Satellite Antenna Tracking Mount

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**Concept of Operations**

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Concept of Operations

for

Satellite Antenna Tracking Mount

Team <35>

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# Executive Summary

Amateur radio systems require specialized equipment and software to operate. Rather than manually adjusting the antenna with dials or computer software, our objective is to provide remote operation that will control the antenna rotator and display data for communication. The Satellite Antenna Tracking Mount will address this issue with a web application and microcontroller that will interface with the mount over the wireless internet. SATM will also provide secure user authentication via hashing account data. This will allow for low-cost remote operation and web browser accessibility.

# Introduction

The purpose of this document is to provide an overview of the Satellite Antenna Tracking Mount (SATM) system. The SATM is designed to accurately target and track satellites as they orbit the Earth. The user interface allows for the selection of the desired satellite for communication, after which the SATM will perform automated tracking to ensure the antenna is correctly pointed at the selected satellite as it passes overhead at any azimuth or elevation. This feature enables the user to concentrate solely on their communication without having to manually track the satellite.

## Background

The majority of legacy systems for moving satellite antennas are semi-manually controlled, with a user having to press a switch to move the antennas in different directions or input data for software. This outdated system tracks satellites across the sky, but requires the operator to be physically present with a laptop. Few strides have been taken to provide control wirelessly and even fewer allow access through web browsers. The SATM intends to replace this manual control system scheme with an automated one, where a Satellite can be selected out of a set catalog, and the tracking mount seamlessly follows it in the sky. This automatic system would allow for more flexibility when operating the antenna, as well as include less error since the data would be instantly updated.

## 

## Overview

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### *Figure 1: Satellite Antenna Tracking Mount Block Diagram*

The SATM system is designed to automate the process of tracking satellites as they traverse the overhead region, eliminating the requirement for manual tracking by the operator using azimuth and elevation controls. The location data of the targeted satellite will be obtained from a pre-existing database that will be continuously updated to ensure accurate and persistent tracking of the satellite. The system is equipped with a web-based user interface, allowing the operator to input the desired satellite to be tracked. This information will be transmitted to the microcontroller, which will drive the motors within the antenna mount, enabling continuous tracking until the satellite descends below the horizon.

## Referenced Documents and Standards

* IEEE Wi-Fi communication standards: IEEE 802.11
* C95.1-2005 - IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
* CCSDS 502.0-B-2 - Orbit Data System Standards
* FCC 97.213 - Telecommand of an amateur station
* CFR P97T47 - Amateur Radio Service

# Operating Concept

## Scope

The SATM will provide wireless connectivity to amateur radio operators that seek to enhance their current manual setups. They will initially configure the device to provide the necessary information to the web application. When the operator accesses the website on any browser, they will login and select a satellite. The next thing they will see is the relative location of the satellite along with the orientation of the antenna in degrees. The microcontroller will handle the intermediate processes that are usually completed by the user or computer software. These include calculating orbital paths, as well as setting the motor to the appropriate motion sequence. The SATM will immediately benefit operators, but may also be used for other IOT projects with slight alterations such as telescope mounts or weaponry.

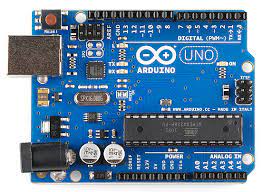
## Operational Description and Constraints

The Satellite Antenna Tracking Mount (SATM) is intended to be used by amateur radio enthusiasts to be able to communicate with satellites without having to manually control the azimuth and elevation controls to track the satellite. The SATM system will take the information from a pre-existing database of satellite locations and use it to track a satellite as it passes overhead.  
  
The resulting constraints are from this operational description are as follows:

* The SATM system must have access to a WIFi connection.
* The SATM system should be placed in an area without obstructions to the sky. This will allow the antenna array to communicate with the satellite.
* The system should be placed on fairly level ground to allow the rotator to track the satellite fully.
* The budget for the whole project is $300 so that limits the components that we will be able to use in the system.
* The external system components must be strong enough to operate in most weather conditions.

## System Description

* Web Application: The user-friendly web application enables the operator to select the desired satellite for communication. The application can be accessed remotely with an internet connection, and it will retrieve satellite location data from a constantly updated database. This information will then be transmitted to the microcontroller.
* Microcontroller: The microcontroller calculates the relative position of the satellite based on the data obtained from the database and drives the motors within the antenna mount to point the antenna towards the satellite.
* Antenna Mount: The antenna mount is equipped with two motors that regulate the azimuth and elevation angles, allowing precise orientation towards the target satellite. The mount is commercially available and will be controlled by the SATM system through the microcontroller. An antenna is mounted on the mount, making it ready for satellite communication.

***Figure 2:*** *SATM Flow Chart*

## Modes of Operations

There will be two main modes of operations: automatic mode and manual mode.   
In the automatic mode, the user will select a satellite from a list provided to them and the device will automatically track the satellite.  
In the manual mode, the user will be able to control the device and point it in the direction that they choose.

## Users

The main users of the system would be David Gent, W5QZ, and the Aggie Radio Club, W5AC. This system should only be used by those who have a ham radio license and call sign due to the fact that this system would be interfacing with antennas and will be transmitting and receiving information that is regulated by the Federal Communications Commission. The level of training for this system would be minimal since the use is mainly for those who have a ham radio license, but for those that are not licensed the basic knowledge of antennas, radio waves, and satellite movements are necessary.

## Support

The support for the SATM will be provided by a user’s manual that includes all modes of operation, as well as schematics and diagrams for the internals of the device. The source code for the device would be provided as well in order for the users to debug any issues that happen in corner cases. The user manual would describe how to operate the SATM, as well as walk the user through the main modes of operation.

# Scenario(s)

## Emergency

Radios are utilized in a lot of different emergency situations since they are not as limited in their scope and broadcast range as mobile phones. The SATM could potentially be utilized in an emergency situation where the only way to communicate with someone would be via a satellite radio. A big part of using radio communication is that many areas have a lot of amateur radio stations that are fail resistant, leading to no choke points or overloading from use.

## Recreation

Operators typically use their setups to simply meet other people and form clubs. The remote operation system will increase access for people with limited mobility or insufficient geography conditions like inclement weather or high rf interference. Users will be able to access the system from anywhere as long as they have an internet connection.

## Competition

Amateur radio contesting or radiosport, is an organized activity where operators try to have the most two-way interactions as possible. The SATM will potentially allow anyone to participate in these activities without physically being there.

# Analysis

## Summary of Proposed Improvements

This system will take a legacy system that is already built that has manual controls, and convert it to a system that can be remote controlled and automatically points the antenna in the direction of the chosen satellite. This allows for a higher level of precision and a better connection to the target over manual controls.

## Disadvantages and Limitations

One major limitation of the system is that it requires you to be connected to wifi to operate, as well as the device being connected to wifi to pull the data for the satellite tracking.

Another disadvantage of the device is that this is specifically designed for the legacy system that is already in place, and cannot be used for different rotators without some modification.

## Alternatives

The other alternatives to this project are to manually control the system by hand, or to find an off the shelf remote controlled system. Both of these alternatives have their own disadvantages. The manual control loses the remote control aspect, and sacrifices the precision from the computer controlled system. The off the shelf component does not directly mount on the legacy system and can cost money, as well as require a license or very specific equipment.

## Impact

The main impact this project would have on the environment is to increase the amount of radio signals that are active in the community. The main ethical concern can be related to increasing the amount of signals in the environment, and staying within the IEEE 95 standards.