International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 353-358 www.ijaem.net ISSN: 2395-5252

A Novel Reflector Antenna with Feed of Dipole arm Based Microstrip Antenna

Aditya Kumar[1], Dharmendra Kumar Singh[2]
Department of Electronics Engineering, Harcourt Butler Technical University
208005 Kanpur, UP, INDIA

Date of Submission: 10-06-2020 Date of Acceptance: 27-06-2020

ABSTRACT: A novel, simple geometry and focal feed Reflector antenna having a microstrip antenna as a feed is proposed. The proposed reflector antenna consist of feed as microstrip antenna which caused minimum blockage to the reflected wave by the reflector due to its vertical polarization. The microstrip antenna can be fixed at the focus of the reflector using single strut support in this way it has minimum blockage.The feed antenna is a printed yadi-uda based microtrip patch antenna.It has two dipole arms one is below the substrate and other is above the substrate. A thin microstrip line is used as a feed of the system with the ground plane is used such that it provides impedance matching with the feed. The diameter of reflector is 45 cm whereas its f/d ratio is taken as 0.25. The feed antenna dimension is in millimetre range with thickness of 1 mm. so the radiation is blocked by feed is only 1 mm thickness.It shows good gain of 18.2 dBi at 3 GHz with an angular width of 17.6^o.

I. INTRODUCTION

For achieving the high gain and less complexity in structure by different communication systems like mobile communication and satellite communication, Reflector antennas are mostly used. Reflector antennas consist of two parts, one is feed antenna and other is reflector surface. Feed antennas of reflector are normally made of horn antennas, coaxial waveguides [1], [2], coffee can feed antennas, sometimes patch and slot antennas [3]. These feed antennas are fixed at the focus of main parabolic reflector surface yet the reflectors blockage is incremented, radiation pattern and gain are reduced due to providing a place for feed antenna system at the focus of reflector. The cross polarization and the side lobe of radiation pattern deteriorated by the support system of the feed antenna. Some solutions of the above problem were tried to resolved by ring [4], [5], cup [6], hat [7], [8], plate [9], [10] structured feed antennas. There are many techniques that are used in the feeding system of reflector antenna such as focal feed system, offset parabolic antenna feed system and cassegrain feed system [11]. In terms of light weight, reduced size and low complexity in geometry, microstrip antennas are most suitable. They also actively adapt to the fabrication techniques i.e. hybrid as well as monolithic integrated circuits at microwave frequency techniques [12]. Initially, Circular horn feed are used in reflector because of their good mechanical and electrical characteristics and its ease of geometry. Due to low cost fabrication and light weight of microstrip antennas, they have variety of applications. For evaluation of the radiation characteristics of the microstrip feed antennas, a numerical solution is presented for the circular feed antenna with a finite ground plane. Some modifications in ground plane have been done for reducing the back lobe level as well as cross polarization. For reducing the back lobe, concept of using a quarter wavelength chocks on the ground plane is also introduced. The effect of chocks is most effective on large antennas. Still these types of feeds required struts for support that block a large aperture area [13]. A printed dipole feed with dipole reflector is used as a feed with a single strut support, reduced blockage and cross polarization. This system is very light weight and low cost [14]. In a specific recurrence run, the period of the reflected wave and the period of the episode wave is equivalent, so this artificial magnetic conductor (AMC) based reflector is utilized for that antennas which has small height [15]. The feed of antenna is a significant piece of powerful and very much planned for reflector antenna [16]. Since the deviated structure of an offset parabolic reflector makes divergence of the circularly polarized waves example tops [17]. The cross polarization execution of a conservative offset feed reflector antenna having good balance edge is concentrated with essential feed antenna like a round and hollow multimode creased horn [18].A Yagi-uda antenna having branches like tree in its structure proposed. It is a dual band antenna which has frequency range of 915-935 MHz and 1760-1805 MHz. It provides a good gain of 5.6 dBi in its frequency range [19].a 3D printed and low profile antenna which provides vertical polarization. It is an ultra- wide band antenna whereas its size is also compact. It has one more property that its radiation pattern is omnidirectional. This proposed antenna has a triangular feed with a triangular shorted structure having two metallic parasitic pins and a hat like structure on top for providing capacitance. It is basically 3D version of inverted F antenna which is used for ultra-wide band ranges. By doing one more modification i.e. adding a small gap inside the antenna in the proposed model they made a band notch antenna with a bandwidth of 100 MHZ in the range of 2.4-2.5 GHz [20].

II. REFLECTOR ANTENNA DESIGN

Reflector is in the shape of parabolawhich has property if waves are coming from the focus of the parabola then its reflected back parallel with the main axis of parabola. In the reflector antenna there are two parameter on which design is based first one is diameter (D) of the parabolic reflector and second is focus to diameter ratio (F/D). F is the focal length of the parabola. In this model focal feed system is used so the diameter of the parabolic reflector is 45 cm and F/D ratio is taken .25. Therefore the focus is at 11.25 cm on the main axis of the parabolic reflector.Fig.1 shows the design of parabolic reflector with microstrip antenna feed which is taken from the simulating environment whose name Computer Simulation Technology (CST) Microwave Studio. These designing parameters are calculated with the help of basic concept of reflector antenna and mathematical equations.

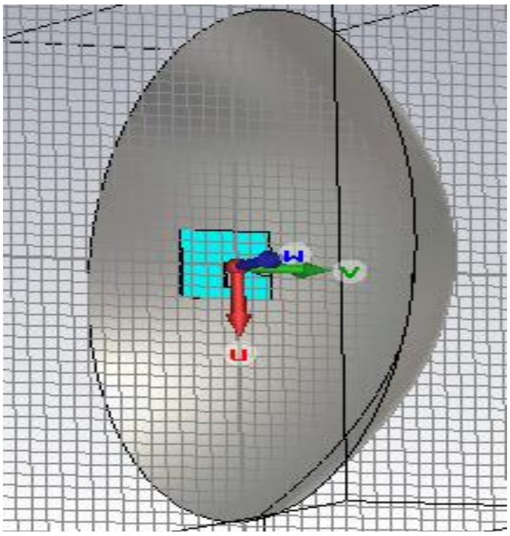

Fig.1 Parabolic reflector antenna with microstrip antenna feed

III. DESIGN OF FEED ANTENNA

The geometry and co-ordinate system of the proposed feed antenna are shown in Fig. 2. The antenna is designed for operation at 3 GHz and is printed on a substrate with metallization on both sides. The two arms of the dipole antenna act as a driver element, which is fed from a microstrip line through a two parallel strips transmission line. The arms of the dipole are located at the end of this transmission line, placed on either face of the substrate in a complementary manner, which creates 180^0 phase difference between the arms, providing the correct feed to the antenna. The length of the printed dipole, i.e. the driver length L_{DRI}= 40 mm, which is basically half wavelength, is chosen through numerical simulation. It is found numerically to be about 0.4 λ_0, indicating that the substrate effective permittivity is about 1.56. Substrate length = width = 60 mm taken .The width of the dipole arm, WDRI is chosen approximately to be one-tenth of a wavelength based on iteration process to achieve good radiation patterns and impedance bandwidth. Length of microstrip line LFeed = 23 mm is tken.The metallization on the bottom plane is a truncated ground plane, and behaves like a director element for the antenna.It is called a “truncated ground plane” because its width WGP, perpendicular to the microstrip feed transmission line, is reduced to less than 4 times the width of the microstrip line. The ground width Wgp = 16 mm and driver arm Ldri = 40 mm and width is Wdri = 8mm. The length of the ground plane L2+L3= 10+7 mm can be set to any length as long as the impedance of the line matches a 50 Ω impedance.The dipole-reflector is placed parasitically on the upper face of the substrate opposite to the ground plane. The main goal of designing the dipole-reflector is to direct the radiation backward, toward the microstrip feed line. Its length LREF is set slightly larger than the driver length, LDRI similar to Yagi antenna case. Its width WREF = 12 mm is chosen approximately to be one-tenth of a wavelength based on iteration process to achieve good radiation patterns and impedance bandwidth. The separation between the driver element and dipole-reflector element is set approximately to one twentieth of the wavelength. This selection is based on the coupling nature between the dipole-reflector and driver element. The dipole length is Lref = 45 mm and width Wref = 8 mm. The feeding structure consists of a microstrip line on one side of the substrate and truncated ground plane on the other side, both connecting to two arms of a parallel strip transmission line L1 = 6 mm that feeds the dipole, as shown in Fig. 1.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 353-358 www.ijaem.net ISSN: 2395-5252

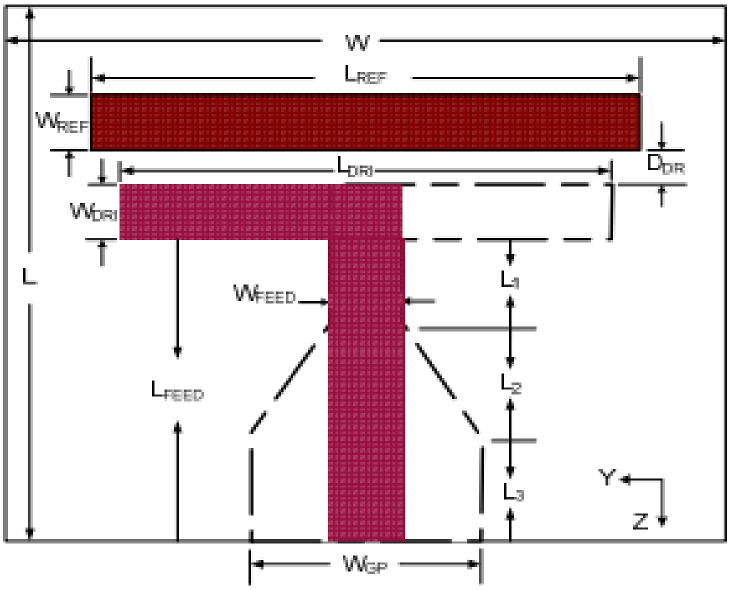

Fig. 2 Design of Feed Antenna

Using this simplified feeding structure, the length of the feed transmission line and consequently, the feed losses are reduced; although, the length should be carefully selected as it affects the radiation patterns of the feed antenna. The width of the microstrip line WFEED = 4.2 mm is set for the characteristics impedance of a 50 Ω [18], based on the substrate thickness t= 1.58, and relative permittivity εr = 2.5 . Fig.3 shows the front and back view of feed antenna.

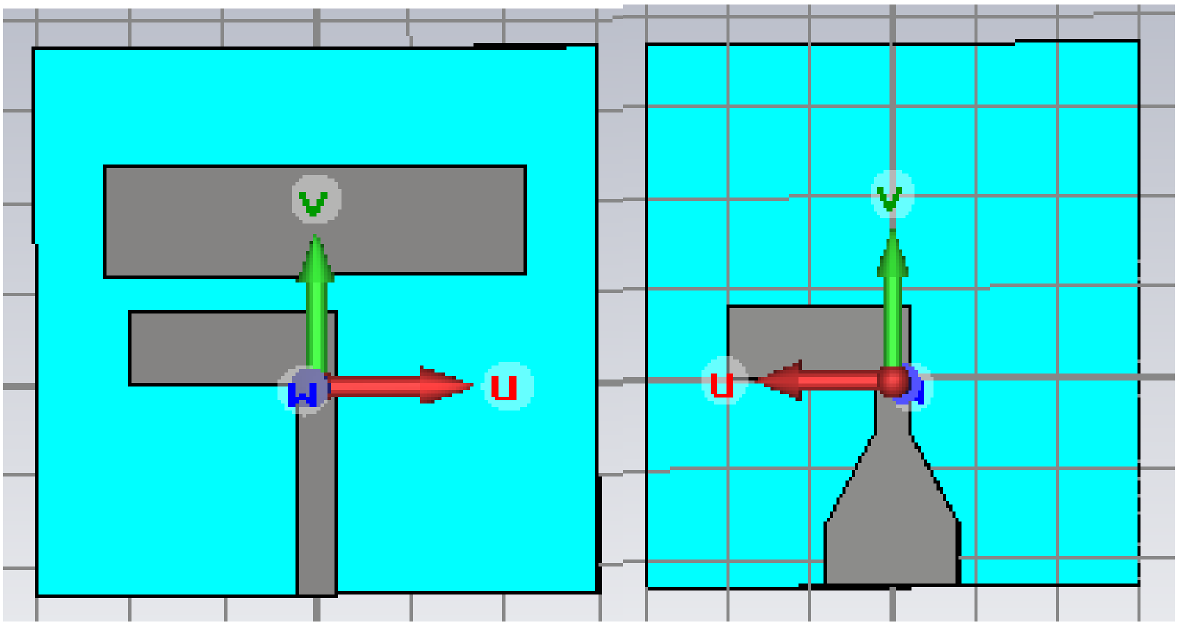

Fig. 3 Front and Back View of Feed Antenna

IV. RESULTS AND DISCUSSION

In this model the output parameter like gain and angular width is quite good. As it shown in Fig. 4 which is a plot of gain vs frequency. The operating range of antenna is taken from 2-4 GHz. Initially gain is 10 dBi at 2 GHz frequency than it increase to 3 GHz and maximises. The gain of this antenna is18.2 dBi which is maximum at 3 GHz frequency. After that it decreases very slowly to 4 GHz and vaue at 4GHz frequency is 17.9 dBi.

International Journal of Advances in Engineering and Management (IJAEM)
Volume 2, Issue 1, pp: 353-358 www.ijaem.net ISSN: 2395-5252

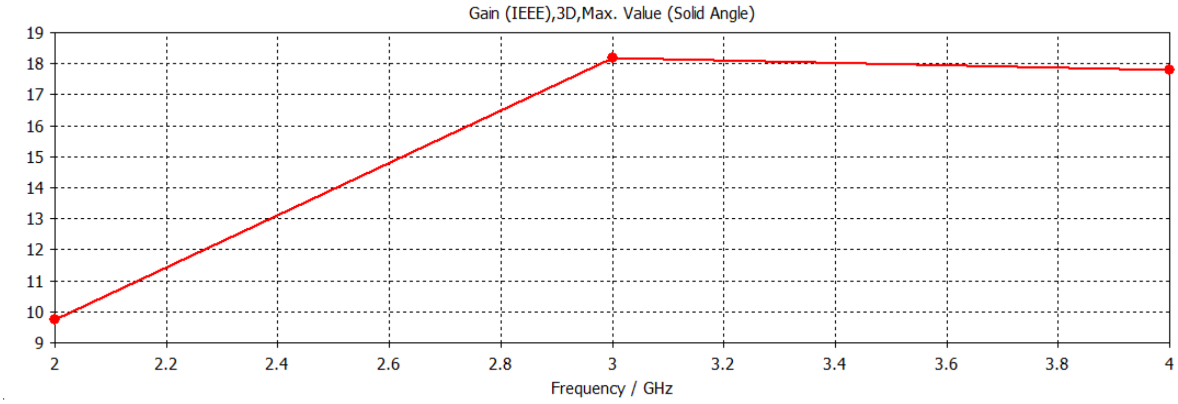

Fig. 4 Gain vs Frequency plot

The 3-D radiation pattern of the reflector antenna is shown in Fig.5. The pattern is symmetric and directive in desired direction with a high gain of 18.2 dBi. These pattern is calculated 3GHz frequency. The pattern is quite denser in the reflected wave direction.

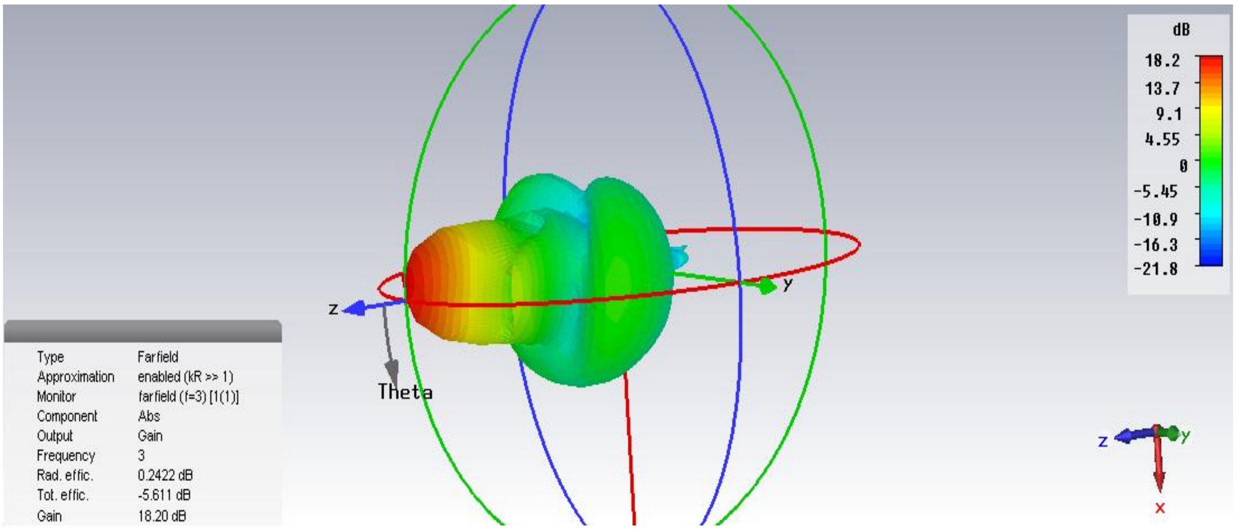

Fig.5 3D Radiation Pattern of Reflector Antenna

The polar plot of the radiation pattern tells us about the main lobe direction with its gain and angular width. In the fig. 6 polar plot of the radiation pattern is shown. Its main lobe is directed in -3 degree and wit gain of 18.4 dBI main lobe magnitude. Its angular width is 17.2 degree. All the values of it are calculated at 3 GHz.

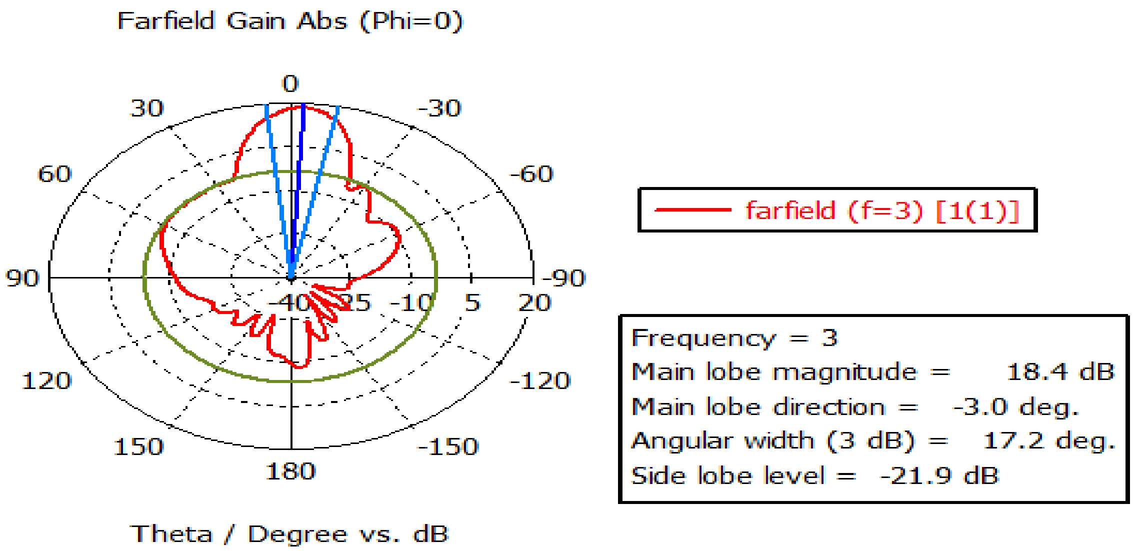

Fig. 6 Polar Plot of the Radiation Pattern

V. CONCLUSION

A reflector antenna with simple geometry with feed of a dipole arm with its patch based microstrip antenna is presented in this paper.The gain of reflector antenna is 18.2 dBi in desired direction with an angular width of 17.2 degree. All the parameters are calculated at 3 GHz frequency The radiation pattern is also symmetric and denser.

REFERENCE

[1]. A. D. Olver, P. J. B. Clarricoats, A. A. Kishk and L. Shafai, Microwave Horns and Feeds, London, UK: Institute of Electrical Engineers, ser. 39, 1994.
[2]. P. J. B. Clarricoats and A. D. Olver, Corrugated Horns for Microwave Antennas, London, UK:Peter Peregrinus, 1994.
[3]. Telsang, Abhishek, B. V. Srividya, and Sandeep Vedargarbham. "A Study on Reflector Antennas and Design of Reflector Antenna for 5GHz Band." 2017
[4]. P-S. Kildal and S. A. Skyttemyr, “Dipole-disk antenna with beamforming ring,” IEEE Trans. Antennas Propag., vol. 30, no. 4, pp. 529- 534, 1982.
[5]. C. C. Cutler, “Parabolic-antenna design for microwaves, “in Proc. of the I. R. E., vol. 35, no. 11, pp. 1284-1294, 1947.
[6]. G. T. Poulton and T. S. Bird, “Improved rear-radiating waveguide cup feeds,” in Proc IEEE Antennas Propag. Int. Symp.,.M. Young, The Techincal Writers Handbook. Mill Valley, CA: University Science, vol. 1, pp. 79-82,1989.
[7]. P-S. Kildal, “The hat feed: a dual-mode rear-radiating waveguide antenna having low cross polarization,” IEEE Trans. Antennas Propag., vol. 35, no. 9, pp. 1010-1016, 1987.
[8]. J. Hansen, A. A. Kishk, P. -S. Kildal, and O. Dahlsjo, “High performance reflector hat antenna with very low side lobes for radio-link applications,” in Antennas Propag. Soc. Int. Symp., vol. 2, pp. 893-896, 1995 .
[9]. G. L. James and D. P. S. Malik, “Towards the theoretical design of splash-plate feeds,” Electron. Lett., vol. 11, no. 24, pp. 593-594, 1975.
[10]. P. Newham, “A high efficiency splash plate feed for small reflector antennas,” in Proc. IEEE Antennas Propag. Int. Symp, pp. 420-423, 1985.
[11]. Telsang, Abhishek, B. V. Srividya, and Sandeep Vedargarbham. "A Study on Reflector Antennas and Design of Reflector Antenna for 5GHz Band.", 2017.
[12]. D. M. Pozar, and D. Schaubert, Microstrip Antennas: The Analysis and Design of Microstrip Antennas and Arrays, London, UK: Institute of Electrical Engineers, 1994.
[13]. A. A. Kishk and L. Shafai, “Optimization of microstrip feed geometry for prime focus reflector antennas,” IEEE Trans. Antennas Propag., vol. 37, no. 4, 1989.
[14]. Qudrat-E-Maula, Mohmamad, and Lotfollah Shafai. "Low-cost, microstrip-fed printed dipole for prime focus reflector feed." IEEE Transactions on Antennas and Propagation 60.11 5428-5433, 2012.
[15]. J. Joubert, J. C. Vardaxoglou,W. G. Whittow, and J.W. Odendaa, “CPWFed cavity-backed slot radiator loaded with an AMC reflector,” IEEE Trans. Antennas

Propag., vol. 60, no. 2, pp. 735–742, Feb. 2012.

[16]. Ali, S. M., Zakariya, M. A., Baharudin, Z., Khir, M. H. M., Baba, A. A., Adz, J. J., ... & Othman, M. A. (2012, December). Recent advances in microwave reflector antenna technology. In 2012 IEEE AsiaPacific Conference on Applied Electromagnetics (APACE) (pp. 287-292). IEEE.

[17]. Thomas A. Milligan, Modern Antenna Design, 2nd ed., IEEE Press: Jhon Wiley & Sons, 2005, pp. 399– 405

[18]. Makwana, B. J., Sharma, S. B., & Parikh, K. (2016, June). A multimode feed for compact offset parabolic reflector antenna system. In 2016 IEEE Indian Antenna Week (IAW 2016) (pp. 8-10). IEEE.

[19]. Xin, Q., Zhang, F., Sun, B., Zou, Y., & Liu, Q. (2010, November). A novel dual-band Yagi-Uda antenna for wireless communications. In Proceedings of the 9th International Symposium on Antennas, Propagation and EM Theory (pp. 289-292). IEEE.

[20]. Koohestani, M., Zürcher, J. F., Moreira, A. A., & Skrivervik, A. K. (2014). A novel, low-profile, vertically-polarized UWB antenna for WBAN. IEEE Transactions on Antennas and Propagation, 62(4), 1888-1894

Aditya Kumar, et. al. “A Novel Reflector Antenna with Feed of Dipole arm Based Microstrip Antenna ." *International Journal of Advances in Engineering and Management (IJAEM)*, 2(1), 2020, pp. 353-358.

International Journal of Advances in Engineering and Management

ISSN: 2395-5252

IJAEM

Volume: 02 Issue: 01 DOI: 10.35629/5252

www.ijaem.net

Email id: ijaem.paper@gmail.com