RUSSIAN-CUBAN OBSERVATORY: OPTICAL OBSERVATION STATION

OBSERVATORIO RUSO-CUBANO: ESTACIÓN DE OBSERVACIÓN ÓPTICA

A. Alonso Diaz[a†], M.R. Rodriguez Uratsuka[a], O. Pons Rodriguez[a], Z. Barcenas Fonseca[a], R. Zaldivar Estrada[a], N. Paula Acosta[a], M.A. Ibrahimov[b], D.V. Bisikalo[b], M.E. Sachkov[b], A.M. Fateeva[b], I.S. Savanov[b], M.A. Nalivkin[b], S.A. Naroenkov[b], A.S. Shugarov[b]

a) Institute of Geophysics and Astronomy, Havana, Cuba; alonso@iga.cu
b) Institute of Astronomy, Russian Academy of Sciences, Moscow, Russia
† corresponding author

Recibido 20/8/2020; Aceptado 20/9/2020

The prolongation of a project to create an optical observation station in the frame of the Russian-Cuban Observatory (RCO) is described. The paper reports some important elements regarding the creation of the RCO optical station layout in Havana. The equipment and some scientific observation projects planned to be done using the layout are discussed. The main instrument of the optical station layout is a wide-field 20 cm robotic telescope. The observational project program includes both fundamental and applied tasks. It is argued that the layout itself could be used as an independent observatory because of its ability to solve universal observational tasks and to serve as a real segment of a global optical telescope network.

El artículo describe la continuación de un proyecto para crear una estación de observación óptica en el marco del Observatorio Ruso-Cubano (RCO). El documento informa algunos aspectos principales relacionados con la creación del diseño de la estación óptica RCO en La Habana. Se discuten los equipos y algunos proyectos de observación científica que se planean realizar utilizando el diseño. El instrumento principal del diseño de la estación óptica es un telescopio robótico de 20 cm de campo amplio. El programa de observación incluye tareas tanto fundamentales como aplicadas. Se argumenta que el diseño en sí mismo podría usarse como un observatorio independiente debido a su capacidad para resolver tareas de observación universales y servir como un segmento real de una red global de telescopios ópticos.

PACS: Telescopes (telescopios), 95.55.-n; optical instruments iInstrumentos ópticos), 07.60.-j; astronomical observations (observaciones astronómicas), 95.85.-e

I. INTRODUCTION

The creation of distributed global optical telescope networks is one of the most important issues of modern observational astrophysics. The main advantage of global networks is an opportunity to realize nearly uninterrupted sky observations 24 hours/365 days a year. Another advantage is a global network possibility to implement universal research tasks. Universality implies ability to monitor nearEarth, near-Solar and deep space to cover an entire variety of available natural and technogenic origin space objects. In order to achieve universality, two types of telescopes have to be included into the network - scan wide-field and astrophysical narrow-field telescopes. Telescopes of such global and universal network should have the following typical characteristics: i) apertures of 0.2-0.5 m and fields of view of the order of several angular degrees for scan telescopes, and ii) apertures of 1m or more and fields of view of the order of fractions of an angular degree for astrophysical telescopes.

This paper describes a prolongation of the Russian-Cuban team collaboration on a project to create a separate segment of the above described network in the Cuban territory. Our first paper dealt with general issues of segment creation and its usage [1]. This paper deals with the creation of the optical station layout within the future segment. The layout equipment and some research projects planned to be done using it are discussed in the paper.

II. RCO AND ITS OPTICAL STATION

Since 2017, Cuba and Russia have been collaborating to create the Russian-Cuban Observatory (RCO). RCO is built on Cuban territory, and believed to be a separate segment of a global optical network created within the frame of world-wide international cooperation. The process of RCO building is divided into two stages. In the first stage, a layout of the RCO will be created. In the second stage, a fully functional observatory will be created. The layout is built in Havana, while the operating observatory will be built in the site of Valle de Picadura, located 80 km east of Havana.

Both the RCO itself and its layout consist of two main stations: a co-location GNSS station and an optical observation station. International partners, equipment and tasks concerning a layout of the GNSS station in Havana are described in [2]. This paper describes the partners, equipment and tasks concerning the layout of the optical observation station in Havana.

The optical station layout is created in cooperation between the Institute of Geophysics and Astronomy, Havana, Republic of Cuba (IGA) and the Institute of Astronomy of the Russian Academy of Sciences, Moscow, Russia (INASAN). Some

advantages of having the RCO optical station in Cuba and thus, of using a large Cuba-Russia arc were discussed and theoretically analyzed in [1].

III. EQUIPMENT OF THE OPTICAL STATION LAYOUT

IGA donated a part of its territory and a separate building to mount the RCO layout. A satellite image of the territory in IGA and a photography of the building are given in [2] (see Figs. 4 and 5 there). Also in [2] (see Fig. 6 there), a scheme of the GNSS station and optical station main observation facilities location is given. These facilities are located on the roof of the building. Inside the building, the electrical, computer and network equipment are accommodated. The latter is fully grounded and a lightning protection system provided by an IGA's specialized team. An automated weather station with its own lightning-conductor is located 20 m from the building.

A more detailed scheme of the layout observation facilities location on the roof of the building is shown in Fig. 1. On a concrete pillar at the left front corner of the roof, a receiving equipment of the GNSS station layout is located (cf. with Fig. 7 in [2]). On a circular parapet also located on the roof, an automated dome for the optical station is deployed. Inside the dome, a 20 cm robotic telescope is installed. The telescope is lifted to roof level using a 4.2 meter concrete column. A drawing of the column inside the building along with the circular parapet, the dome, and 20 cm robotic telescope is shown in Fig. 2.

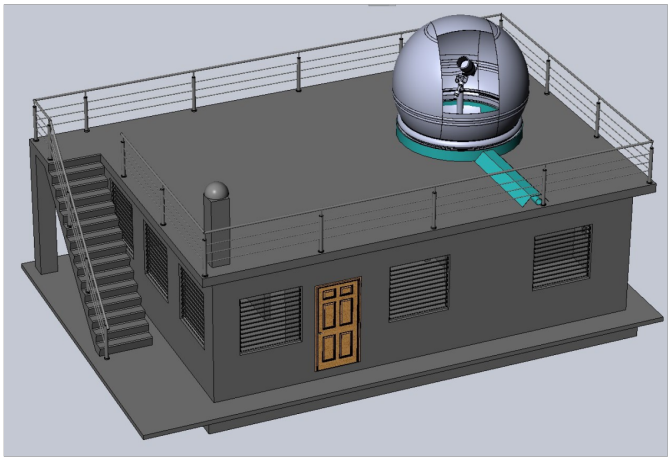

Figure 1. Scheme of the RCO layout at IGA (Havana). See text for explanations.

The equipment of the RCO optical station layout includes:

a) automated dome,

b) wide-field telescope with large field of view,

c) telescope mount,

d) image registration unit with CCD camera and focusing device,

e) computer, network and meteorological equipment.

To robotize the observations, the following specific equipment were chosen for the station:

- 3-meter ScopeDome 3M automated dome;
- 20-cm Officina Stellare Veloce RH20 wide-field telescope with 5 angular degrees field of view, automated focusing unit, a set of optical photometric filters, Atlas FLI automated filter wheel for 7 positions, and FLI PL16803 4K CCD camera;
- high-precision 10Micron GM1000 HPS equatorial mount with 25 kg load capacity and absolute position sensors.

The 20 cm Officina Stellare Veloce RH20 widefield telescope provides collection and conversion of optical information. 10Micron GM1000 HPS mount with absolute encoders, providing pointing to an object using its specified coordinates and tracking the object. The image registration unit includes CCD camera, focusing device and filter wheel. All equipment is controlled and operated by a server computer using USB interface.

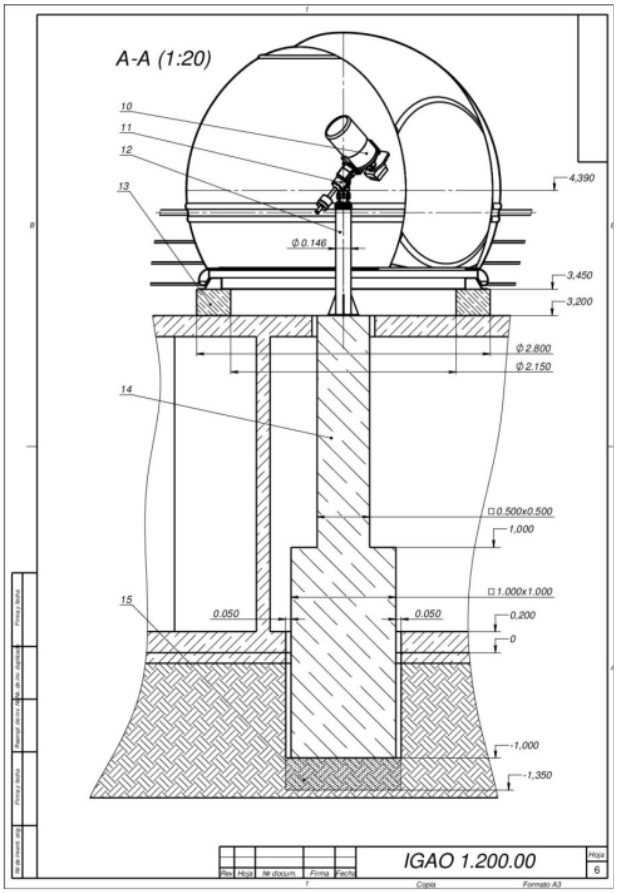

Figure 2. Drawing of installation of the RCO optical station layout main observational equipment: 20 cm telescope lifted using the 4.2 m concrete column and its dome on the roof of the building.

The time service unit operates using GPS and GLONASS time signals. It provides timing for all acquired frames and obtained coordinate information. The dome control unit is responsible for the telescope protection by closing the dome following a signal from meteorological unit. The power supply unit includes an uninterrupted power supply

device, a 8-port SNMP power management device, IP and GPRS interfaces, and lightning protection systems. The data exchange between all the units of the optical station layout is provided by the data exchange unit. It includes a router with Ethernet and fiber-optic interfaces, USB extenders, and lightning protection devices. Full operation of optical station layout equipment is provided by standard programs and device drivers, which are used within the specially created software package.

IV. SCIENTIFIC PROJECTS FOR THE OPTICAL STATION LAYOUT

The 20 cm wide-field robotic telescope is the main observational instrument of the optical station layout at IGA (Havana). In the future, a wide-field 1-m telescope is planned to be installed in the RCO full operating optical station in Valle de Picadura. These two telescopes are thought to be used for both fundamental and applied observational tasks. Eventually, both optical stations in Havana and Valle de Picadura will create a united Cuban segment of a global optical telescope network. This segment is thought to be able to perform the following universal tasks:

a) Monitoring near-Earth and near-Solar space to solve applied tasks: planetary Earth defense and monitoring of natural and technogenic origin objects which posed space threats (potentially hazardous objects and space debris);

b) Monitoring deep space to solve fundamental tasks: ground-based optical follow-up observations to support already launched and awaiting launch scientific space missions and multitask observations of various types of optical transients (Gamma-Ray Bursts, observational effects of gravitational-wave events in optics, etc).

So far, the Cuban segment of a global network is under construction. So, all taskes described above are supposed to be carried out using 20-cm robotic telescope of the RCO optical station layout. Obviously, the observations of some specific objects have to be done taking into consideration the technical limitations of a 20-cm telescope.

It is important to note that observation projects using the 20 cm telescope are planned to be carried out in collaboration with telescopes of INASAN Zvenigorod Observatory [3] and INASAN Collective Using Center [4, 5]. This center includes a 1 m Zeiss-1000 telescope of INASAN Simeiz Observatory [6] and a 2 m Zeiss-2000 telescope of INASAN Terskol Observatory. Such collaboration will be crucial to check the efficiency of the RCO itself and its layout as a segment of a global optical telescope network.

V. CONCLUSIONS

The creation of the Russian-Cuban Observatory (RCO) in the Republic of Cuba is in progress. The RCO is being created in 2 stages: first, a layout of the observatory is built in Havana, then the operating observatory will be built in Valle de Picadura. Here, we have described the equipment and some scientific observation projects planned to be implemented using the RCO optical station layout in Havana. The main instrument of the optical station layout is a wide-field 20 cm robotic telescope. The entire observational project program includes the both fundamental and applied tasks. For these reasons, the layout itself could be used as an independent observatory, because of its ability to solve universal observational tasks and to serve as a real segment of a global optical telescope network.

ACKNOWLEDGMENTS

The Russian team acknowledges financial support by the Ministry of Science and Higher Education of the Russian Federation (Project No. RFMEFI61319X0093, Agreement No. 075- 15-2019-1716 of November 20, 2019). The Cuban team acknowledges material, technical, and financial support by the Ministry of Science, Technologies and Environment of the Republic of Cuba.

REFERENCES

[1] D.V. Bisikalo, I.S. Savanov, S.A. Naroenkov, M.A. Nalivkin, A.S. Shugarov, *et al.*, Astron. Rep. **62**, 367 (2018).

[2] D. Marshalov, O. Pons Rodriguez, Yu. Bondarenko, V. Suvorkin, I. Bezrukov, S. Serzhanov, Rev. Cubana Fis. **37**, 73 (2020).

[3] INASAN Zvenigorod Observatory: http://www.inasan.ru/en/divisions/zvenigorod/

[4] INASAN Collective Using Center: http://www.inasan.ru/divisions/terskol/ckp/ (in Russian).

[5] INASAN Collective Using Center: http://www.inasan.ru/scientific_activities/projects/ckp_project/ (in Russian).

[6] I.V. Nikolenko, S.V. Kryuchkov, S.I. Barabanov, I.M. Volkov, Institute of Astronomy RAS Scientific Proceedings **4**, 85 (2019).