Mechanical Design of a "Clam Shell" Type Dome For TÜBİTAK National Observatory

Abstract

Mechanical Design of a Clamshell Dome for TÜBİTAK National Observatory (TNO and its common name of TUG) gets its motivation from designing a clamshell dome with a diameter of 1.5 m with an integrated controller mechanism, and pursue unorthodox methods to increase isolation at intersection points between slices and at joint section around pivot tube which also coincides with the standards of TÜBİTAK National Observatory, and represents the name of Turkey with a delicately innovated design [1]. First step consisted of distinguished technical perspective and conceptual design. Other steps followed the predetermined technical perspective and the design has achieved its current form. Pursuing such distinguished technical perspective allowed us to succeed in finalizing the project, and perform practical and experimental tests to prove our claims such as isolating the scientific instruments placed inside the dome from outer effects.

Figure 1: Dome we have designed

Project Description

Clamshell domes are used to protect the telescope from the environmental conditions. That is needed because, telescopes are immobilized at the observatories and they need to stay there in all weather conditions. [2]

Domes are designed to be in spherical shape because, such geometry is the best against harsh environmental conditions, in terms of particulate and fluid flow. The design consists of four slices and two motors that act on each half of the sphere. A belt mechanism is used to transmit the torque generated by the motor in terms of tension to allow mobility of slices.

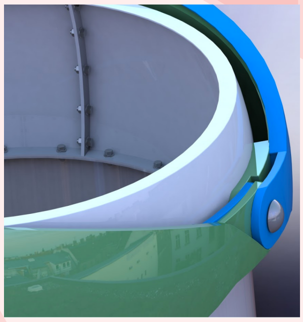

Figure 2: Slices have more compact layout in our design

Technical Properties

- Resistant to 300 km/h wind
- Water and dust resistance
- Impact resistance (eg. hail)
- Reliability of slice motion through both worm gear and break-motor

Milestones and Methods

- Milestones for this project are determined in cooperation with TUG, and satisfied throughout the process of design and production.
- Acquisition of our own project through personal attempts and network capabilities
- Satisfying the needs for initial documents and requirements of the project and obtaining BIDEB fund
- Complete literature search for intended clamshell dome type and establishing a final concept suited for all units and individuals involved.
- Successful design of components of the desired end-product and adequate solutions to the problems given in the definition.
- Scaled down, 3D printed version for a visual aid and mechanical analysis of the system.
- Proper mechanisms, motors, gears are selected suited for the conditions and requirements for the design
- Recognition of the design to build a full-scale product by our mentor.

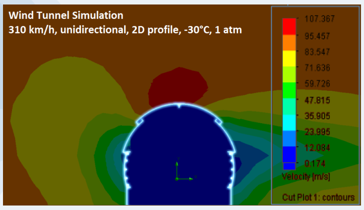

Figure 3: Simulation Analysis of the Wind Resistance Criteria. Wind can't enter the dome

Results

The main problem of traditional clamshell domes is solved which was to prevent external factors such as dust, snow, water etc. from infiltrating inside of the dome and resultantly interfering with the proper operation of the telescopes and the dome itself. To test and evaluate the functionality and competence of the dome, a prototype was manufactured via 3D printer. Several tests were performed on the joint area where slices meet around the pivot tube [3]. It was seen that the prototype succeeded and withstood the effects of wind, dust and low temperature. Several design changes such as thickness and orientation were made to improve the strength of the design. A tensile test on the PLA material was performed which showed that the prototype could withstand 27.3 MPa of stress.

The comparison of the standard clamshell domes and our design can be seen aside. First figure contains gaps which is a problem solved in our design by a more compact and intelligent layout of the slices. Original design [4] implements grey gaskets that are added later by TNO as a way to block incoming particles meanwhile new design has a smoother surface on the outside for a better flow deflection and also has no external components.

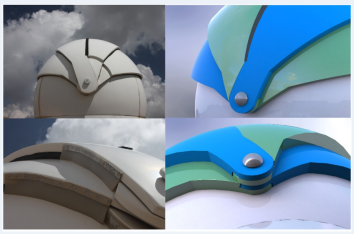

Figure 4: Comparison of domes between the one in Antalya (left) and our design (right)

Conclusions

The produced clamshell dome is capable of preserving a small telescope to be used for DIMM observations on the site of TÜBİTAK National Observatory, at top of the Saklıkent Mountain-Antalya. Alternatively, it can also be applicable for military cases. It is the first domestic clam-shell dome ever designed and produced in Turkey, with much less production cost than its foreign equivalents. Domestication will also eliminate the possible communication and transportation problems with foreign dome companies, where most of them are located in U.S.A. or Canada. Moreover, if the case of dome export trade may arise in future, it will provide revenue to national economy and recognition in markets. The research and development (R&D) in this area is currently inactive. This project assures know-how accumulation and will lead possible future R&D projects with the assistance of TNO.

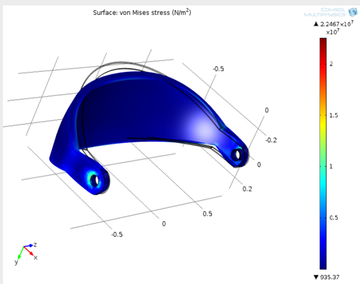

Figure 5: Simulation Analysis of the Wind Resistance Criteria done via COMSOL.

Bibliography

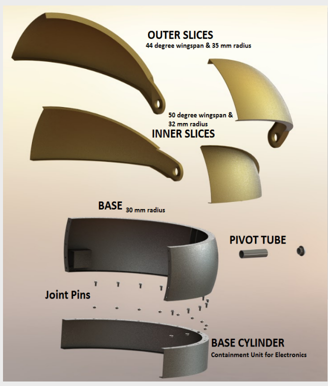

Figure 6:Mechanical assembly

[1] "Solar - Differential Image Motion Monitor at the TÜBİTAK National Observatory", TUG, [Online]. www.tug.tubitak.gov.tr/dokumanlar/tug_sdimm/

[2] "Dome Types", Vik Dhillon, University of Sheffield, [Online]. www.vikdhillon.staff.shef.ac.uk/teaching/phy217/telescopes/phy217_tel_domedes.html

[3] "Introduction to Thermal and Fluids Engineering", Deborah A. Kaminski, Michael K. Jensen, 2011

[4] "Astrohaven Domes", Fiberglass clamshell domes for observatory, planetarium, radar tracking housing, portable backstand [Online]. www.astrohaven.com/

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