NITRO: a gadget to transform standard rollators into smart rollators for monitoring user conditions

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Contents

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An ageing population

- New approach: prevention and monitoring.
- Key metric: Stability.
- Manual assessment: Tinetti Mobility Test.
- Automatic assessment: automatic adquisition of spatiotemporal gait parameters, such as walking speed or stride-to-stride variability.

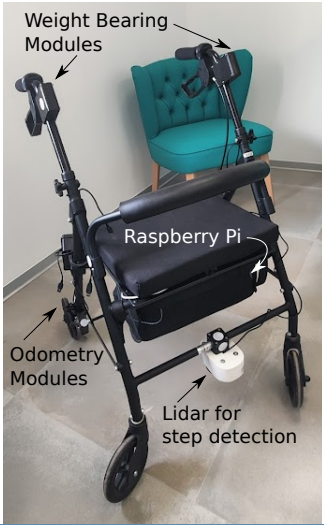
Monitoring through mobility assistive devices.

First version: custom made rollator

- ✓ gait analysis based on weight bearing.
- ✓ motorised.
- ∼ precise odometry, but non reliable.
- × difficult to replicate and customize.
- × expensive.
- × rollator is not medically certified.
- × change barrier: users are reluctant to use a strange device.

Second version: sensoring a commercial device

- ∼ gait analysis based on weight bearing, but patients have lighter supports.
- ∼ brake control.
- × non reliable odometry.
- ✓ easy to replicate and customize.
- ✓ reasonable price.
- ∼ rollator is medically certified, save from brake control.
- ∼ change barrier: users are reluctant to use any device but the one they are used to.



Third version: lidar-based gait analysis

- ✓ gait analysis based on weight bearing and lidar detections.
- ∼ brake control.
- ∼ improved lidar-based odometry.
- ✓ easy to replicate and customize.
- ✓ reasonable price.
- ∼ rollator is medically certified, save from brake control.
- ∼ change barrier: users are reluctant to use any device but the one they are used to.

Fourth version: NITRO Platform

- ✓ gait analysis based on lidar detections.
- ✓ passive.
- ✓ improved multi-sensor odometry.
- ✓ no change barrier.
- ✓ reasonable price.
- ✓ no medical certification needed for its use.
- ✓ easy to replicate and customize.

We have sacrificed some features to improve adaptability:

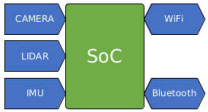
- × handle pressure sensors.
- × brakes.
- × odometry encoders.

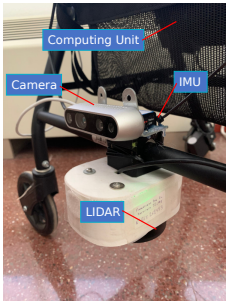
The WalKit architecture in a nutshell

Open Source modular architecture.

- based on off-the-shelf components.
- affordable costs.
- can tur**N** a rollator **I**nto a smar**T** **RO**llator.

NITRO sensoring kit specs



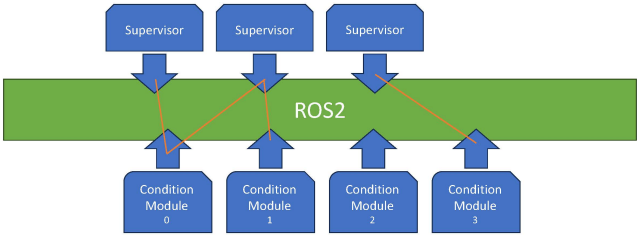


Based on an NVIDIA Jetson Nano SoC computer:

- reasonable power requirements.
- multiple communication buses: wireless, bluetooth, USB 3.0 . . .
- ARM64 architecture with a 128-core Maxwell GPU.

Managing the following sensors:

- IMU: WIT motion BWT901CL.
- Camera: Intel Realsense D435.
- LIDAR: Slamtec RPLidar A1.



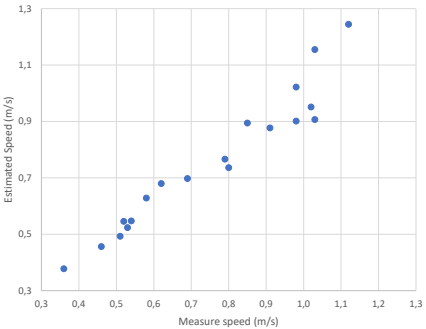
NITRO is built around three main software components:

- **Condition Monitoring Modules**: process sensor data (gait patterns, walking speed, travelled distance ...), continuously measuring user's condition.
- **Supervisor entities**: receive real-time updates, monitoring users' well-being remotely.
- **ROS2 Middleware**: communication backbone, enabling seamless data exchange between modules.

VIO odometry system

- NITRO uses a stereo camera and an IMU to calculate the odometry.
- Tests are focused on proving that visual inertial odometry (VIO) can be used to track rollator motion.
- Basalt Visual Inertial Odometry was used for these tests.

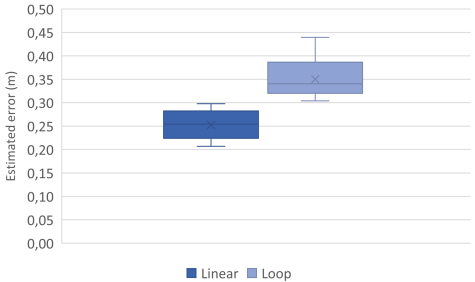
Speed error analysis



- Rollator moves at a constant speed for ten meters.
- A visual mark is placed at 2 and 8 meters.
- Time spent walking through the marks is measured.
- Tests are repeated 20 times at different speeds.

Estimations are optimal around 0.7-1.1 m/s range.

Pose error analysis



Two subtests have been carried out 20 times each, in order to measure different displacement errors:

- Linear: User moves forward 10 meters.
- Linear/angular: User moves freely for 30 seconds, starting and ending in the same position.

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Conclusions

- NITRO can transform any standard rollator.
- The price and reproducibility are in mind.
- The proposed architecture uses the backbone ROS2.
- Open source.

Future Work

- Tests at home facilities to validate its usability and performance.
- User feedback surveys & questionnaires to validate acceptance.
- Energy compsumtpion studies to ensure a prolonged and reliable operation.
- Pair NITRO with external wearable devices for additional functionalities.
- Explore the GPU capabilities to include AI-based tools for monitoring.

Thanks for your attention.
Questions?

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