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A Novel 6G based Antenna System for Marine Communication

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Abstract

The work discussed proposes a novel 6G based antenna system using Intelligent Reflecting Surface (IRS) for efficient communication over the ocean. Offshore people in travel, fishing or staying as part of their work have no facility for communication using cellular or Wi-Fi networks. Even the information about the warnings depending upon the sea states could not be passed due to the lack of an efficient communication system. So using IRS assisted MIMO systems with line of sight communication having terahertz antennas, placed on the ships/boats/fishing vessels/any other structures could ensure complete coverage and connectivity for the people offshore.

Keywords: 6G, Antenna, Intelligent Reflecting Surface (IRS), Terahertz.

1. Introduction

In India, the present mode of communication using mobile phones is either using 3G or 4G connectivity [1-3]. The connectivity using these technologies is based on radio waves and does not require any line of sight for communication [4-5]. But for those who are traveling in ships or fishing vessels, there is no way to communicate via mobile phones as the connectivity of mobile phones extend only upto 15-20 Km towards the ocean from the shore [6-9]. Moreover the propagation of waves through the marine environment is entirely different from that of land [10]. Over the sea, reflections are higher and the mode of propagation is entirely different. A solution to all these issues with the development of high speed high data rate 6G communication using Terahertz - IRS based antennas is proposed in this paper [11].

6G is the sixth generation standard for wireless communication supporting the cellular mobile networks after 4G and 5G. 6G networks will use higher frequencies for communication, usually terahertz antennas using IRS integrated with MIMO systems [12-15]. With the implementation of 6G technology all the devices will be connected over the internet like the Internet of things (IoT) network in the 4G and 5G networks [16].

Antennas are the key components in any wireless communication system for transmission [17]. Using long range Wi-Fi transmission of signals offshore is possible with the help of microwaves. But as studies show, the continuous exposure of high power microwave radiation could lead to health issues to the living communities, its better to test with the terahertz frequency for long range line of sight communication [18-19]. In the 6G communication, terahertz antennas with Intelligent Reflecting Surface (IRS) are used. IRS is an advanced technology which could improve the performance of wireless communication systems [20-21]. The IRS units consist of a large number of smaller intelligent units that could transmit high data rates with line of sight communication. The overview of the system implementation of 6G integrated with IRS and MIMO technology for marine communication with its challenges is described in the below sections.

2. System Design

The marine communication can be enhanced with the 6G integrated with IRS and MIMO technology. The system architecture for the marine communication scenario is represented in Figure. 1. This scenario of the operation is based on considering the ocean parameters, antenna used for communication, speed of the fishing vessels and all the environmental conditions. By considering all the parameters the IRS based system is introduced in the marine network. The signal from the base station is transmitted using the sector antenna. The IRS integrated surfaces within the marine environment like the ships, boats, fishing vessels etc. at the first level could get connectivity through these IRS antennas on the transmitting sector antenna. That is, these signals pass

through the ocean surface and reach the intermediate point. In this case the fishing vessel is considered an intermediate node with the IRS placed on its surface. When the signal from the base station falls on its surface based on its property it has the ability to enhance the received signal strength and be transmitted towards the next level. These surfaces integrated within the boats will act as both transmitter and receiver.

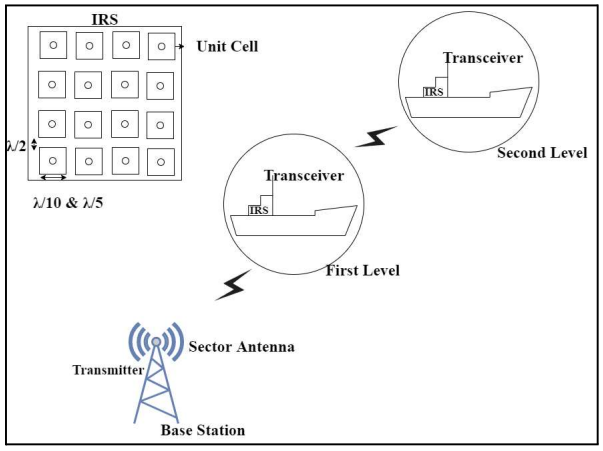

Figure 1. System architecture integrating 6G IRS to marine communication.

IRS on the first level boat enhances the signal strength and communicates with the nearby boat further. The intermediate IRS installed boat could receive the signal from the transmitting antenna from the shore and could amplify the signal and could act as the transmitting section for the second and other higher levels. Based on the dimension of the patches on the IRS, the enhancement of the signal strength could be done. The interspacing distance between the patches will lead to the pattern orientation and phase configuration. Similarly the higher level communication between the boats can be continued. So same as the scenario, the operation of the system can be controlled and enhances marine communication in an effective way.

3. Research Challenges

Eventhough 6G based IRS technology could provide complete connectivity, certain challenges in the area have to be considered. A few challenges related to the study are as follows:

- Dynamic reconfiguration of IRS at marine environment.
- Digital beam forming and implementation of huge antenna arrays at the base station.
- Complex physical layer designs.
- Accuracy in setting the focus of incident electromagnetic waves.
- Coordination of IRS systems and estimation of channel state information (CSI) from multiple IRS units installed within the system.

4. Conclusion

The paper gives an overview about the 6G IRS integrated network for wireless communication. Using the technology, complete coverage could be ensured to the marine people who are working in ships, gone for fishing or for travel purposes. IRS technology offers energy saving solutions for retransmission of the signals without modulation, enhanced security, high interference suppression over existing marine propagation models. These systems could convert the existing marine communication to low cost with least propagation loss making the marine communication smarter.

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References

1. Yadav, P., Upadhyay, A., Prasath, V.B., Ali, Z. and Khare, B.B., 2021. Evolution of Wireless Communications with 3G, 4G, 5G, and Next Generation Technologies in India. In Advances in Electronics, Communication and Computing (pp. 355-359). Springer, Singapore.
2. Ezhilarasan, E. and Dinakaran, M., 2017, February. A review on mobile technologies: 3G, 4G and 5G. In 2017 second international conference on recent trends and challenges in computational models (ICRTCCM) (pp. 369-373). IEEE.
3. Chandramohan, J., Nagarajan, R., Satheeshkumar, K., Ajithkumar, N., Gopinath, P.A. and Ranjithkumar, S., 2017. Intelligent smart home automation and security system using Arduino and Wi-fi. International Journal of Engineering And Computer Science (IJECS), 6(3), pp.20694-20698.
4. Alsemmeari, R.A., Bakhsh, S.T. and Alsemmeari, H., 2016. Free space optics vs radio frequency wireless communication. Int. J. Inf. Technol. Comput. Sci, 8(9), pp.1-8.
5. Kim Geok, T., Zar Aung, K., Sandar Aung, M., Thu Soe, M., Abdaziz, A., Pao Liew, C., Hossain, F., Tso, C.P. and Yong, W.H., 2020. Review of indoor positioning: Radio wave technology. Applied Sciences, 11(1), p.279.
6. Rao, S.N., Ramesh, M.V. and Rangan, V., 2016, October. Mobile infrastructure for coastal region offshore communications and networks. In 2016 IEEE Global Humanitarian Technology Conference (GHTC) (pp. 99-104). IEEE.
7. Raj, D., Parthasarathy, V., Rao, S.N. and Ramesh, M.V., 2017, January. Performance assessment of an

extremely challenged mobile infrastructure network over the oceans. In Proceedings of the 18th International Conference on Distributed Computing and Networking (pp. 1-6).

8. Rao, S.N., Raj, D., Aiswarya, S. and Unni, S., 2016, May. Realizing cost-effective marine internet for fishermen. In 2016 14th International Symposium on Modeling and Optimization in Mobile, Ad Hoc, and Wireless Networks (WiOpt) (pp. 1-5). IEEE.
9. Rao, S.N., Raj, D., Parthasarathy, V., Aiswarya, S., Ramesh, M.V. and Rangan, V., 2018, April. A novel solution for high speed internet over the oceans. In IEEE INFOCOM 2018-IEEE Conference on Computer Communications Workshops (INFOCOM WKSHPS) (pp. 906-912). IEEE.
10. Bulleri, F. and Chapman, M.G., 2010. The introduction of coastal infrastructure as a driver of change in marine environments. Journal of Applied Ecology, 47(1), pp.26-35.
11. Chowdhury, M.Z., Shahjalal, M., Ahmed, S. and Jang, Y.M., 2020. 6G wireless communication systems: Applications, requirements, technologies, challenges, and research directions. IEEE Open Journal of the Communications Society, 1, pp.957-975.
12. Chen, Z., Ning, B., Han, C., Tian, Z. and Li, S., 2021. Intelligent reflecting surface assisted terahertz communications toward 6G. IEEE Wireless Communications, 28(6), pp.110-117.
13. Ji, B., Han, Y., Liu, S., Tao, F., Zhang, G., Fu, Z. and Li, C., 2021. Several key technologies for 6G: challenges and opportunities. IEEE Communications Standards Magazine, 5(2), pp.44-51.
14. Chen, Z., Ma, X., Han, C. and Wen, Q., 2021. Towards intelligent reflecting surface empowered 6G terahertz communications: A survey. China Communications, 18(5), pp.93-119.
15. Rajatheva, N., Atzeni, I., Bjornson, E., Bourdoux, A., Buzzi, S., Dore, J.B., Erkucuk, S., Fuentes, M., Guan, K., Hu, Y. and Huang, X., 2020. White paper on broadband connectivity in 6G. arXiv preprint arXiv:2004.14247.
16. Mahdi, M.N., Ahmad, A.R., Qassim, Q.S., Natiq, H., Subhi, M.A. and Mahmoud, M., 2021. From 5G to 6G technology: meets energy, internet-of-things and machine learning: a survey. Applied Sciences, 11(17), p.8117.
17. DurgaRao, K. and Pillai, K.N., 2020, June. Design array antenna using different feeding technique in HFSS. In 2020 International Conference for Emerging Technology (INCET) (pp. 1-4). IEEE.
18. Meenu, L., Aiswarya, S. and Menon, S.K., 2022. A novel and effective technique to reduce electromagnetic radiation absorption on biotic components at 2.45 GHz. Electromagnetic biology and medicine, 41(2), pp.184-200.
19. Meenu, L., Aiswarya, S. and Menon, S.K., 2020, October. A Survey on Heating Effects of Electromagnetic Radiation on Human Body. In 2020 5th International Conference on Computing, Communication and Security (ICCCS) (pp. 1-4). IEEE.
20. Wu, Q. and Zhang, R., 2019. Intelligent reflecting surface enhanced wireless network via joint active and passive beamforming. IEEE Transactions on Wireless Communications, 18(11), pp.5394-5409.
21. Cui, M., Zhang, G. and Zhang, R., 2019. Secure wireless communication via intelligent reflecting surface. IEEE Wireless Communications Letters, 8(5), pp.1410-1414.