**SOFTWARE REQUIREMENTS SPECIFICATION**

**Autoguider Camera**

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# 1. Introduction

## 1.1 Purpose of Requirements Document

This document explains the functional and non-functional requirements for creating a connection between the autoguider camera G1-1400 that is attached to observatory infrastructure through Gx Camera Ethernet Adapter Micro using the SDK (Software Development Kit for Gx and Cx camera control from Windows applications), to send data about movements of the telescope. It will help us to create the system and be sure all the demands of the client will be met. This document is for the developers involved in the project, as well as the clients.

## 1.2 Scope of the Product

The scope of this product encompasses the development of a software that obtains data about movement of the telescope from the autoguider camera using its SDK. The goal is to use this data for correcting the error of currently used telescope control system. An existing software facilitating communication of a computer with the autoguider camera is SIPS (Scientific Image Processing System), but the project aims to build an alternative solution, allowing for direct interaction with the camera via the SDK. The final product will ensure the camera's operational modes, including star tracking and image capture, are fully supported through the custom solution.

## 1.3 Definitions, Acronyms, and Abbreviations

* **R.A (Right Ascension) :** A coordinate in the celestial coordinate system that measures an object's angular distance eastward along the celestial equator from the vernal equinox. It is analogous to longitude on Earth and is typically expressed in hours, minutes, and seconds. RA helps to locate celestial objects in the sky.
* **DEC (Declination):** A coordinate in the celestial coordinate system that measures an object's angular distance north or south of the celestial equator. It is analogous to latitude on Earth and is expressed in degrees. DEC helps in pinpointing the location of celestial objects in the sky.
* **SDK (Software Development Kit):** A set of tools, libraries, and documentation that developers use to build software applications for a specific platform or device.
* **Autoguider Camera :** A specialized camera used in astronomy to track celestial objects by locking onto a reference star or a pattern of stars. It communicates with a telescope's control system to make real-time adjustments, ensuring accurate alignment and long-exposure stability during observations.
* **SIPS:** Software tool used in astronomy particularly for image processing. It stands for Software for Image Processing, which is used in managing data and enhancing images captured by telescopes.

## 1.4 References

* IEEE/ISO/IEC 29148 Standard
* Software Development Kit for Gx and Cx camera control from Windows applications (<https://www.gxccd.com/cat?id=148&lang=409>)
* Autoguider camera G1-1400  
    <https://www.gxccd.com/art?id=328&cat=52&lang=409>  
    <https://www.gxccd.com/art?id=362&cat=52&lang=405>
* Gx Camera Ethernet Adapter Micro  
    [https://www.gxccd.com/art?id=422&lang=409](https://www.gxccd.com/art?id=422&lang=409" \t "_blank)  
    [https://www.gxccd.com/download/GxETH%20uzivatelska%20prirucka.pdf](https://www.gxccd.com/download/GxETH%20uzivatelska%20prirucka.pdf" \t "_blank)
* Scientific Image Processing System from Moravian Instruments  
    [https://www.gxccd.com/cat?id=146&lang=409](https://www.gxccd.com/cat?id=146&lang=409" \t "_blank)

## 1.5 Overview of the Remainder of the Document

The rest of this document provides a general description of the product, functional and non-functional requirements, specific use cases, and any other things relevant to the backup system.

# 2. General Description

## 2.1 Product Perspective

This system is designed to control and manage the auto guider camera used in astronomical observations. It automates the process of tracking celestial objects by communicating with the telescope and ensuring precise adjustments of its position for accurate alignment. The system integrates with the observatory's current network and telescope setup, enabling remote access and reducing the need for manual intervention. It supports both office and field-based operation, with camera access from different locations.

## 2.2 Product Functions

The system enables real-time communication with the auto guider camera, ensuring precise tracking of celestial objects. It offers control over two camera modes: allowing it to track either the brightest star or a constellation of stars. The system will be operated either locally from the machine in the observatory, or possibly remotely through a remote-desktop solution.

The software will be able to acquire, display and save the images from the camera. The system will be able to retrieve, record and visualize a history chart of the information from the camera about current error of object/position tracking in both coordinates (RA, DEC). The software is capable to send the absolute rotational error measured by the autoguider camera to another software that could be able to compensate for this error.

This project assumes that the infrastructure of the observatory has the capability of resetting the camera when it is required, such as when it is not available for connection.

## 2.3 User Characteristics

* **Administrator:** Manages the camera settings, IP configurations, and ensures the camera is integrated correctly with the network and telescope systems. Responsible for troubleshooting and ensuring smooth operation during observation sessions.
* **End User (Astronomer/Observer):** Operates the telescope and utilizes the camera indirectly through the telescope control software. They rely on the camera's accuracy for capturing celestial images but do not directly interact with the camera system.

## 2.4 General Constraints

* The camera system should function without impacting the telescope’s performance.
* System must maintain consistent and accurate communication with the software, which is going to be developed by another group for adjusting the speed of the motors. The group specification document is designed in coordination with this one.

## 2.5 Assumptions and Dependencies

* The system will operate on the observatory's existing network infrastructure.
* The camera will be powered from camera ethernet controller, which is powered from 12V power supply that is available at the telescope.
* The system will run on any Windows 10 or newer machine with ethernet connection.
* Required drivers and software are pre-installed and up to date.

# 3. Specific Requirements

## 3.1 Functional Requirements

1. **Camera Connection and Access:** The system must be capable of connecting to the auto guider camera via the observatory's network accessing the camera's required functionality.
2. **Camera Modes:** The system must support switching between two camera modes: tracking the brightest star or tracking a constellation of stars.
3. **Real-Time Adjustments:** The system must support time-adjustments with as little latency as possible, estimated 7 seconds of time-exposure.
4. **Provide data:** The system should provide the options of configuration of the auto guider camera used at each moment, as well as the output that it provides (RA, Dec, coordinates, and time exposure), to the software that compensates for the error.
5. **Calculates rotational error:** System should calculate absolute rotational error measured by the autoguider camera, and send it to the software that compensates for the error
6. **Store images**: The system will be able to acquire, display and save the images from the camera.
7. **Store history**: The system will be able to retrieve, record and visualize a history chart of the information from the camera about current error of object/position tracking in both coordinates
8. **IP Configuration Management:** The system must store and manage the camera’s network configuration (e.g., IP address, subnet mask) and allow for easy updates and adjustments.

## 3.2 Non-Functional Requirements

1. **Network Efficiency:** The system must ensure efficient use of the network for continuous communication between the camera and telescope control software without causing major latency or delays in operation.
2. **Performance:** Camera operations, including image capture and star tracking, must not interfere with the telescope’s primary function or performance during observation sessions.
3. **Reliability:** The system must ensure reliable and consistent operation of the camera, to connect without issues. It must also handle periods of inactivity and reconnect seamlessly.
4. **Usability:** The camera control system should have an intuitive interface, allowing administrators and technicians to easily configure the camera, manage its connection, and troubleshoot any network or connection issues.
5. **Scalability:** The system must support future expansion, such as integrating additional cameras or telescope control software updates, without requiring significant modifications.