Onboard Orientation Software

Oskar Idland & Jannik Eschler
Institute of Theoretical Astrophysics, University of Oslo
(Dated: October 17, 2022)

This is an abstract Complete this summary at the end of the paper

I. THEORY

For theory, see section **Relevant Mathematics** Jannik legger in kilde

II. INTRODUCTION

As there is no up or down in space we will have to create our own way of navigating the cosmos. For this purpose we have made software capable of orientation in space. It will be able to calculate the angular orientation, find the velocity and get the position of the spacecraft.

III. METHOD

A satellite is orbiting our home planet and has taken a $360^o \times 360^o$ picture of the entire sky where all positions are described using spherical coordinates. As the stars and galaxies as very far away we are going to assume the pictures looks the same from the perspective of our shuttle. Using this picture we can create a stereographic projection as a means to convert from spherical coordinates to planar coordinates. Comparing the picture taken from a camera at on the shuttle we can find our orientation.

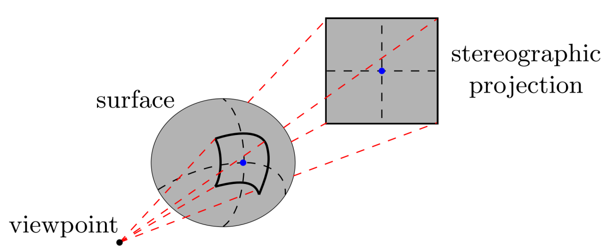

Figure 1. Illustration of stereographic projection

To relate the spherical coordinates θ, ϕ to the planar coordinates X, Y we use the following equations Husk å ta med utledning :

$$X = \kappa \sin\theta \sin(\phi - \phi_0) \tag{1}$$

$$Y = \kappa(\sin\theta_0 \cos\theta - \cos\theta_0 \sin\theta \cos(\phi - \phi_0)) \tag{2}$$

When the camera onboard takes a pictures it will be limited by its field of view (FOV). The FOV will be described as the maximum angular width α of the photo. We use the following equations to define it.

$$\alpha_\theta = \theta_{max} - \theta_{min}, \quad \alpha_\phi = \phi_{max} - \phi_{min} \tag{3}$$

This creates ranges of coordinates for θ and ϕ:

$$-\frac{\alpha_\theta}{2} \leq \theta - \theta_0 \leq \frac{\alpha_\theta}{2}, \quad -\frac{\alpha_\theta}{2} \leq \phi - \phi_0 \leq \frac{\alpha_\theta}{2} \tag{4}$$

This, in turn, also creates limitations on the coordinates (X, Y) of the stereographic projection:

$$X_{max/min} = \pm\frac{2\sin(\alpha_\phi/2)}{1 + \cos(\alpha_\phi)} \tag{5a}$$

$$Y_{max/min} \pm \frac{2\sin(\alpha_\theta/2)}{1 + \cos(\alpha_\theta/2)} \tag{5b}$$

Explain how we made the pixel grid

Explain how we are gonna generate the picture

IV. RESULTS

V. DISCUSSION

VI. CONCLUSION

VII. APPENDIX: MATHEMATICAL DERIVATIONS