Knights Technical Presentation
Robotics Dojo 2025

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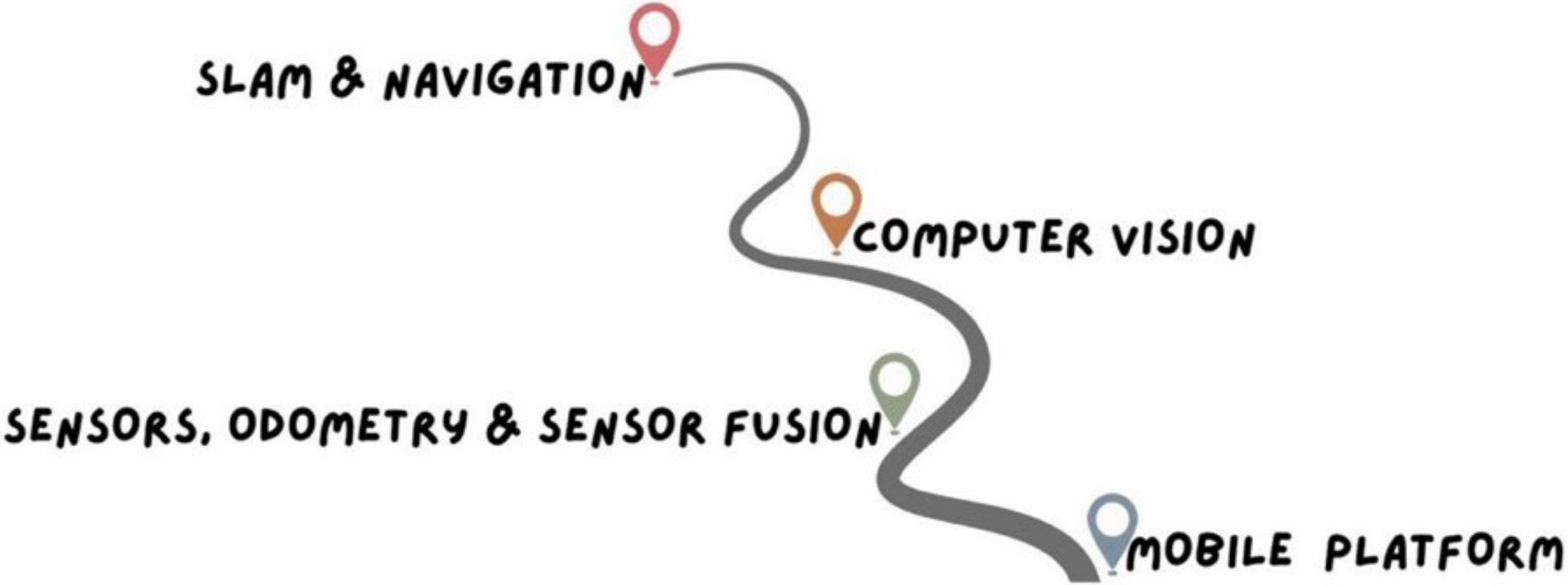
NAGASAKI UNIVERSITY

Robotics Dojo

jica



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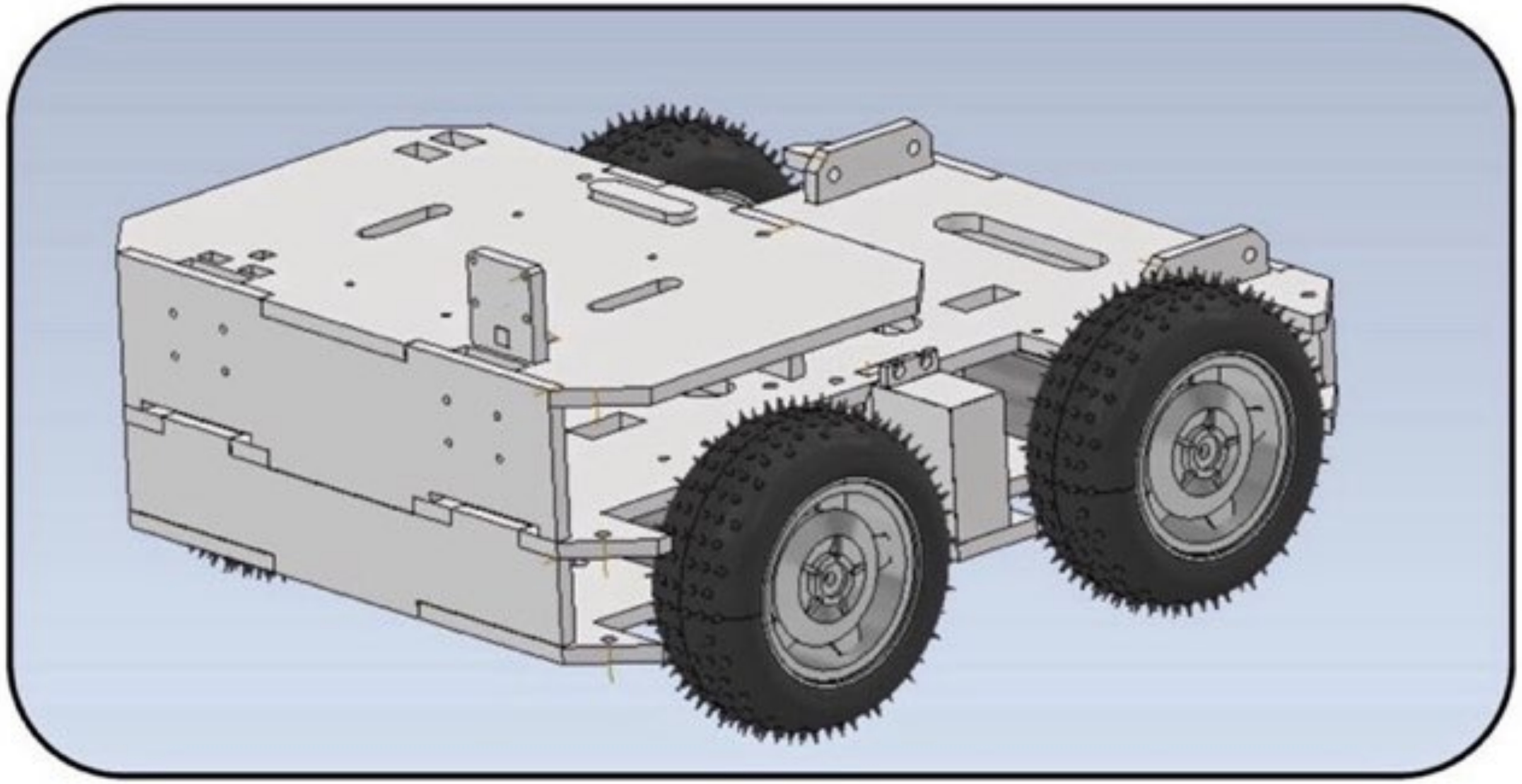
MOBILE PLATFORM: MECHANICAL

Drivetrain: 4-Wheel Differential Drive

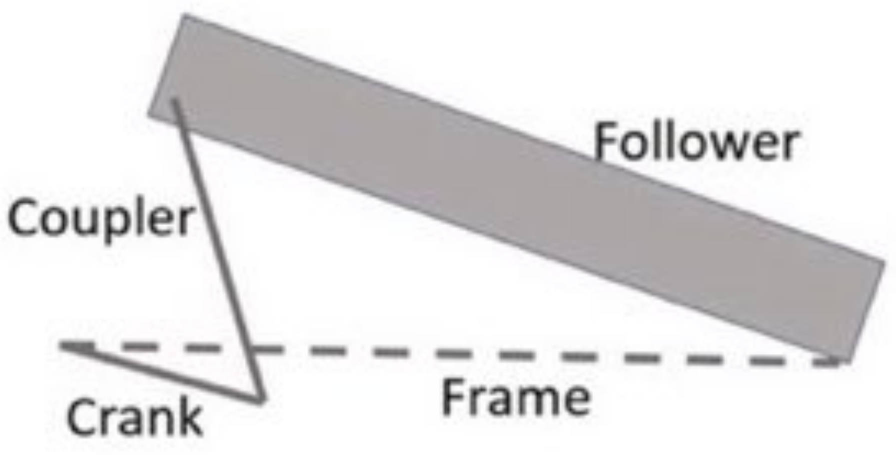
Frame Material: PMMA

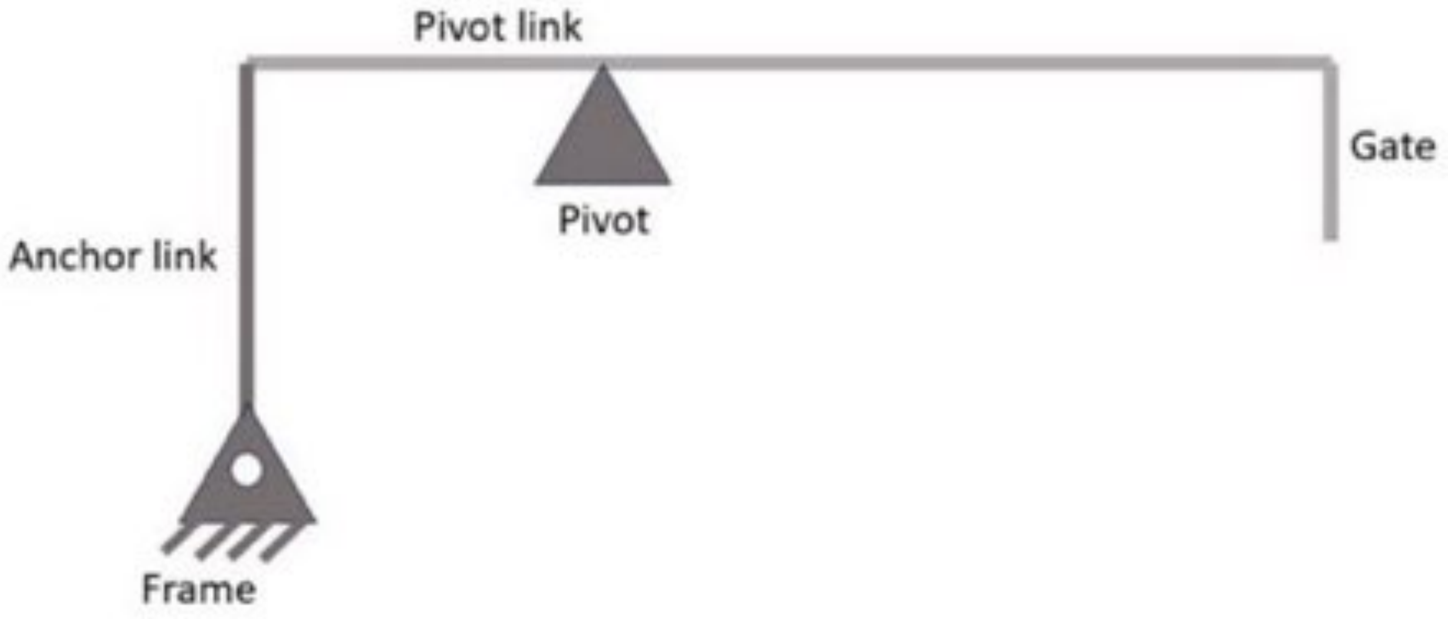
Aimed to minimize track, wheelbase, height

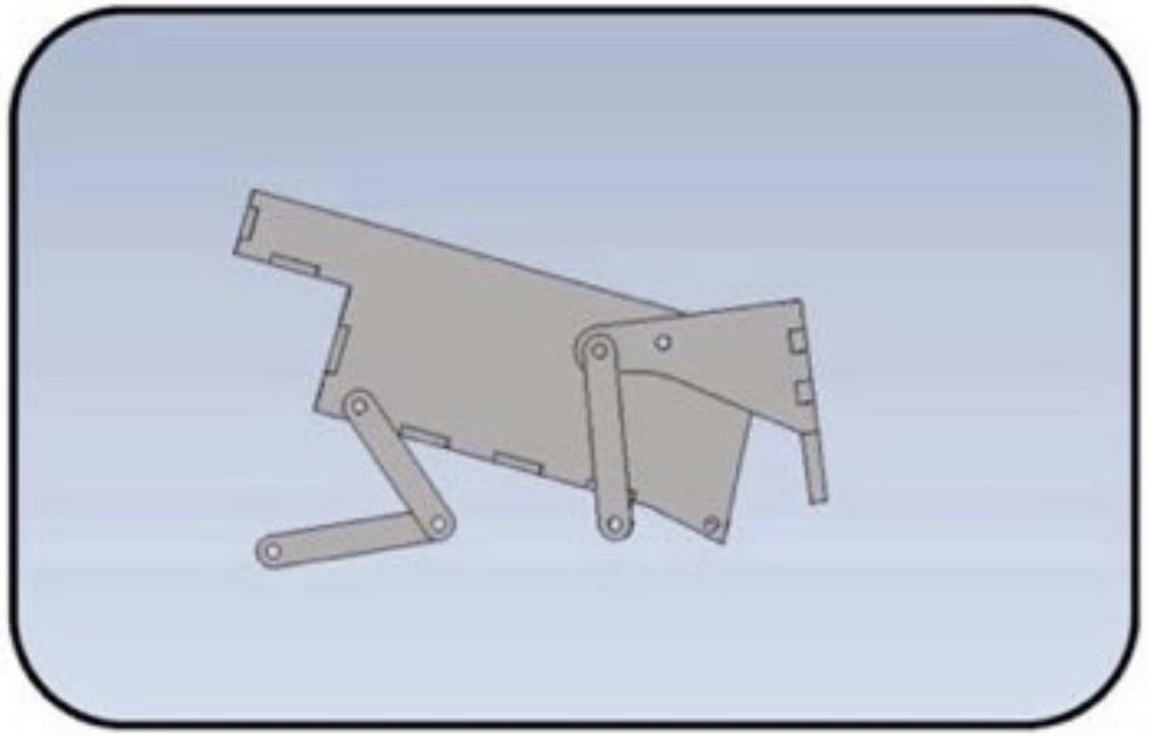


MOBILE PLATFORM: MECHANICAL

Offloading: Single-servo actuation







MOBILE PLATFORM: ELECTRONICS

Sensors: 4 rotary encoders, IMU, Lidar, Pi Camera

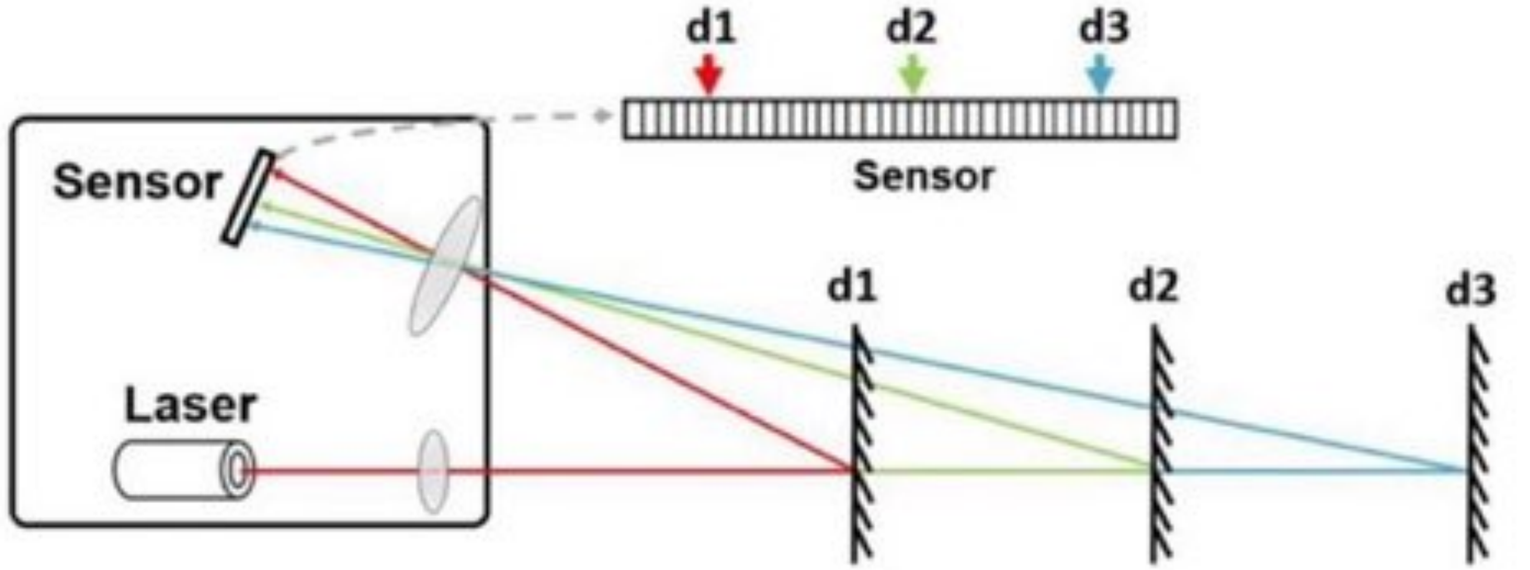
Actuators: 4 12V DC Motors, high-torque servo motor

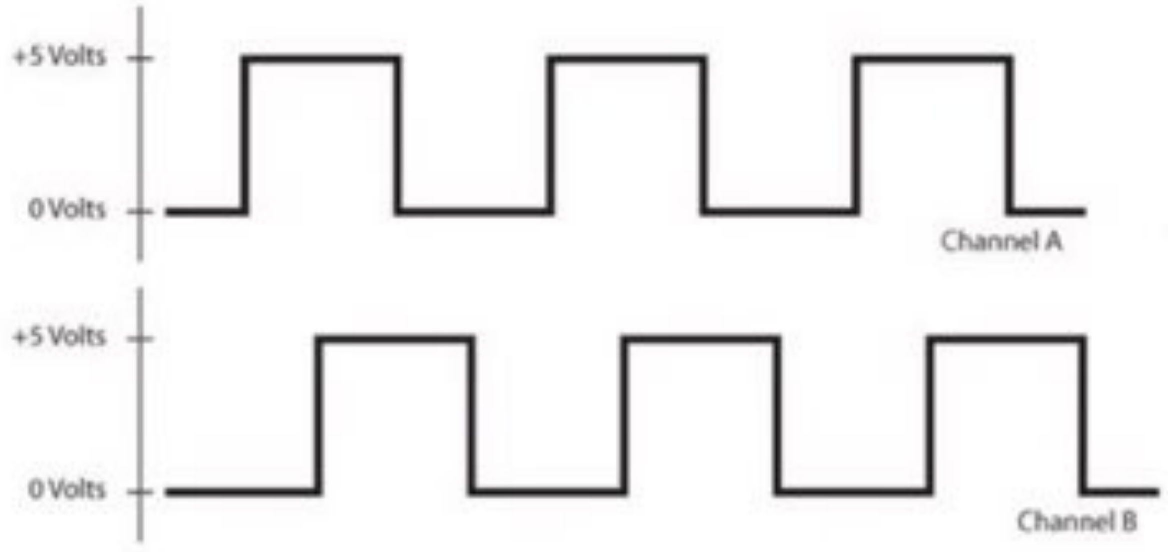
Low-Level Controller: STM32F4 series MCU

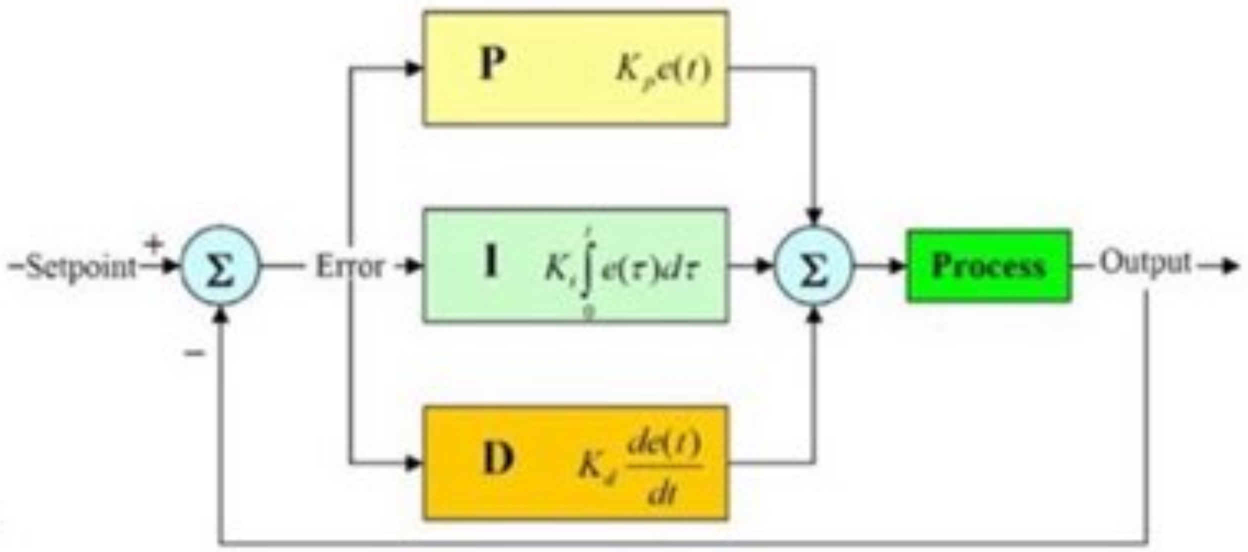
High-Level Controller: Raspberry Pi 4

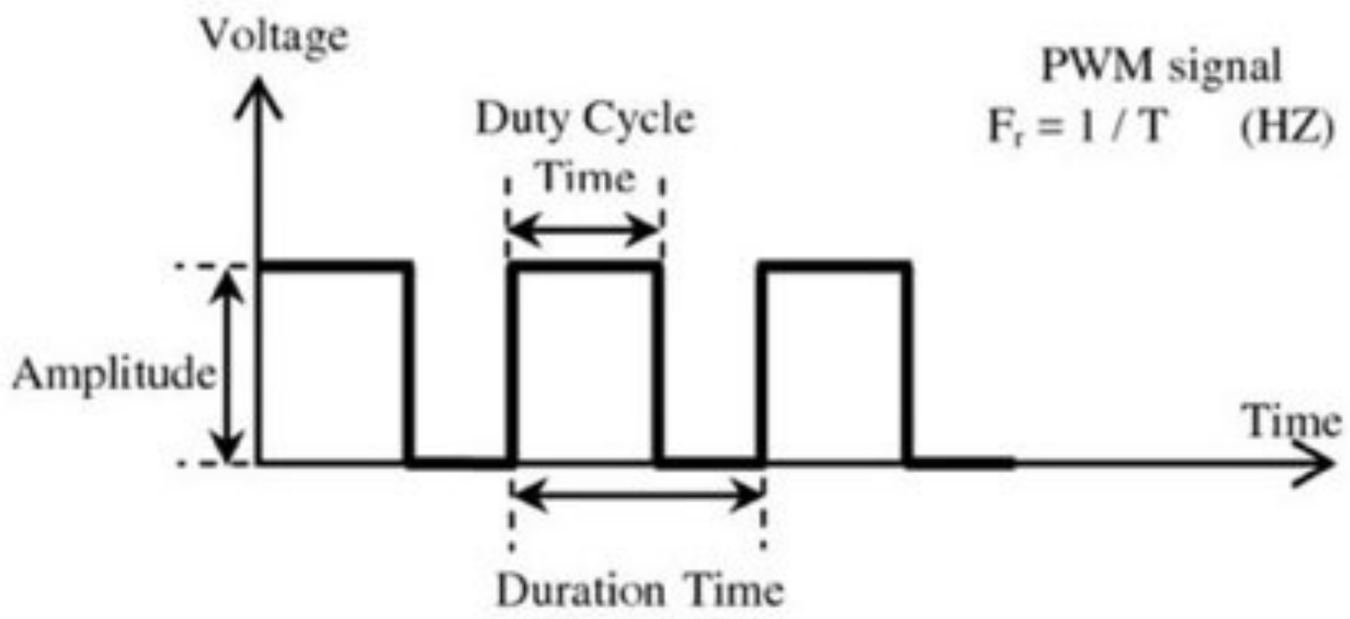
Power Supply: 11.1V Li-Po battery, USB Power bank

Featuring High Frequency PWM; PiD motor control



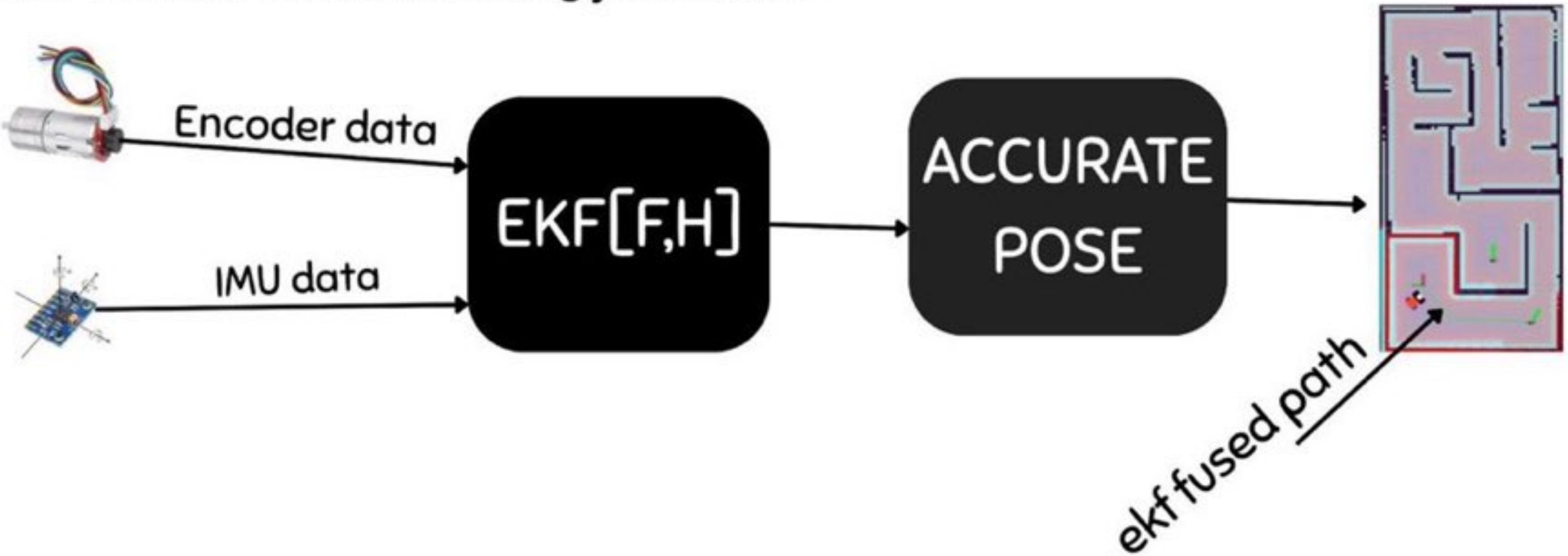






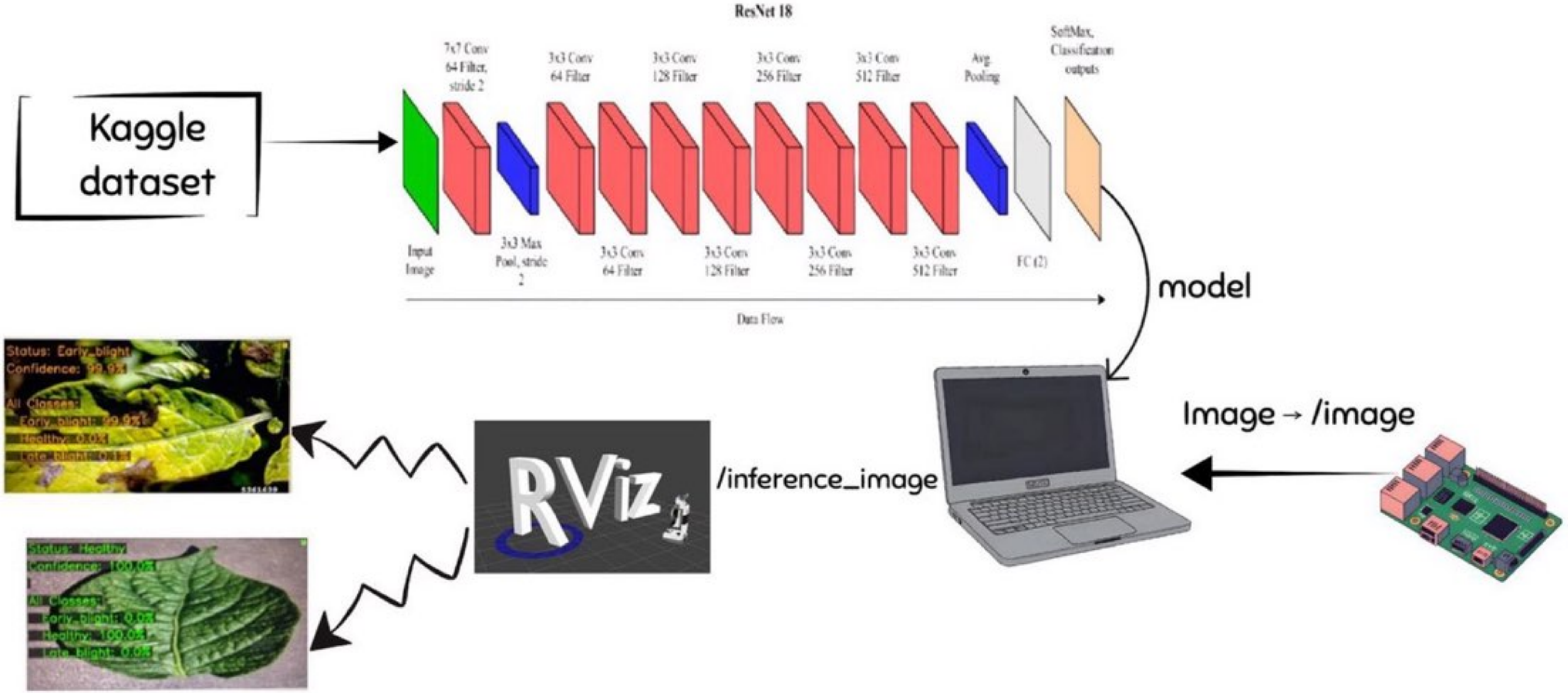
ACCURATE LOCALIZATION THROUGH SENSOR FUSION

- Encoders – Track wheel rotations → estimate linear & angular displacement
- IMU (MPU6050) – Measures acceleration & angular velocity → robot orientation
- EKF Fusion – Uses non linear models like robot motion and orientation and linearizes them around the current estimate using jacobians



COMPUTER VISION

IMAGE CLASSIFICATION



COMPUTER VISION

IMAGE CLASSIFICATION

Resnet 18 architecure used – 18 layers deep . Utilized transfer learning approach

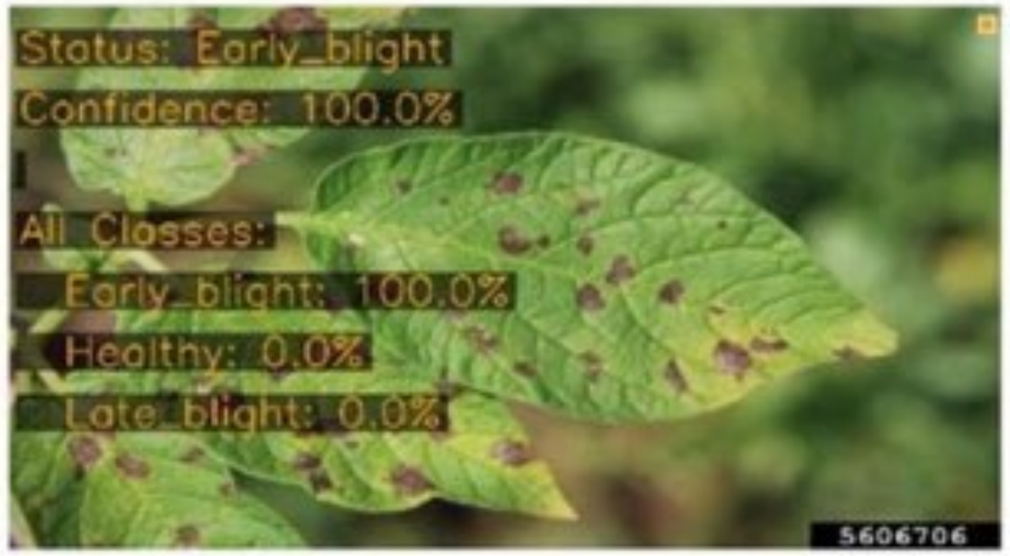
Pretrained on 1.2 M ImageNet images – 1000 classes

Target – 3 classes (healthy, early blight, late blight) → in potatoes

Early blight – Dark brown spot with concentric rings

Late blight – Gray-Green water soaked lesions

Prepared a new dataset with 21452 images



Why Resnet 18?

- Pretrained.
- Lightweight → 11 M parameters. Good for this task compared to Resnet 50+
- Proven effective for plant disease detection → don't reinvent the wheel
- Relatively less computational resources

Optimization algorithm → Adam

Why Adam?

- Good for small datasets
- Faster convergence than SGD.

COMPUTER VISION

OBJECT DETECTION

Task → Deposit the loaded cube to the correct color coded offloading area.

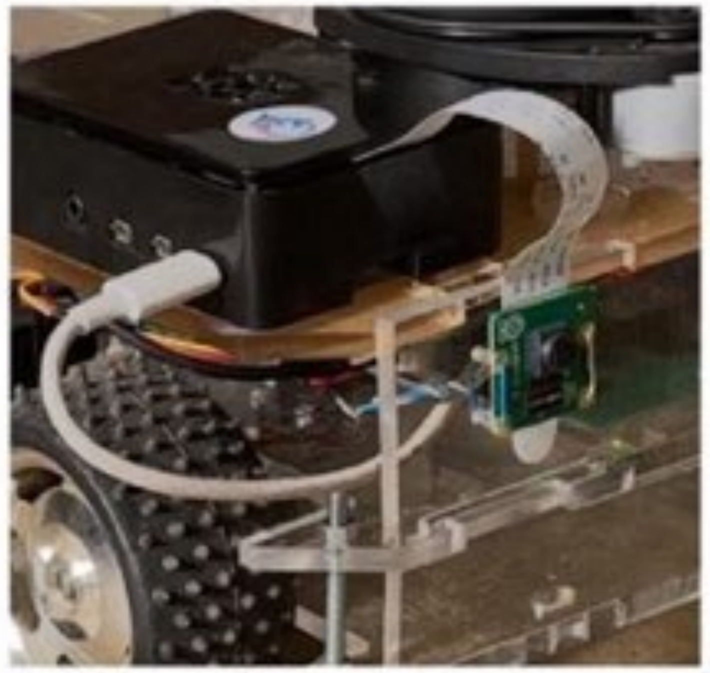


Image → /
detected_color

/servo_controller
/commands

For color detection – OpenCv extensive libraries

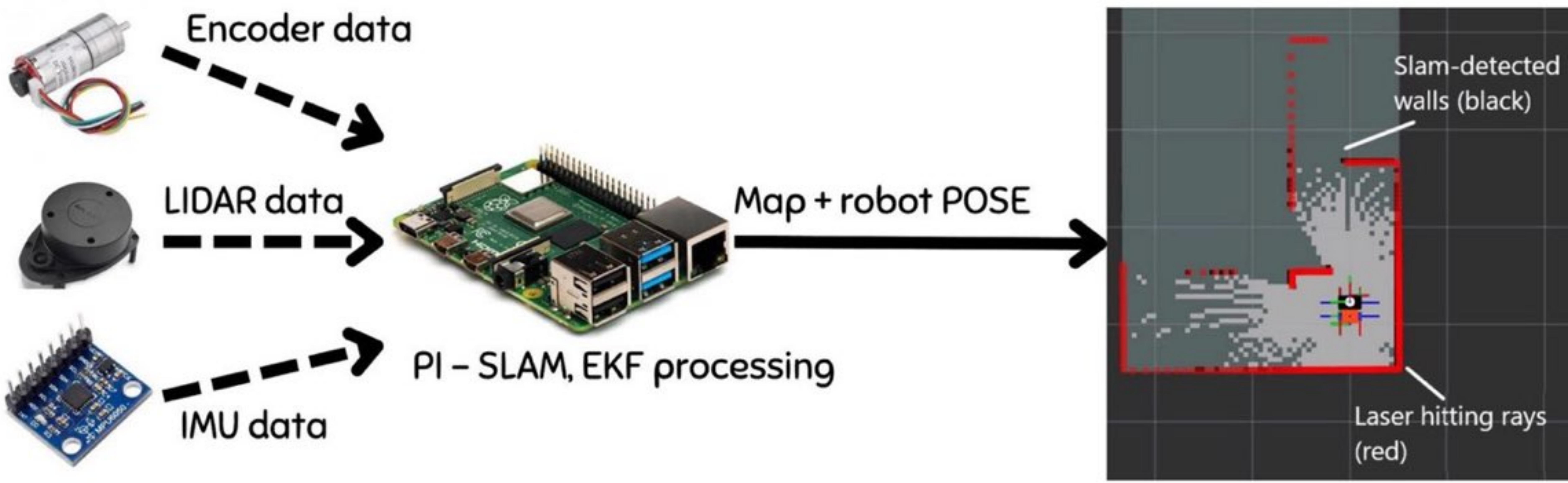
HSV color space preferred over RGB

Time based rebounding – real world robustness

Modularity achieved – ROS2 nodes (2)

SLAM AND NAVIGATION

- SLAM (Simultaneous Localization and Mapping) – Allows a robot to create a map of its environment while keeping track of its own location within the map.
- It uses data from sensors such as encoders, LIDAR and IMU and odometry to build a consistent map without losing the robot's POSE (Position and Orientation).

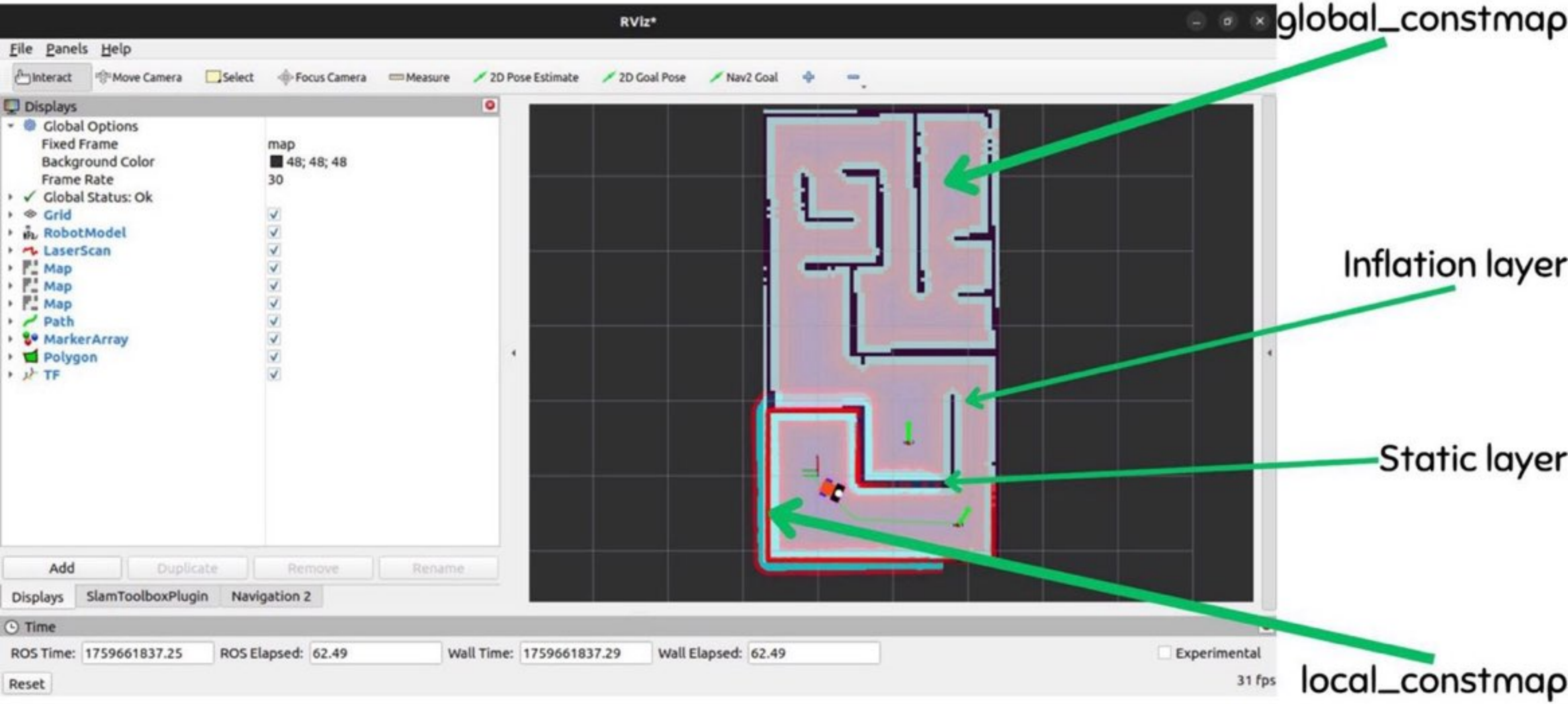


Some of the packages used in SLAM include:

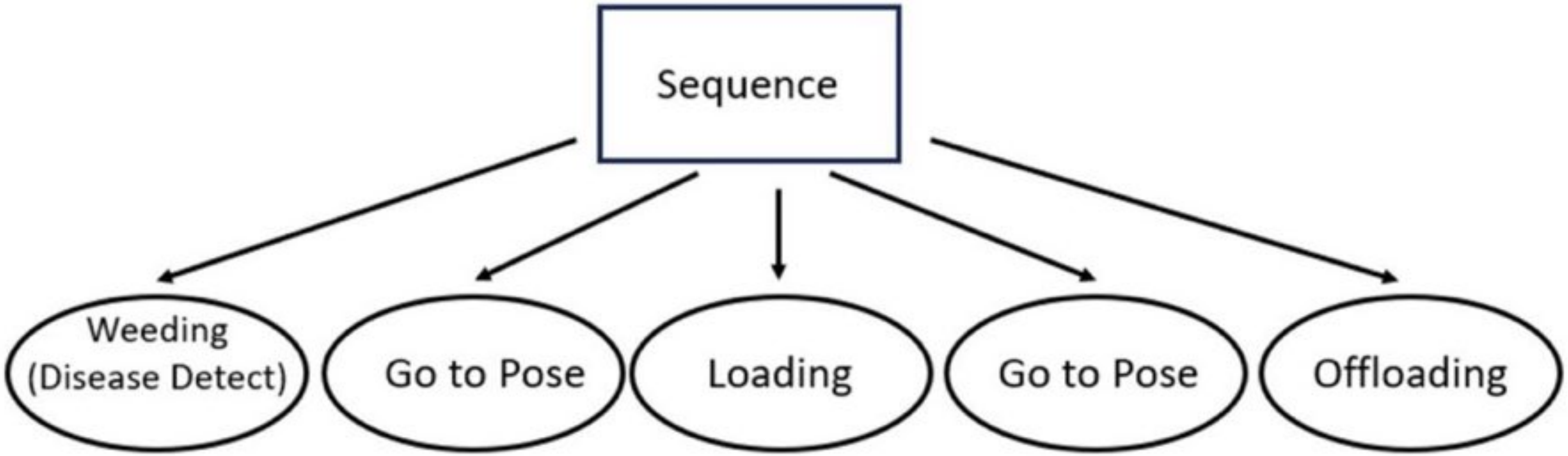
- slam_toolbox: Responsible for publishing the coordinate transformations between the map frame and odom (odometry) frame which allows the robot to understand its POSE in the map.
- amcl (Adaptive Monte Carlo Localization): Used mainly after mapping has taken place and facilitates autonomous navigation of the robot within the map by using LIDAR data for localization.

After mapping, Navigation takes place using a costmap. A costmap contains cells that quantify the the difficulty of the robot traversing each cell.
The costmap is made up of two types:

- global_costmap: Covers the entire map and used for long distance path planning.
- local_costmap: Covers the immediate surroundings of the robot and helps the robot avoid new obstacles not recorded on the saved map.


RViz*
File Panels Help
Interact
Move Camera
Select
Focus Camera
Measure
2D Pose Estimate
2D Goal Pose
Nav2 Goal
Displays
Global Options
Fixed Frame
map
Background Color
48; 48; 48
Frame Rate
30
Global Status: Ok
Grid
RobotModel
LaserScan
Map
Map
Map
Path
MarkerArray
Polygon
TF
Add
Duplicate
Remove
Rename
Displays
SlamToolboxPlugin
Navigation 2
Time
ROS Time: 1759661837.25
ROS Elapsed: 62.49
Wall Time: 1759661837.29
Wall Elapsed: 62.49
Experimental
Reset
31 fps
global_constmap
Inflation layer
Static layer
local_constmap

PYTREES



Sequence
Weeding
(Disease Detect)
Go to Pose
Loading
Go to Pose
Offloading

THANK YOU