

Walker-based Body Parameter Measurement

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Problem Statement (Subproblem)

- Design a line following detection and correction mechanism to allow a user to follow a straight line. If the straight line is not given in unstructured environments, additional sensors to be used to measure if the path is straight.
- Detect the posture of the user and provide corrective instructions. Detect fall or imbalance and raise alerts accordingly.

Scope

1. Line Following Functionality

- a. Capable to detect given line in a cluttered environment.
- b. Ability to measure deviation from given line.
- c. In absence of line, using encoders to compute the trajectory.
- d. Provide feedback to the user if large deviation occurs.

2. Pose Detection

- a. Capable of detecting the joint and limb poses in a quick manner.
- b. Compare pose of the user with standard models of walking.
- c. Use of vision and IMU to detect fall and generate alerts accordingly.

3. Assumptions

- a. Walker is a legged + wheel walker (2 wheels in front, 2 legs at the back), with sufficient modularity to add pressure sensors and rotary encoders.
- b. To be used on smooth floor
- c. Raspberry Pi 3B+ level onboard embedded device to be used
- d. Well lit environments

Plan of Use for Software

1) Line Following

Front facing Raspberry Pi compatible Camera for line detection. To detect line, first we perform canny edge detection. Estimate the correct line using Hough Transform on the detected lines. Additionally, the position and the deviation of the camera from the desired line estimates the error.

2) Straight Line in Unstructured Environments (No line, smooth floor)

To enable user to walk straight, additional rotary encoders can be attached to wheels. The readings of encoders can be computed to find straight line deviation.

3) Haptic Feedback

Vibratory devices can be mounted on either handles of the walker to provide feedback to the user for the direction in which to move to correct position.

4) Posture Detection

User facing Raspberry Pi camera. Use of lightweight OpenPose Software to detect joints and limb positions. Comparison with standard walking model dataset.

5) Weight Distribution

Pressure Sensors on the 4 legs of the walker measure the user's weight distribution for walking. Use of trained models to detect and predict imbalance.

6) Fall Detection

Using OpenPOSE and IMU, a fall can be detected and an alarm on the device can be raised and emergency services will be called.

Overview

The previously mentioned functionalities would be integrated within the embedded device. The relevant data would be shared across the nodes using messages published on topics and a higher level code would ensure constant processing of the raw data received.

ROS will be used as the middleware to pass messages between various nodes of the software and also provide capabilities for asynchronous operation of the various submodules of the system.

Task Distribution

