → Future position



Inverse kinematics

1. Wheel speeds derived from the robot's desired position change
2. Non-holonomic system: cannot move freely in all directions
3. Difficult → Simplification

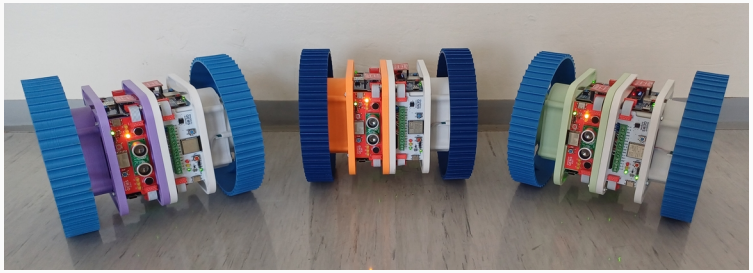
Task

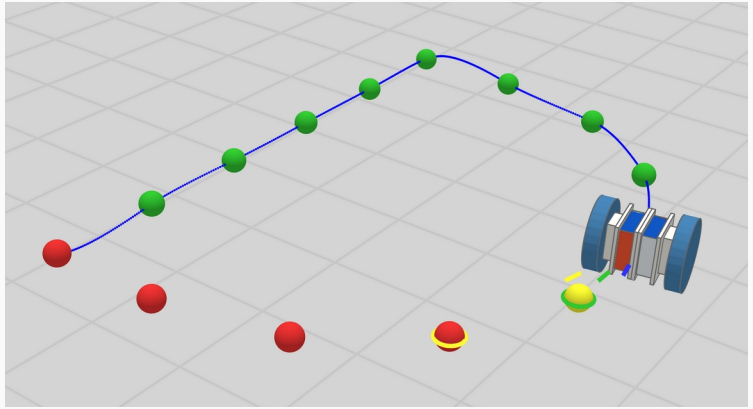
Forward kinematics

Arduino program

1. Target: ESP32C3/S3 reusable function
2. Input: L and R motor speed, robot geometry from CAD (Github)
3. Output: translation speed, rotation speed and path radius

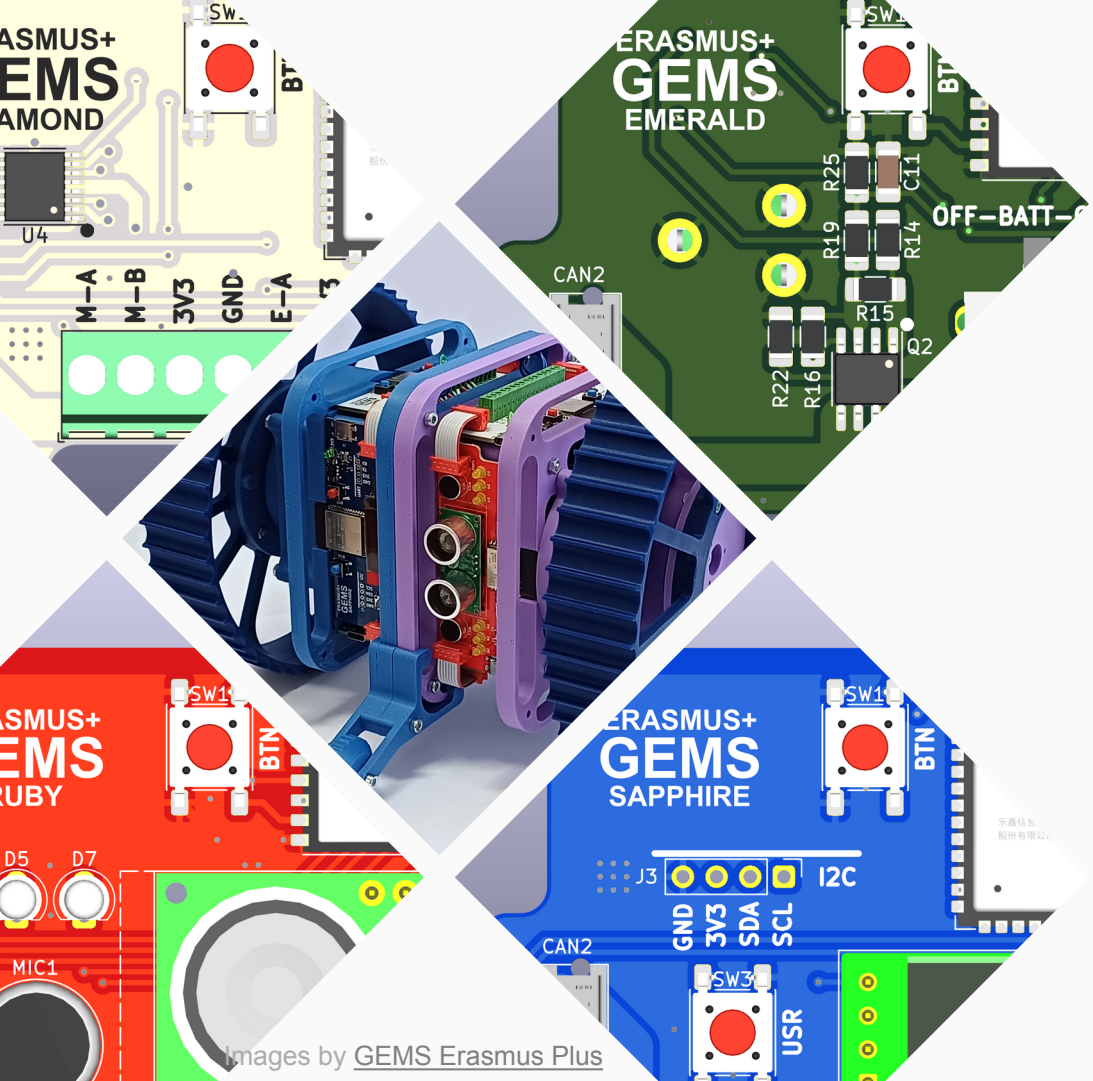
Conclusion





Mobile robot with differential drive

1. Simple configuration
2. Mechanical connections → change robot characteristics
3. Kinematics → control



Thank you for watching!

This video was created by University of Ljubljana for the GEMS Erasmus+ project (a collaboration between University of Ljubljana, University of Alcala, Teaching Factory Competence Center, and Delft University of Technology).

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