Observatory Automation Control System

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Software Requirements Specification Document

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1. Introduction

Ariel University is installing an Observatory and would like to automate it as much as possible so we as our final project will help with starting the steps to automate it, we will explain how it is build and how we will connect to the machinery in order that there will be no need for human interaction with the physical Observatory.

1.1 Purpose

When the Observatory is automated the University professors will be able to use it, and also maybe rent out the time of observing the sky, and maybe also let other Observatories use our design.

1.2 Scope

(1) Understanding how the Observatory works.
(2) Build the communication system of the machinery to the main manager.
(3) Make sure data can flow in from the machinery, and that commands can be sent back to them.
(4) Build a GUI that can show the state and actions that are done by the machinery.

1.3 Definitions, Acronyms, and Abbreviations.

ASCOM- Astronomy Common Object Model
ACP- Astronomer Control Panel
SIPS- Scientific Image Processing System
DLL- Dynamic-Link Library
WPF- Windows Presentation Foundation
Dome- The housing unit to protect the telescope, it has motors to rotate and to open/close to allow the telescope to see the stars.
Mount- mechanical structure which supports a telescope
Focuser- helps the telescope focus on objects
Guider- is a camera that helps the telescope stay looking at a specific object

2. The Overall Description

This Observatory has specific machinery that we will list later, we would like that for the start of this project we will create an abstract system that can communicate with a verity of machines and then zoom in to this Observatory specific needs.

2.1 Product Perspective

This Observatory components area as follows: Telescope, Focuser, Mount, Dome, Camera, Auto-Guide Camera, electricity-supplier, Higrometer, main computer, Projector, Network-camera and led-lights.

2.1.1 Telescope

The MEADE LX850 ACF is a Telescope of 14" f/8 Advanced Coma Free Optics - 2845mm focal length, 90 pound instrument capacity, StarLock automatic guider, Heavy-duty tripod, Zero Image Shift Electronic Micro-Focuser.

2.1.2 Focuser

The Focuser is A premium quality direct-replacement thread-on focuser for larger SCTs with a 3.25” threaded back such as the Meade 10,12 and 14”, Celestron 11” and 14” SCT and Celestron EDGE 9.25”, 11” and 14” Fine-focus 8 to 1 reduction system uses an inline all ball-bearing planetary design with zero backlash and no image shift.

2.1.3 Mount

The EQ8 High Precision EQ mount is pier tripod based. It comes with a SynScan hand controller, 2x10kg counterweights, with a payload of 50kg. The patented Freedom Find (dual-encoder) technology allows the telescope to be moved manually whenever the user wishes - but with no need for re-alignment! 50 kg Payload Capacity

2.1.4 Dome

The dome is made from polyester–glass laminate of up to 6 mm thickness, providing full resistance to weather conditions, and ensuring high durability and aesthetics at the same time. In addition, it is reinforced by special convex profiles on the outside of the mazer and reinforcements placed inside the structure. The dome is made up of 8 basic elements – it strongly facilitates transport and the assembly on the high buildings. Driving system of the dome is made of two silent low power engines supplied from the 230V. One controls the dome's rotation, the second allows you to open and close observation window. Special encoder mounted on a circuit of the dome cooperates with the dedicated driver which constantly measures the location of the dome and adjusts the engines' work respectively to the position of the telecope. Dome diameter: 4000 mm, Shutter width: 1400 mm, Dome height: 2960 mm, Diameter of the base ring: 3500 mm, Height of the base: 1100 mm, Fully automated driving systems for dome rotation and the shutter, Dome weight: 400 kg.

2.1.5 Camera

Large format CCD cameras of the G3 series are designed for up to 24x36 mm (photographic "full-frame" format) CCD detectors. G3 series inherits from G2 cameras — camera handling, software control, power supply and connection to the host PC using fast USB interface is the same. Design of both series is very similar and although G3 camera head is naturally bigger, it contains all mechanics and electronics and offers only power and USB connectors. As like in the case of G2 cameras, G3 head contains mechanical shutter and integrated filter wheel for five 2-inch filters. Read noise is also limited only by CCD itself so G3 series surpasses competing products. Precisely regulated cooling achieves detector temperatures up to 50 °C below ambient temperature.

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2.1.6 Auto-Guide camera

ASI120MM Mini camera integrates AR0130CS 1/3″ sensor (4.8 mm x 3.6 mm). It is ZWO new mini camera. This camera has 1280 x 960 pixels. The pixel size is 3.75 µm x 3.75 µm. This camera provides 12bit ADC and its QE peak is almost 80%.

2.1.7 Electricity-Supplier

This Electricity-Supplier does not exist yet but will be install in the future, it will be put on the mount, and will be able to control the electricity flow to all sensors and machines.
It will be the main controller and will communicate with the main manager computer to be controlled from far.

2.1.8 Higrometer

The Higrometer is the sensor that measures the humidity and temperature of the inside of the telescope room(Dome).
The Accuracy 2.0 higrometer uses the precision of a modern digital technology with the aesthetic appeal of an analog hygrometer, featuring an advanced humidity sensor that maintains accuracy to +/- 1%.

2.1.9 Main Computer

The Main Computer is the main brain of this whole operating system, it garhers all data from the sensors and makes decisions based on them, the Computer can also tell the machinery to move and act upon complex demands such as following a star over the night but if its rainy or cloudy close the dome, and protect yourself. The Computer will also be connected to the outside world to be able to get plans from the Users.
It contains the Program SIPS and

2.1.10 Light Projector

The Prohector is a simple light that has to be controlled through the Main Computer incase that the Maintenance people will want to see the inside of the Dome.

2.1.11 Network-Camera

The Network-camera is connected to the Main Computer, and can be turned on and off from far, this is due to maintenance u[keeping, for example if there is an error and we would like to see the inside of the Dome so we turn on the Network-Camera and the Projector so we can see, and we can see the inside of the Dome.

2.1.12 Led Lights

TheLed lights are located near the flor of the Dome, and can be turned on or off, the main reason for these lights are to make the Dome look nicer, for investors to see the Dome and be impressed.

2.2 Product Functions

Overall the Observatory can track and record stars through the night it, it can do this in many ways, there are different types of imaging processes it goes through, and using all these machinery and sensors it can do it.

For clarity:
(1) Tracking and recording stars is a complex process and takes a procise outcome of combined machinery to do this task, All the machinery needs to work together and managed.
(2) Keeping the Dome safe from outside hazzerds are also a complex process, it needs to get the weather report or from more sensors outside the Dome, in order to decide if to open or close the Dome.

This means that the User can at any point ask the Observatory to track a star with specific demands on how to do that and the Observatory will find the time while it is safe to look up and record the data, amd return it to the user once done.

2.3 User Characteristics

The Observatory Users will consists of people who want to look up to the stars, this can be the Professors that are trying to learn about the stars, it can be used by amature astronomors that want to look up, and above all hope to find more unknown stuff that we cant even list here since we don't know what is out there.

Our hope of the design we put into this Observatory is that it will improve the functoinality of the Observatory and maybe also be asked to implement in other Observatories.

2.4 Constraints

This Project has many limitations across many fields, These can include:

(1) Weather
(2) Hardware limitations (for example, to expensive equipment)
(3) Interface to other applications across different hardwares
(4) Timeline
(5) Location light polution
(6) Electricity supply
(7) Higher-order language requirements
(8) And unknown constraints that we will find out through the process.

We will need to consider all these constraints while developing our system.

2.5 Assumptions and Dependencies

We are under the Ariel University Observatory, to develop the systems to communicate with the machinery, at any point the Observatory may change their demands and we will need to adjust to that.
For now we assume the need for this system, and we hope to provide it in the timeframe required.

3. Specific Requirements

In Our Project we will build the communicating system between the User and the machinery in the Observatory, it will be able to move and gather data from any instrument, to make complex decisions about plans for Users and safety for the Dome.

- Specific requirements to the System Manager
- Access to the machinery
- Adjustable to change in machinery
- Network with outside and inside the Dome
- GUI for User use
- Capable to get more data by adding machinery
- Can be overriden by human
- Able to do also small tasks not only big processes
- Alert human attention in case of emergency

The System shall be able to control the Observatory and all it contains.
The System shall be able to show a User all the Observatory states on a GUI.
The System shall be able to alert a Human in case of an emergency.
The System GUI should be adjustable incase more machinery will be added to the Observatory.
The System may be written in .NET language.

3.1 External Interfaces for Developer

The system will be written in .NET and will have a config that will be listing the machinery and the sensors and their output details and common actions that can be done to them. The system will have an interface that every object will inherent from so there will be a common functions to run on all objects. It contains both content and format as follows:

- Name of item
- Description of purpose
- Source of input or destination of output
- Valid range, accuracy and/or tolerance
- Units of measure
- Timing
- Relationships to other inputs/outputs
- Screen formats/organization
- Window formats/organization
- Data formats
- Command formats
- End messages

3.2 Functions

The system must first check that all inputs are approachable and wont "die" in the process of receiving the input, this is the pre-running of the observatory, then we will need to check communications by sending commands and getting the input data seeing that it changes as the commands requested, then we can start the ongoing run that will run the User demands, and gather the data to send back to him.
These include:

- Validity checks on the inputs
- Exact sequence of operations
- Responses to abnormal situation, including
    - Overflow
    - Communication facilities
    - Error handling and recovery
- Effect of parameters
- Relationship of outputs to inputs, including
    - Input/Output sequences
    - Formulas for input to output conversion
- GUI display
    - Accessible to the User
    - Correct information
    - Commands are being sent

Things might change as we go on in the project.

3.3 Logical Database Requirements

The Database will be split here in to 2.

1) The Operating System must include the storage of the Users that can access the System and all Objects running in the System, this is manly the Head of the System which will know who and what can be part of the System.
2) The data recovered from requests, this Database is mainly for ongoing run of the System, it will include the data received from the Observatory and attach it to the User requested ot.

A diagram will come in the future when we get more accurate description of the System.