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Abstract

We have developed a weeding robot(Aigamo Robot). This robot works automatically using Global Navigation Satellite System (GNSS). Previous independent positioning measure included several meter differences and dispersion of the positions and directions. Therefore, in this study, we implement the Real Time Kinematic-GNSS (RTK-GNSS) on the right and left side of the robot in order to reduce these errors. This method can obtain the position and direction more accurately when the robot is not only in operation, but also under suspending. Moreover, this method can suppress the errors within about 10 cm to the south-southeast when the path tracking.

1 Introduction

我々の研究グループは小型の水田除草用ロボット(アイガモロボット)を開発している.[1] このロボットは水田内を自動で走行し、除草を行う。ロボットは広大な環境を走行するため、ロボットの自己位置を知ることは重要である。ロボットの自己位置を知るには、カメラやビーコンなどを用いる手法が存在する。しかしながら、天候などの外乱の影響を受けやすいため、我々のロボットには適用が困難である。そのため、自己位置を知る手法として Global Navigation Satellite System(GNSS)を採用する。従来のロボットは単独測位法を用いて、ロボットの位置を取得している。しかし、位置や向きの誤差やばらつきが大きくなる問題がある。そのため、より高精度な Real Time Kinematic-GNSS(RTK-GNSS)を用いる。我々のグループは2つのGNSSモジュールを用いることによってロボットの位置と向きを取得することに成功し、先行研究ではそれらの精度を調査し、高精度な測位が可能であることを示した。本研究では我々の測位システムにカルマンフィルタを導入することによって、より高精度なGNSS測位システムの提案を行う。

2 カルマンフィルタの説明

この章では提案するカルマンフィルタのモデルを説明をする。本研究ではアイガモロボットを対象としており、このロボットは2次元平面上を移動する。カルマンフィ

ルタの予測フェーズ

$$\begin{aligned}\hat{x}_{t+\Delta t|t} &= F_t \hat{x}_t + B_t u_t \\ &= \hat{x}_t + B_t u_t\end{aligned}\quad (1)$$

$$\begin{aligned}\hat{P}_{t+\Delta t|t} &= F_t P_{t|t} F_t^T + Q \\ &= P_{t|t} + Q\end{aligned}\quad (2)$$

$$\begin{bmatrix} \hat{x}_{t+\Delta t|t} \\ \hat{y}_{t+\Delta t|t} \\ \hat{\theta}_{t+\Delta t|t} \end{bmatrix} = \begin{bmatrix} \hat{x}_{t|t} \\ \hat{y}_{t|t} \\ \hat{\theta}_{t|t} \end{bmatrix} + \begin{bmatrix} \Delta t \cos \hat{\theta}_{t|t} & 0 \\ \Delta t \sin \hat{\theta}_{t|t} & 0 \\ 0 & \Delta t \end{bmatrix} \begin{bmatrix} v_t \\ \omega_t \end{bmatrix}\quad (3)$$

$$e_t = \hat{x}_t - x_t = \begin{bmatrix} \hat{x}_t - x_t \\ \hat{y}_t - y_t \\ \hat{\theta}_t - \theta_t \end{bmatrix}\quad (4)$$

$$P_{t|t} = E(e_t e_t^T)\quad (5)$$

$$\begin{aligned} & \begin{bmatrix} \sigma_{xx,t|t+\Delta t} & \sigma_{xy,t|t+\Delta t} & \sigma_{xz,t|t+\Delta t} \\ \sigma_{yx,t|t+\Delta t} & \sigma_{yy,t|t+\Delta t} & \sigma_{yz,t|t+\Delta t} \\ \sigma_{zx,t|t+\Delta t} & \sigma_{zy,t|t+\Delta t} & \sigma_{zz,t|t+\Delta t} \end{bmatrix} \\ &= \begin{bmatrix} \sigma_{xx,t|t} & \sigma_{xy,t|t} & \sigma_{xz,t|t} \\ \sigma_{yx,t|t} & \sigma_{yy,t|t} & \sigma_{yz,t|t} \\ \sigma_{zx,t|t} & \sigma_{zy,t|t} & \sigma_{zz,t|t} \end{bmatrix} + \begin{bmatrix} q_x^2 & 0 & 0 \\ 0 & q_y^2 & 0 \\ 0 & 0 & q_\theta^2 \end{bmatrix} \end{aligned}\quad (6)$$

カルマンフィルタの更新フェーズ

$$y_t = z_t - H_t \hat{x}_{t+\Delta t|t}\quad (7)$$

$$S_t = R + H_t P_{t+\Delta t|t} H_t^T\quad (8)$$

$$\hat{x}_{t+\Delta t|t+\Delta t} = x_{t+\Delta t|t+\Delta t}\quad (9)$$

3 カルマンフィルタに用いる分散の取得実験

Regarding the styles of your manuscript, please conform to the following

3.1 Title

The title should be centered across the top of the first page and should be in a distinctive point size or font.

3.2 Author's Names and Address

The authors' names and addresses should be centered below the title. It is desirable that these lines are typed in at least eleven point font size, but the particular point sizes and fonts are not critical and are left to the direction of the authors. Times new Roman 12 point is suggested. Please include your E-Mail address.

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Main headings are to be column centered in a bold font without an underline. They may be numbered, if so desired.

Subheadings should be in a bold font or underlined lowercase with initial capitals. They should start at the left-hand margin on a separate line.

Sub-subheadings are to be in a bold font or underlined type. They should be indented and run in at the beginning of the paragraph.

3.4 Figures and Tables

Figures and photos should be consecutively numbered like Fig. 1, Fig. 2, Figures should be inserted near their citation or at the end of the manuscript. Large figures and tables may span across both columns if necessary. Figure captions should be placed below the figures.

3.5 References

List and number all references at the end of the paper as shown below. Number reference citations consecutively in square brackets [1].

3.6 Page Numbers

Do not write page numbers on your manuscript. These will be inserted later by the proceedings printer together with the session number and conference identifications.

4 Manuscript Submission

Authors are requested to send their manuscripts electronically by **July 31, 2018** on the web:

<http://sci-sss.org/sss2018/sub/submission.php>

5 Conclusions

Please make an extra effort to adhere to these guidelines as the quality of the publications depends on you. Thank you for your cooperation and contribution. We are looking forward to seeing you at the 49th ISCIE International Symposium on Stochastic Systems Theory and Its Applications (SSS'17).

References

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