Title:	Real-time Spherical Omnidirectional Visual Gyroscope
Author(s):	Das Dalal, Kiranjit
Supervisor(s):	Venkatesh, K S
Keyword(s):	Omnidirectional Camera Dual Fisheye Camera Ricoh Theta S Visual Gyroscope Orientation Estimation Azimuthal Equidistant Map Projection Real-time
Subject(s):	Autonomous Navigation, Unmanned Aerial Vehicle Attitude estimation
Abstract:	Unmanned Arial Vehicles (UAVs) or drones are becoming ubiquitous day by day due to its seemingly multifaceted applications. There is an increasing demand to make the UAVs fully autonomous in order to replace manned systems where accessibility and safety are of major concern. Being able to learn the orientation is one of the major requirements for these vehicles to become fully autonomous. Most of the commercial-grade UAVs rely on a MEMS-based gyroscope for measurement of change in orientation. However, these gyroscopes are prone to error due to temperature, shock, or vibrations. We present an efficient algorithm to compute the change of orientation of a UAV using visual data captured by a dual fisheye omnidirectional camera with the intention to replace the MEMS gyroscope without compromising on the accuracy and consistency. The algorithm captures video from a specifically mounted dual fisheye camera and calculates angular velocities in real-time. To achieve real-time performance, the processing is done on the raw input dual fisheye video frame without converting it to the equirectangular form. We use a clever selection of corner points on the video frame and correct computation of the angle difference per frame by tracking those points in subsequent frames. Calculation of angular displacement per frame is done using the knowledge of the projection of the scene onto the image sensor which is an equidistant projection. The three-axis rotation is thus calculated using the difference in the projection of the meridians consisting of the corner points in the projection.

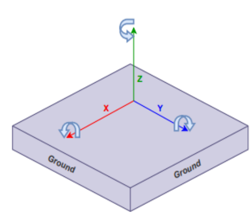
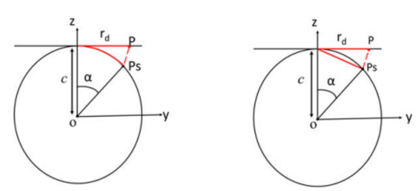


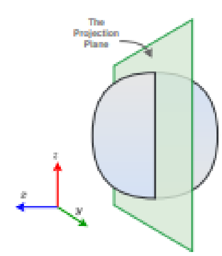
Figure 2.1: Reference axes for gyroscope angular velocity measurement



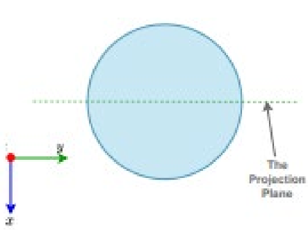
(a) Equidistant Projection

(b) Equisolid Projection

Figure 2.3: Fisheye projections from [1]



Side View



Top View

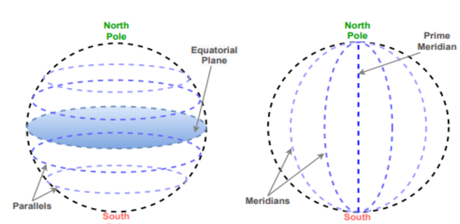
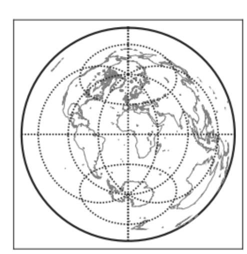
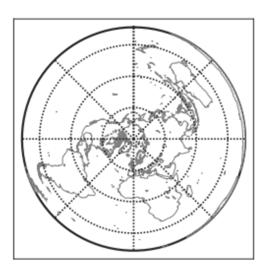


Figure 2.2: Parallels and Meridians


(a) Equatorial aspect ($\phi_1 = 0°$)


(b) Polar aspect ($\phi_1 = 90°$)