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Radio Technology for Moonbounce

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Abstract— Moonbounce is Earth-Moon-Earth (EME) communication. It is a wireless space communication activity done by community of amateur radio operators. Here, the Moon becomes a passive reflecting satellite for two way communication done using radio telescopic antennas. Therefore, sophisticated equipment is required to bounce a signal off the moon and hear its return because Moon has an irregular surface and it is a bad reflector of electromagnetic rays including radio waves. Hence, radio technologies must be enhanced by Visual Moonbounce, digital techniques for Digital Moonbounce, use of dielectric lenses in radio telescopic antennas and new modes allowing photographs to be bounced off the Moon more clearly, allowing less power usage and construction of much smaller antennas.

Keywords— Moonbounce, Dielectric Lens Antenna, Radio Telescope at Arecibo Observatory, Giant Metrewave Radio Telescope, Moonbounce Imaging.

I. INTRODUCTION

The moon is away from Earth approximately to 250,000 miles and radio waves travelling at 186,282 miles per second. So, Earth-Moon-Earth communication helps in transmitting a signal from one location on Earth and is received at another location on Earth when bounces off the Moon. And a signal which is sent to Moon is returned after 2.7 seconds get elapsed [3]. As a wave propagates away from an antenna, path loss is the biggest thing caused by spherical expansion of a radio wave. The radio waves propagate at speed of light and trails of echo which are reflected from irregular surface are delayed from the leading edge by twice the value. Earth-Moon-Earth signals are affected by Doppler shifts which are caused by relative motions of Moon and Earth. There are big antennas, high power, modulation techniques, low noise receiver, coding, etc, for Earth-Moon-Earth (EME) and improvements were made in the design of the parabolic dishes. So, a large number of equipment and propagation effects are required providing interesting challenges for Moonbounce and estimates of minimum antenna sizes and transmitter powers have to be made on each amateur band. Along with this, efficient digital mode is to be designed for communication with weak signals that will compress user messages into a compact form along with addition of multi-fold redundancy in form error-correcting code. Such codes ensure recovery of full message with great confidence, even when various transmitted signals get corrupted or lost. Digital techniques will be made to create Digital EME communication, which will allow much less power and much smaller dielectric lens antennas for Moonbounce. There will be new modes made to allow photographs to be bounced off the Moon, much clearly with less power usage.

II. ANTENNAS FOR EME

A. Construction of Dielectric Lens Antennas

The entire Earth-Moon-Earth communications can be made advanced using dielectric lens antennas with reduced dimensions. The guided surface waves are enhanced using this dielectric lens which has an elliptical formation.

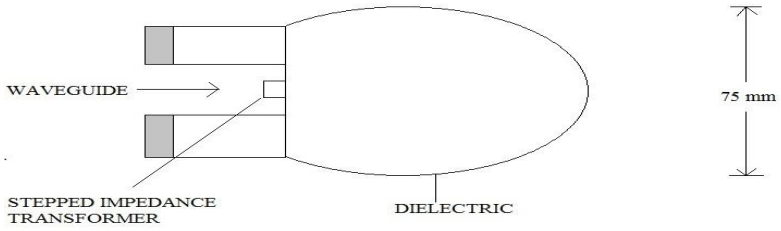


Fig. 1 Dielectric Lens Used in Radio Telescope

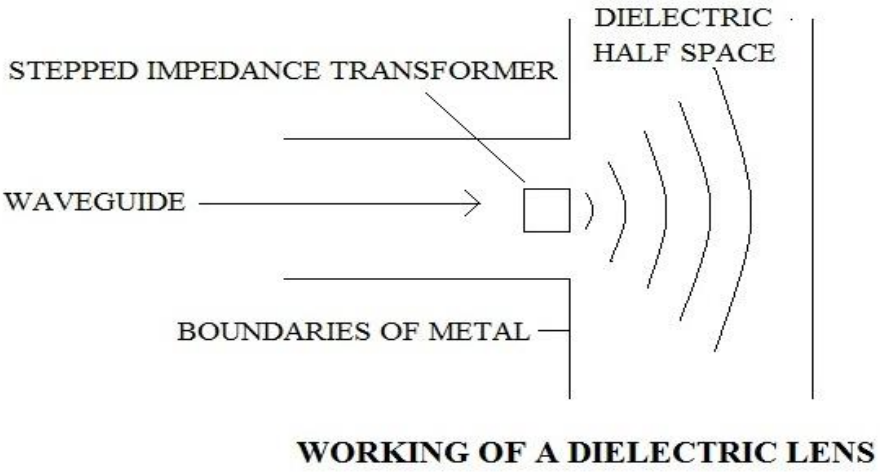


Fig. 2 Working of Dielectric Lens in Radio Telescope

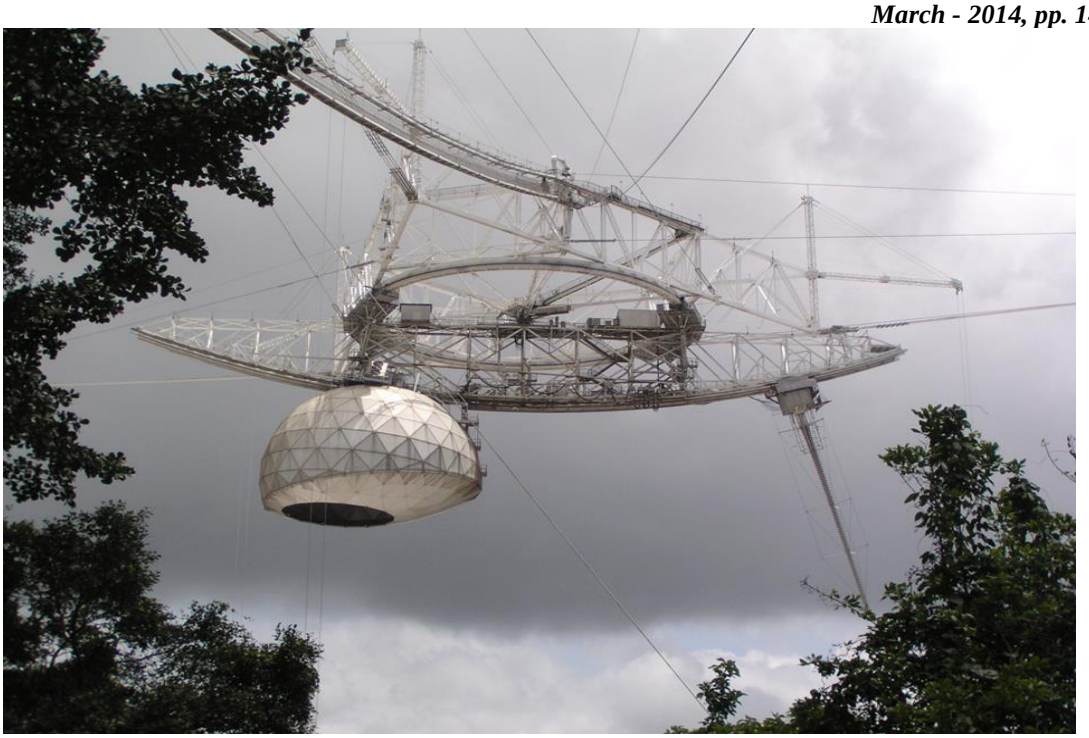
The dielectric lens antenna is fed by a circular waveguide along with providing broadband input matching impedance using a stepped impedance transformer. Good input matching impedance is shown by the transient input impedance with multiple reflections inside the dielectric lens. This dielectric antenna with usable frequency range provides propagation field with the guided surface wave for radiated field focussing for higher gain. A small portion of signal is reflected after reaching the surface and that portion gets absorbed at the port. Hence, a robust dielectric antenna must be designed to have high aperture efficiency.

B. Radio Telescope at Arecibo Observatory

The World's Largest Aperture Radio Telescope was set up at Arecibo Observatory

"Courtesy of the NAIC-Arecibo Observatory, a faculty of the NSF"
www.niac.edu/public/about/photos/hires/ao001.jpg

Fig. 3 World's Largest Single Aperture Radio Telescope at Arecibo Observatory in Puerto Rico



Closest View of World's Largest and Most Sensitive Radio Telescope located in Arecibo Observatory, Puerto Rico
Fig. 4 The above picture is taken during Moonbounce by Mr. Patrick Barthelow, a Ham Radio Operator for 40 years

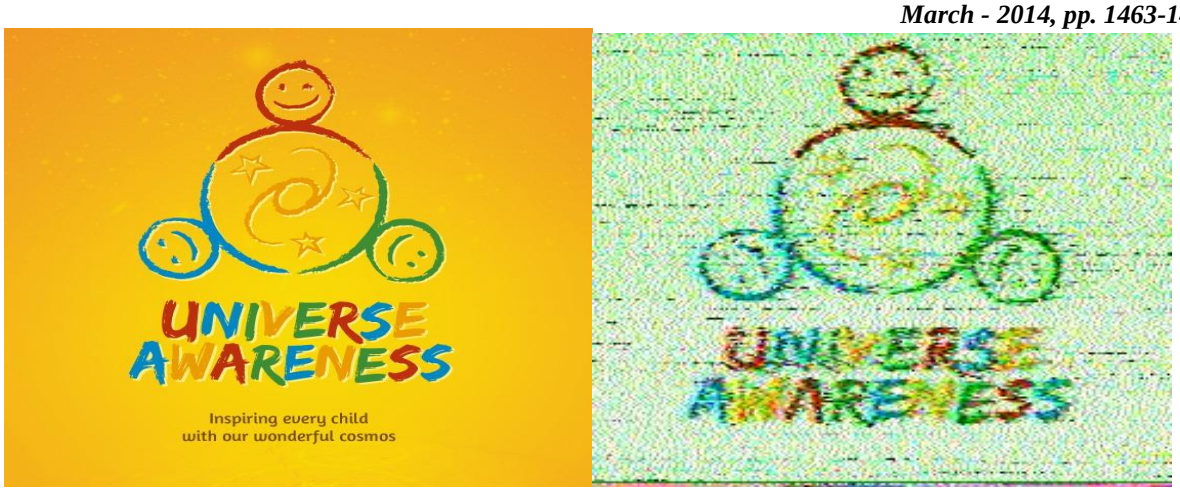
C. Giant Metrewave Radio Telescope Antenna at Pune, Maharashtra, India.

The GMRT consists of 30 steerable gigantic parabolic dishes of 45m in diameter and each dish is spread over distances about 25kms. It can be used in Future Moonbounce communication.

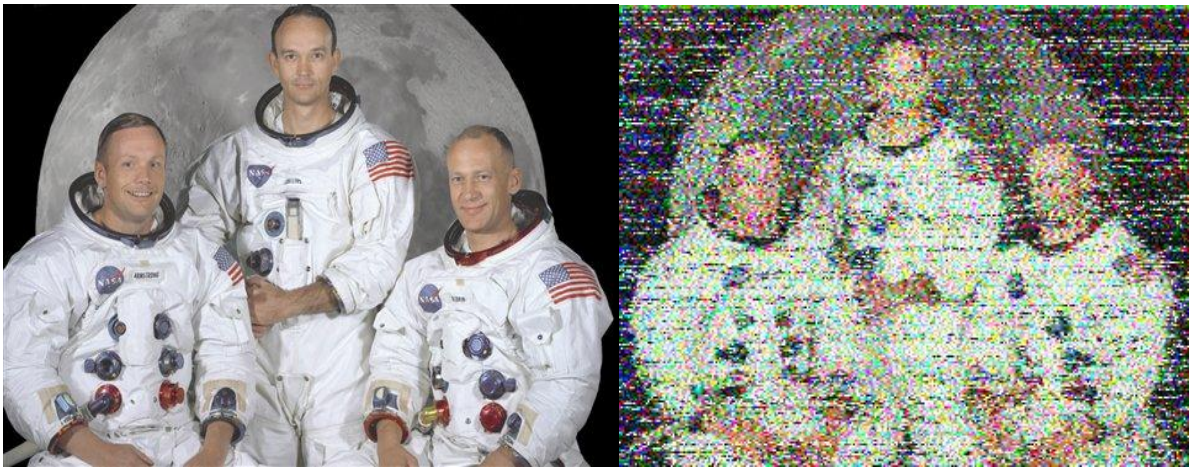
"Courtesy of the GMRT Tata Institute of Fundamental Research"
http://gmrt.ncra.tifr.res.in/gmrt_hpage/Gmrt_Images/7.jpg
Fig. 5 The above picture is taken by Mr. Pravin Raybole of GMRT Antenna located in Pune, Maharashtra, India; Future Moonbounce

D. Images bounced off the moon

The Moonbounce Imaging is a good technique to bounce images off the Moon using big dish stations and dusty pictures are obtained on Earth using sophisticated antennas.



"Courtesy of the Worldwide Science Outreach Organization"
http://www.unawe.org/
Fig. 6 The image is Moonbounced on 4th October 2011



"Courtesy of Smithsonian National Air and Space Museum"
https://airandspace.si.edu
Fig. 7 Apollo 11 Crew photo Moonbounced

III. CONCLUSIONS

There is a need for good equipment to successfully bounce a signal off the Moon using Digital Moonbounce Dielectric Lens Antennas. There is a use of antennas with high directivity and rotation in both elevation and azimuth planes. Moonbounce communications benefit society by bouncing off photos through crater walls, mountains, etc. done by amateur radio operators.

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