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AUTONOMOUS DOME FOR A ROBOTIC TELESCOPE

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RESUMEN

El Laboratorio de Investigación de Física opera un telescopio robótico de 50 cm de diámetro ubicado en el Monte Abu (Rajsthan, India). El Telescopio Automatizado para Estudios Variables (ATVS) usa el sistema de control de observatorio RTS2 para las operaciones automatizadas. El observatorio alberga una cúpula de 3,5 m de diámetro realizada por Sirius Observatories. Nosotros hemos desarrollado la electrónica haciendo uso de tarjetas con la lógica necesaria y el software para controlar las operaciones. Estamos en el proceso de completar los "drivers" para conectar nuestro Arduino con RTS2. Este trabajo es una breve descripción de las fases diversas en relación al desarrollo y su integración para alcanzar el objetivo necesario.

ABSTRACT

The Physical Research Laboratory operates a 50 cm robotic observatory at Mount Abu (Rajsthan, India). This Automated Telescope for Variability Studies (ATVS) makes use of the Remote Telescope System 2 (RTS2) for autonomous operations. The observatory uses a 3.5 m dome from Sirius Observatories. We have developed electronics using Arduino electronic circuit boards with home grown logic and software to control the dome operations. We are in the process of completing the drivers to link our Arduino based dome controller with RTS2. This document is a short description of the various phases of the development and their integration to achieve the required objective.

Key Words: instrumentation: miscellaneous

1. INTRODUCTION

The Physical Research Laboratory operates a robotic 50 cm telescope. This is an autonomous telescope for variability studies (ATVS) in its observatory at Mount Abu (latitude : $24^\circ\, 39^m\, 9^s$ North, longitude: $72^\circ\, 46^m\, 47^s$ East, altitude : $1680\, m$). The operating conditions are quite tough in terms of range in humidity, temperature and wind. The telescope is protected from the environment by a fibre glass dome manufactured by Sirius Observatories.

2. DOME CONTROLLER FOR AUTONOMOUS OPERATIONS

The telescope operates in the robotic mode (Ganesh et al. 2013) and efforts are made in order to fully automate it using Remote Telescope System (RTS2, `http://rts2.org/`). The observatory has over 200 clear nights in a year but needs to be completely closed and sealed during the Indian monsoon season (generally mid June to September) each year. Apart from this there are occasions when the skies become cloudy and/or wind conditions also become drastically worse. Therefore, for autonomous operations to succeed, we need the dome controller to be very reliable with redundant weather sensors so that the shutters can be closed automatically in case of bad weather.

Humidity is a major cause of repeated failures of electronic boards. We have not found commercially feasible solutions available for controlling the dome. Hence we have decided to go for a locally engineered solution using cheap, general purpose, electronic boards available easily. The objective of this work was to make an autonomous dome controller for a robotic telescope using easily replaceable electronics. The controller is in charge of the dome functions like closing and opening of the shutter and clockwise and counter-clockwise motion of the dome to track the telescope. It also keeps the record of the position of the dome and can be controlled by a Windows or Linux based computer using appropriate drivers.

We built the dome controller using the ubiquitous Arduino boards. An Arduino is an open source physical computing platform based on a simple micro-controller board. It consists of a physical programmable circuit board. It can be programmed

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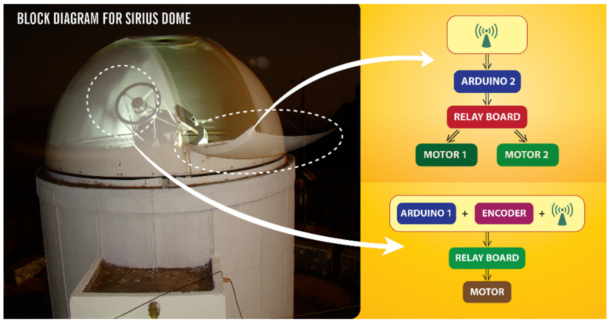

Fig. 1. View of Sirius Dome housing the PRL 50cm telescope at Mount Abu (left panel). Block diagram of dome and shutter control logic (right panel).

via the USB port of the computer using the Arduino IDE (integrated Development Environment) built with a software platform known as Processing. The Arduino IDE includes support for various electronic components such as encoders and other sensors, relay boards etc. We used one Arduino board to control the shutter movement of the dome (opening and closing) and another one to control the dome rotation (clockwise or counter-clockwise). Both the boards communicate with each other using RF transceivers. This is needed because the dome rotation controller is connected to the PC and the shutter controller is connected via the dome controller. The shutter controller, powered by a battery, is mounted in a box on the dome and rotates with it. Thus wireless communication is mandatory. For monitoring the orientation of the dome we use an incremental rotation encoder which converts the angular motion of the dome into a series of digital pulses which encode the movement of it. To control the motion of the motors of the shutter and the dome, we have used semiconductor relay boards with physical limit switches. These semiconductor relay boards are operated using digital pulses from the Arduino microcontroller board.

3. DRIVE DEVELOPMENT PHASES

The work was divided in different phases and the work of all the phases was accomplished one by one and finally integrated to make the drive. The different phases were the following:

1. Making a programmable controller of the dome's shutter.
2. Making a programmable controller of the dome's rotation.
3. Conversion of the motion of the dome into digital code.
4. Setting up a wireless connection between the rotation controller and the shutter of the dome.
5. Making it compatible with RTS2.

In the first phase, a mechanical controller circuit for the shutter of the dome was made using limit switches and was successfully tested. After that a programmable control circuit was made using an Arduino board and semiconductor relays to control the motors and was coded for opening, intermediate stop and closing operations of the shutter. Work on the position encoder was also started to record the position of the dome.

Simultaneously, work on the rotation part of the dome was started and a programmable control circuit was made using another Arduino board and was coded for clockwise, counter-clockwise motion and for detecting home position. Then the position encoder was integrated with this controller and the code was modified accordingly. Work on the wireless communication between dome rotation and shutter controllers was started using radio frequency transceivers and a communication protocol was established and encoded for transferring the command to the controller boards.

The electronic circuits have been tested at the observatory and software coding has been developed for synchronizing the dome orientation with the azimuth being pointed by the telescope. We plan to integrate the shutter control board with independent(redundant) cloud, rain and wind sensors to allow quick closure of the shutters without computer/manual intervention.

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