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Optical Mouse-Based Odometer and Motion Tracker

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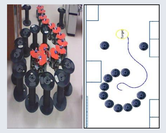
College Of Engineering Sciences & Applied Engineering
Electrical Engineering Department
Senior Design Project
EE411 - T162 - Sec#11

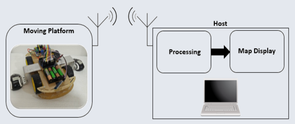
Overview

To construct an optical odometer that is carried onboard a moving platform to online record its trajectory and orientation.



System Components:

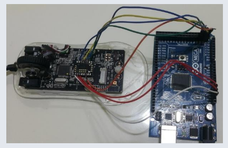
1. Two wireless optical mice.
2. RC platform
3. MATLAB-based processing and display



Optical Mouse

An optical mouse contains a full image processing system that analyses optical flow and produces relative displacement.

An optical mouse with a laser illumination sensor was hacked to access the pixel data in order to show a live view of what the sensor is capturing through its lens.

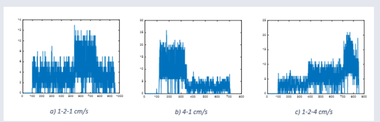


Circuit Setup

Captured image

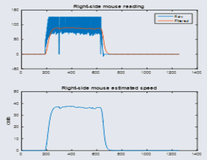
Mouse Output Consistency

Tests were devised to make sure that the mouse output does not change with different ground textures or speed profiles.



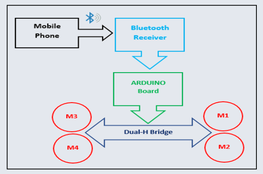
Data Filtering

The raw mouse output displacement signal is extremely noisy. Different filters were examined to reduce noise.



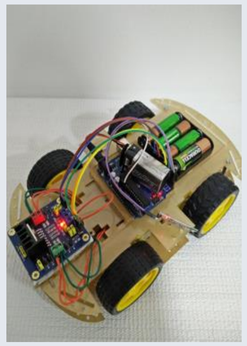
RC Platform

A 4WD differential RC platform was constructed to carry the odometer. The platform is built from ARDUINO driving four motors through Dual H-bridge module and controlled by mobile phone application through Bluetooth.



Platform layout

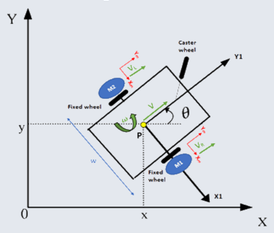
RC application interface



The platform

Odometer Setup

The two mice were installed along the platform's center of rotation axis parallel to the wheel's axes.



$$\theta(0) = \frac{\pi}{2}$$

$$\begin{bmatrix} V \\ \omega \end{bmatrix} = \begin{bmatrix} 0.5 & 0.5 \\ \frac{1}{W} & \frac{-1}{W} \end{bmatrix} \begin{bmatrix} V_R \\ V_L \end{bmatrix}$$

$$\theta = \int \omega \, dt$$

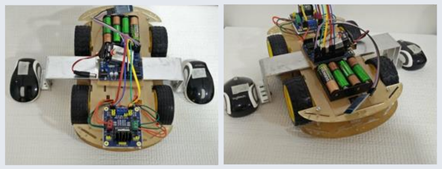
$$v_x = V\cos(\theta) \qquad v_y = V\sin(\theta)$$

$$x = \int v_x dt \qquad y = \int v_y dt$$

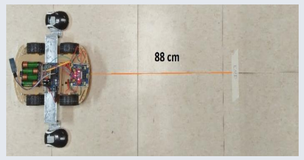
A processing procedure is derived based on the differential kinematics of the platform to process the mice data in their local coordinates and produce the platform's position and orientation in the global platform coordinates.

Odometer Calibration

Due to irregularities in the manufacturing of the mice and uncertainties in the measurements of the dimensions, tests are devised to calibrate the odometer as a whole system both software and hardware.



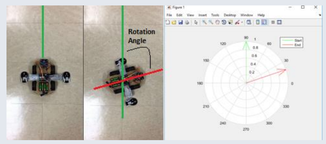
The platform was moved along a straight line to check if the readings of the two mice are identical. Irregularities were found and compensated for by multiplying the output of one of the mice by a correction factor.



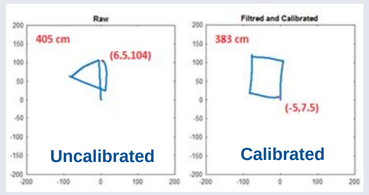
Trial	Estimated distance	Real distance	(estimated/real)
1	88.76	88.80	1.00
2	286.05	288.20	1.01
3	200.11	201.30	1.01
4	329.82	332.60	1.01
5	147.16	138.30	0.94
6	116.86	112.40	0.96
7	271.86	260.50	0.96
Average			0.98

A group of odometer linear estimates were compared to their base-truth counterparts to obtain the translation calibration constant.

A similar procedure was carried out to obtain the rotation calibration constant.

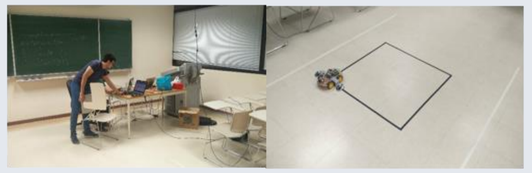


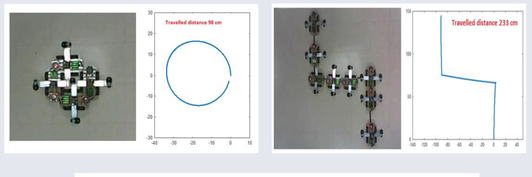
The figures below show the results from the calibrated and uncalibrated odometer.

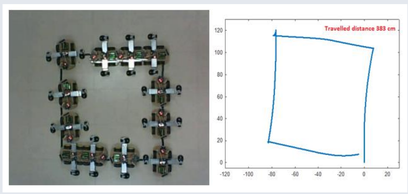


Experimental Testing

Several experiments were conducted to assess the odometer's ability to correctly record different patterns of motion.







Recommendations

1- Increase the optical mouse distance from ground by at least 15 cm using a focusing lens.

2- Direct coupling of multi wireless mice to the processing software.

3- Better filtering (e.g. Kalman filter).