A Practical IMU-based Angle Measurement Method for a Single Axis Rotation

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I. Introduction

This file set is a supporting material for our paper [1]. In this paper, a practical method is proposed to measure the angle of a single axis rotation, where the single axis rotation is invisible or hard to access as shown in Fig.1. The rotation from an initial state to a final state is represented by a quaternion consisting of the direction of the rotation axis and its rotation angle. The angle needed to measure corresponds to the rotation angle of the quaternion. The proposed method utilizes the angular velocity of an IMU to compute the direction of the rotation axis by a proposed method. Since the attitude angles of the measured object vary as its rotation angle changes, then an equation is established with respect to the unknown rotation angle. Then, an interpolation algorithm is proposed to solve the equation and simulation is further illustrated. Finally, with a turntable and an IMU embedded in Pixhawk, comparative experiments are carried out to validate the proposed method.

Please use MATLAB to run all of the files in the file set. All the M-files have been checked availably on MATLAB R2014a.

II. File list and usage

There are five folders here. Each folder includes a file named readme.txt.

A. Simulations(4 folders)

1. The_relationship_between_x_y_z_and_rotation_angle_alpha

xyzplot.m: main function. Three curves are drawn to reveal the relationship between x, y, z and the rotation angle α as shown in Fig.2.

2. Angle_measurement_error_mean_value_for_different_axes

rotationangle1.m The main function to generate the rotation angle measurement error alpha_e1.mat.

annlyze_diff_axis.m: The file analyzes alpha_e1.mat and presents angle measurement mean error as shown in Fig.3.

3. Angle_measurement_error_mean_value_for_different_roll_and_pitch_noises

rotationangle.m The main function to generate the rotation angle measurement error alpha_e.mat.

analyze_diff_rp_noise.m: The file analyzes alpha_e.mat and presents angle measurement mean error for different noise level of roll_alpha and pitch_alpha as shown in Fig.4.

4. Noise_immunity_for_different_axes

rotationangle2.m The main function to generate the measurement mean error of the rotation angle mean_n.mat.

ana_daita_noiserp_r.m: The file analyzes mean_n.mat and presents noise immunity for different rotation axes as shown in Fig.5.

B. Experiments(1 folder)

5. The_experimental_results

fig.m: The file to represent the experimental results as shown in Fig.6.

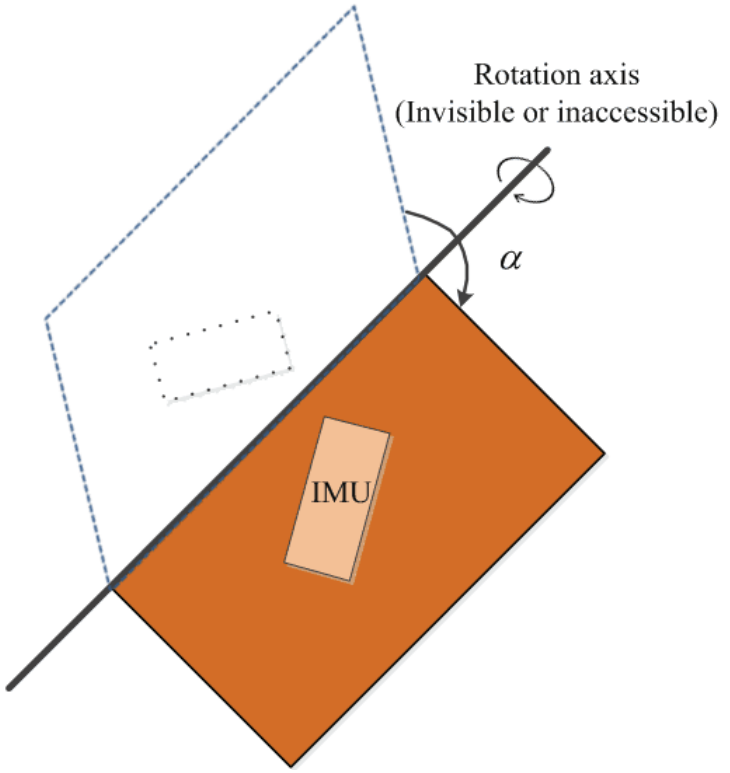

Fig.1 Schematic diagram of the rotation angle measurement

III. NOTICE

Please read the specification in the files to get the further information. If you have any questions, then please feel free to contact Shuaiyong Zheng (syzheng500@gmail.com) or Quan Quan (qq_buaa@buaa.edu.cn). If you use these files or results in your paper, please cite it as: Shuai-Yong Zheng, Hong-Xin Dong, Rui-Feng Zhang and Quan Quan, “A Practical IMU-based Angle Measurement Method for a Single Axis Rotation”, http://rfly.buaa.edu.cn/resources/, February, 2016.

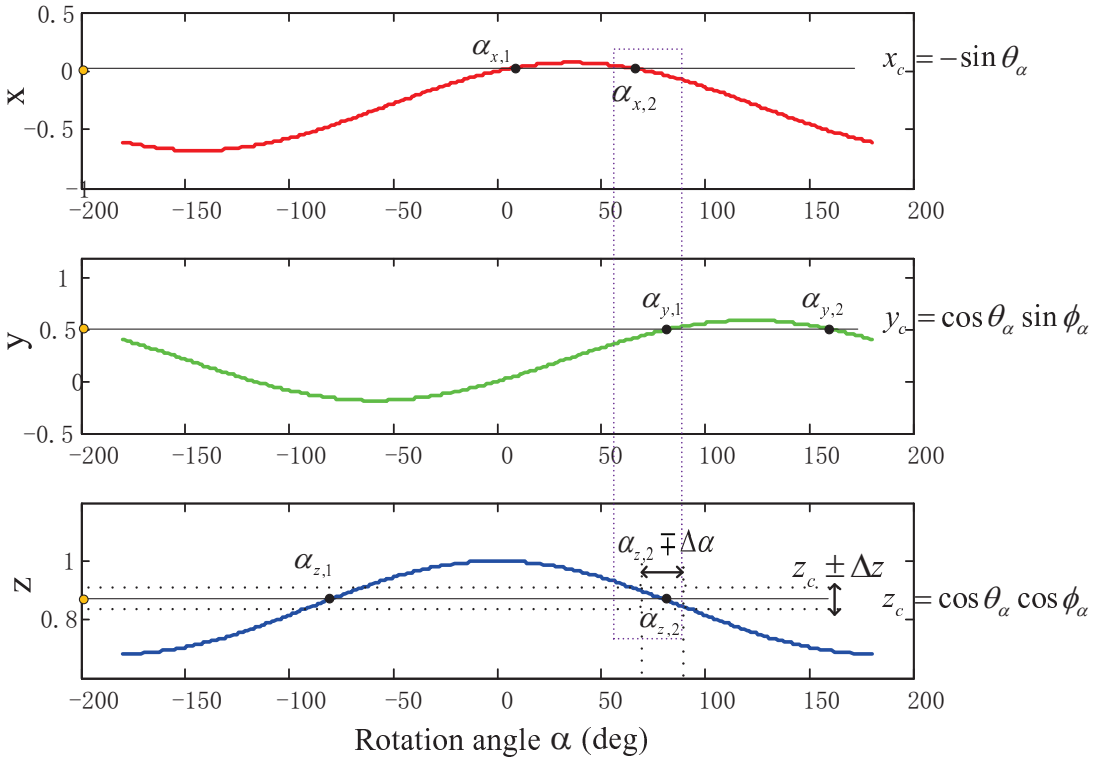

Fig.2 The relationship between x,y,z and rotation angle α

REFERENCES

[1] Zheng S Y, Dong H X, Zhang R F and Quan Q. (2016). A Practical IMU-based Angle Measurement Method for a Single Axis Rotation (Submitted).

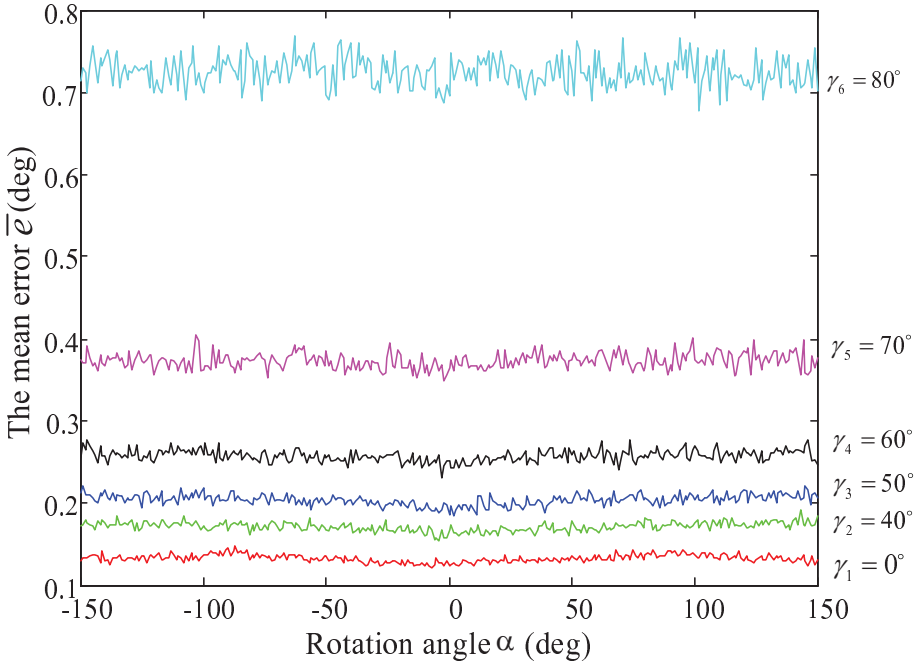

Fig.3 Angle measurement mean error for different axes

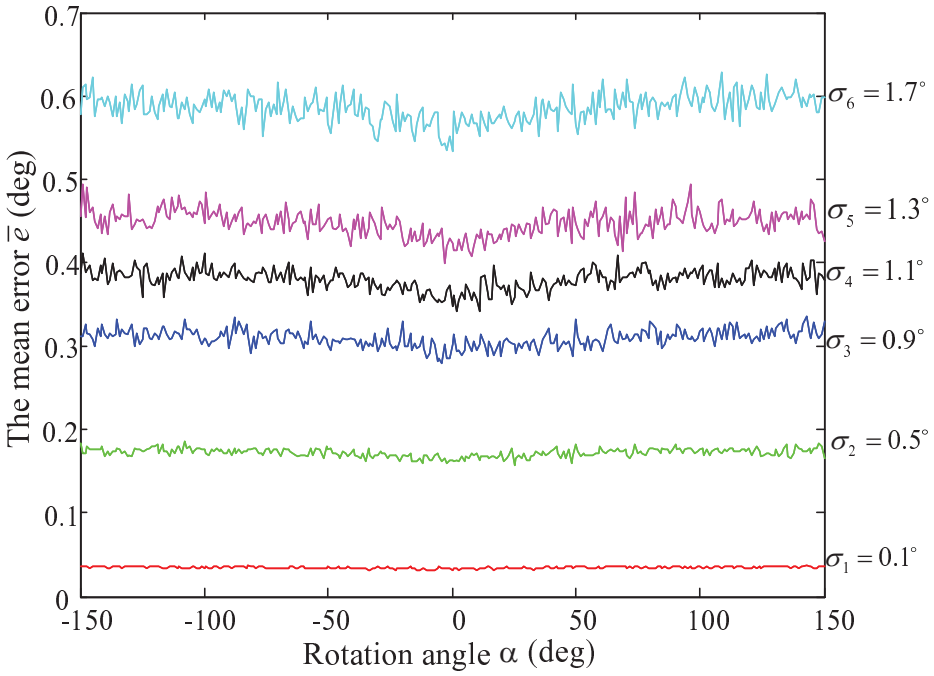

Fig.4 Angle measurement mean error for different noises of roll and pitch

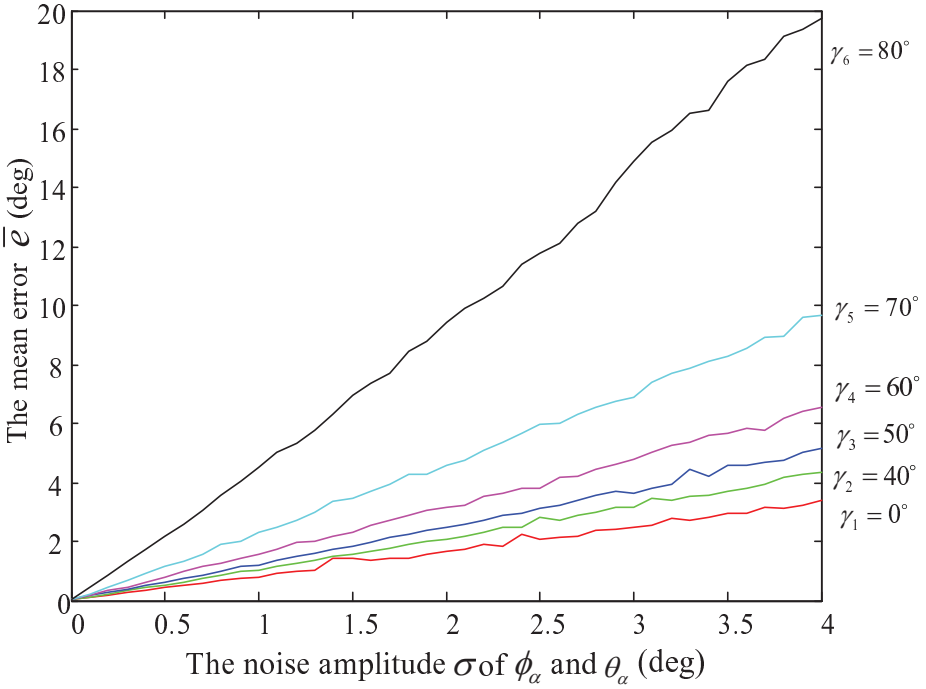

Fig.5 Noise immunity for different axes

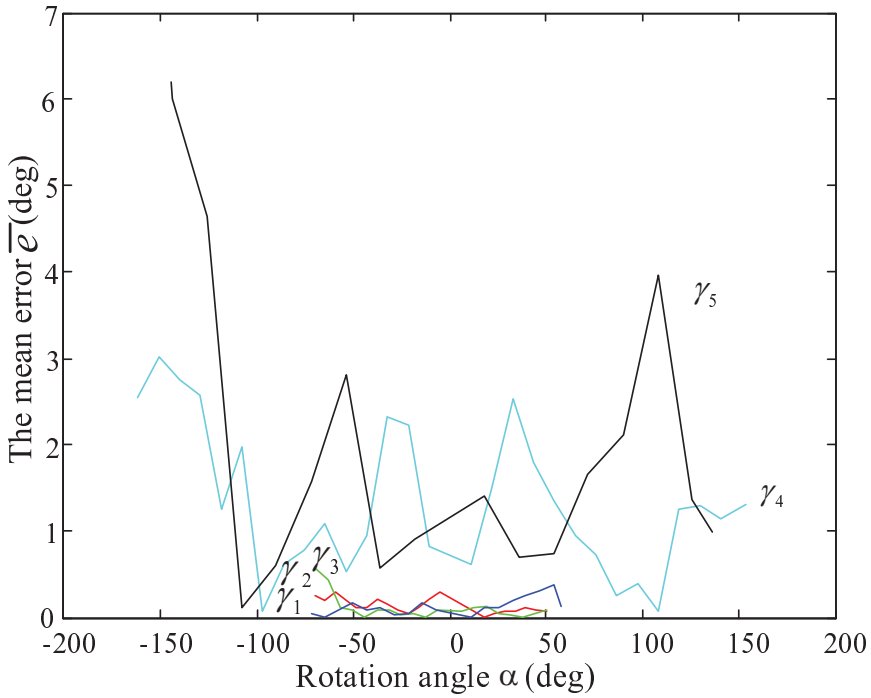

Fig.6 The experimental results