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Small Satellite Remote Sensing Constellation for Fast Polar Coverage

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Abstract

As polar ice cover retreats due to climate change, economic and political interest in Earth's polar regions has increased. At the same time, however, environmental conditions in these regions remain hazardous, and any operations there require intensive remote sensing. Noting that remote sensing constellation missions targeting only certain regions on Earth are impractical to construct other than with relatively cheap small satellites, the current study has designed a small satellite constellation that can image the polar regions frequently. A Walker delta configuration of satellites is sufficient to provide the coverage in the 60 to 85° region, with two hours average time or less between images, at worst. The number of satellites needed depends on the altitude of the constellation: at a 1000 km altitude, four satellites are needed; at 725 km, six satellites; and at 450 km, eight. The altitude choice depends on the requirements of the imaging instrument. Based on the Walker delta geometry, when using secondary payload slots or group small satellite launches, an onboard propulsion system capable of delivering relatively high ΔV change to the satellite is needed to get the constellation satellites to their intended orbit parameters from the initial orbit in which they are left by the launcher. Differential orbits using natural precession are cheap ΔV alternatives to launcher selection and propulsion system maneuvers, but add significantly more time to the formation of the constellation. However, by either choosing a longer deployment period or a powerful small satellite propulsion system, a small satellite Walker delta constellation capable of fast coverage of the polar regions is possible.

1. Introduction

Satellite remote sensing is a widely used, essential part of modern day life. Groups of remote sensing satellites, such as constellations, enable completely new modes of remote sensing, since the overall temporal resolution and image periodicity of that particular area improves dramatically when several satellites image the same area with similar image parameters. Satellite constellations are generally intended for global service (i.e., navigation or telecommunication constellations, such as GPS or Iridium, which target the whole planet). However, several regions of the planet have specific requirements in terms of remote sensing or communication. Moreover, a speedy and reliable delivery of remote sensing data is essential in various operations that require remote sensing services. This translates into requirements for a constellation with

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