AUTO INDOOR HYDROPONIC FODDER GROW CHAMBER

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Abstract: The goal of this project is to improve urban agriculture by developing and implementing a high-tech indoor hydroponic system. A sustainable and effective way to handle the problems associated with food production in urban environments is through the use of mineral fertilizer solutions in water, or hydroponics, a soilless plant culture technique. The goal of the project is to develop a small-scale, automated indoor system that maximizes yield while using the least amount of water and nutrients. The automated fertilizer delivery system, energy-efficient LED lighting tailored for various plant growth phases, and an integrated monitoring system that provides real-time data on plant health and environmental variables are some of the system's main advantages. Different plant species were cultivated in order to evaluate the adaptability and efficiency of the system. In comparison to conventional soil-based techniques, the results showed notable gains in crop quality and growth rates, as well as a 90% decrease in water consumption and improved nutrient absorption. The system is scalable due to its modular design, which makes it appropriate for both home and business use. Future developments will concentrate on enhancing automation capacities, integrating renewable energy sources, and increasing the range of plants that can be grown.

Keywords: Indoor Hydroponics, Urban Agriculture, Automated Nutrient Delivery, Energy-efficient Lighting, Sustainable Food Production, Real-time Monitoring, Modular Design, Water Conservation, Nutrient Efficiency.

1.Introduction

Urbanization is changing the food production landscape quickly, requiring creative solutions to keep up with the increasing demands of the urban population. There are several obstacles facing traditional agriculture, such as a lack of arable land, excessive water use, and the effects of farming methods on the environment. In this regard, hydroponics—a sophisticated technique that uses mineral nutrient solutions in water to produce plants without soil—emerges as a viable substitute. Numerous benefits come with an indoor hydroponic system, such as effective space utilization, water conservation, and the capacity to grow vegetables all year round regardless of the outside weather. Compared to conventional soil-based agriculture, hydroponics can provide larger yields and faster growth rates by managing the growing environment. Because of this, it is especially well suited for metropolitan environments, where there is a great demand for fresh produce that is cultivated nearby. The creation and application of a small, autonomous indoor hydroponic system designed for urban farming is the main goal of this project. The system is made to optimize crop yield while consuming the fewest resources possible, in line with sustainable farming methods. One of the system's main features is automated nutrient delivery, which minimizes waste and improves nutrient absorption by guaranteeing plants receive the exact amount of nutrients needed for healthy growth. Energy-efficient LED lighting: Lights made especially to deliver the right wavelengths during different phases of plant growth, encouraging wholesome growth while using the least amount of energy possible. The objective is to show that indoor hydroponics is a viable and sustainable response to the problems associated with urban agriculture. Upcoming advancements will center on improving automation, incorporating renewable energy sources, and broadening the variety of plants that may be grown.

2.Significance of the Study

A revolutionary approach to urban agriculture, the indoor hydroponic system solves a number of pressing issues with conventional farming practices. This system's contributions to resource efficiency, food security, sustainability, and urban resilience make it significant.
1. Sustainability
Because the indoor hydroponic system uses less soil and arable area, it encourages sustainable agricultural methods. Soil deterioration and erosion are key difficulties in traditional agriculture; this technology minimizes these issues by growing plants in a controlled, soilless environment. Furthermore, the system's design lessens the need for chemical herbicides and pesticides, improving ecosystem health and lowering pollution levels in the environment.

2. Food Security
Fresh vegetables supplied locally is in greater demand as urban populations continue to rise. A workable answer is provided by indoor hydroponics, which makes it possible to cultivate a wide range of crops year-round regardless of climatic or seasonal variations. This improves food security by guaranteeing a steady supply of fresh food and lessens reliance on lengthy supply lines that are prone to interruptions.
3. Resource Efficiency
The economical use of nutrients and water in hydroponic systems is one of their biggest benefits. Although hydroponic farming consumes up to 90% less water than traditional agriculture, it is still a great option for areas where water is scarce. By recycling nutrients and water, the closed-loop system ensures minimum waste and maximum plant development. This efficiency also applies to the usage of nutrients, as specific delivery systems minimize environmental effect and nutrient runoff.
4. Economic Opportunities
Adoption of indoor hydroponic systems can promote economic growth by generating new employment opportunities in technology development, maintenance, and urban farming. This can encourage entrepreneurship and innovation by causing a new sector of the urban economy to emerge. Ventures into sustainable agriculture technologies can also benefit from the possibility of scalable commercial applications.
5. Health and Nutrition
Urban dwellers' access to fresh, locally grown vegetables improves the nutritional value of the food they can eat. Vegetables cultivated hydroponically frequently have higher

nutritional contents because of the carefully regulated growth environment. By giving communities access to healthier food options, this can improve public health outcomes.

3.Objectives of The Study

The following are the goals of an indoor hydroponic system:

Maximize Crop Yield: By enhancing plant growth conditions, hydroponic systems seek to maximize the amount of produce grown in a given area.

Resource Efficiency: Use energy, water, and nutrients more effectively than with conventional soil-based agriculture. When combined with controlled environment agriculture (CEA), hydroponics can be more energy-efficient and generally consume less water.

Year-Round Production: Give farmers the capacity to cultivate crops all year round, irrespective of the outside weather, guaranteeing a steady supply of fresh produce.

Space Optimization: Make efficient use of indoor spaces by using vertical farming and other space-saving methods, such as urban settings, rooftops, basements, or other non-traditional agricultural locales.

Pest and Disease Control: Use of a soilless system can lower the prevalence of soil-borne pests and illnesses, reducing the need for chemical pesticides and herbicides.

Environmental Control: Allow for exact control over the distribution of nutrients, light, temperature, humidity, and other environmental factors. This can promote faster growth and better-quality produce.

Reduced Environmental Impact: Reduce the negative effects on the environment by conserving water, minimizing soil damage, and maybe utilizing renewable energy sources to power your equipment.

4.Proposed System

In hydroponics, plants receive water from the fertilizer solution you give them, carbon dioxide from the air, and sunshine from the sun or grow lights. In the natural world, plants depend on the soil to maintain them and supply nutrients. Growers that use hydroponics do away with the requirement for soil by creating a nutrient solution from nutrient-rich liquids or powders mixed with water. Additionally, the structure and support that soil often provides are substituted with soilless growing media such as rock wool, perlite, or coco coir, or with a straightforward plastic net cup. In deep water cultivation, a seedling is suspended above a nutrient solution reservoir with its stem and leaves in the air and its roots submerged in the liquid. While the leaves take in light and carbon dioxide, the roots take in water and nutrients. This is how hydroponics works: the plant receives all the nutrients it requires without the use of soil.

Here, the system is being automated with the use of an ATmega328p microcontroller. Grow lights, an alternative to sunshine, LED lights to chill the environment, a 5 volt power source, a cooling fan, humidity, temperature, moisture, pH, and float sensors are all used in this system. Moisture-based fodder cultivation is more appropriate in locations that are prone to drought and have very little water. For optimal results, hydroponic-based fodder cultivation has to maintain a moisture level of 80%. This system also adapts to the surrounding conditions, ensuring that water is used as efficiently as possible. This hydroponic system operates entirely automatically, calculating the amount of nutrients needed for plants based on data from sensors that track their concentration in the tank. By taking climate into account, the water requirements are satisfied and water disturbance is thus avoided. This setup also includes provisions for lights and a computer cooling fan that will function based on ambient circumstances to maintain appropriate humidity, temperature, and lighting.

In hydroponic systems, nutrient-rich water is essential for plant growth. It is necessary to dissolve in water a balanced mixture of vital nutrients that the plants need to receive on a regular basis. In order to solve this issue, we employ a float sensor to track the water and nutrient levels, and it uses a DC water pump to automatically deliver the nutrient solution to the plants. A computer cooling fan is used to regulate the temperature by expelling the heated air generated by the grow lights. In a similar vein, the LED lights lower the chance of heat burn to the plants by cooling the chamber. Plants can be protected against fungal infections by utilizing pH sensors to monitor and manage pH levels. Because hydroponics is a soilless method, growth media is necessary to sustain plant roots and maintain moisture levels. To resist the plants, we thus utilize the net cups.

5.Block Diagram

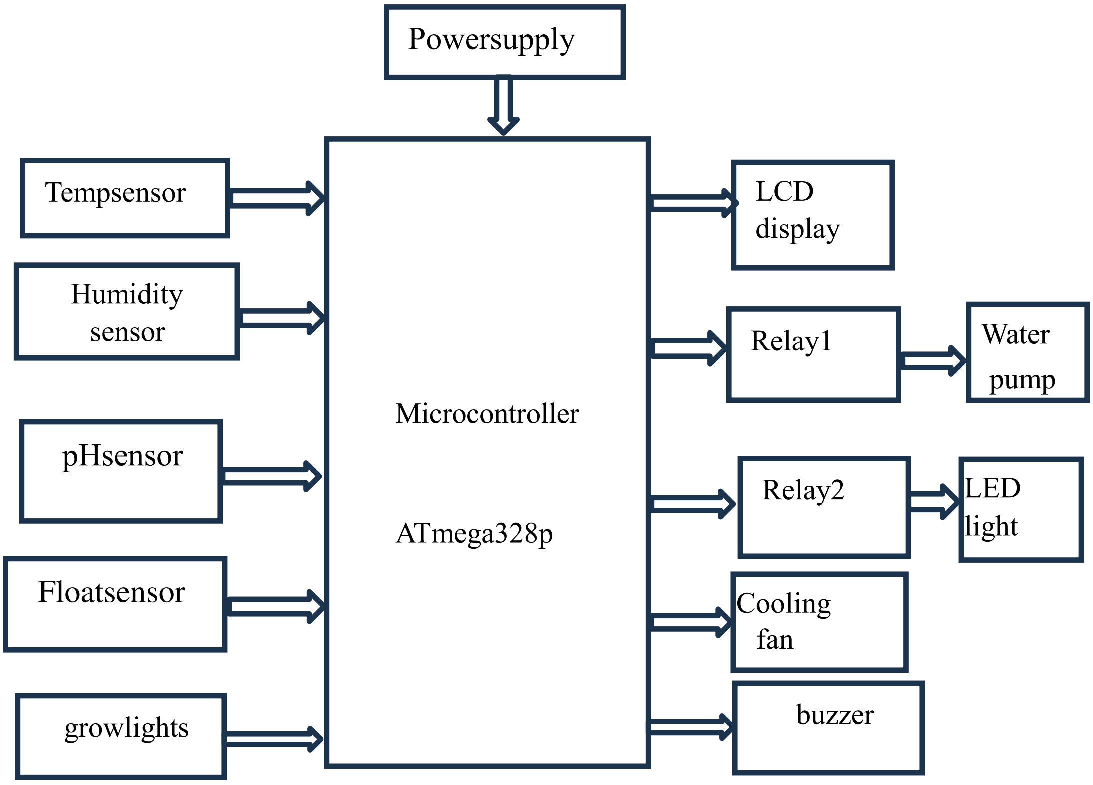


Fig 1 : Proposed block diagram for hydroponic system

6.Working Principle

The automated hydroponics system's basic operation is depicted in the block diagram above. It begins by gathering data from the system's sensors, including the Ph, humidity, and temperature sensors. The microcontroller will then calculate the difference between the desired and actual values for the PH and nutrition levels using the grow system settings that are programmed into it. The software will determine the approximate quantity of nutrients or acid/base that needs to be added to the system based on this calculation. An outline of the automated hydroponics system's operation can be found in the block diagram above. Initially, it gathers data from the system's sensors, including the Ph, temperature, and humidity sensors. The grow system's settings are then programmed into the microcontroller, which uses them to calculate the difference between the desired and actual values for the PH and nutrition levels. The estimated amount of acid/base or nutrients that need to be introduced to the system will be determined by the software using this computation.

7.Implementation

Set Up Hydroponic System: This stage entails putting the hydroponic system up from the ground up, which includes assembling the parts and getting the growing environment ready.

Add Nutrient Solution to Reservoir: The reservoir is filled with the nutrient solution, which contains the necessary elements for plant growth.

Environmental Parameters: Temperature, humidity, light intensity, and pH levels are just a few of the variables that sensors continuously track.

Are the parameters in their ideal range? Verify that the parameters being tracked are within the ideal range for plant growth. If not, an alarm might be generated and the system might need to be adjusted.

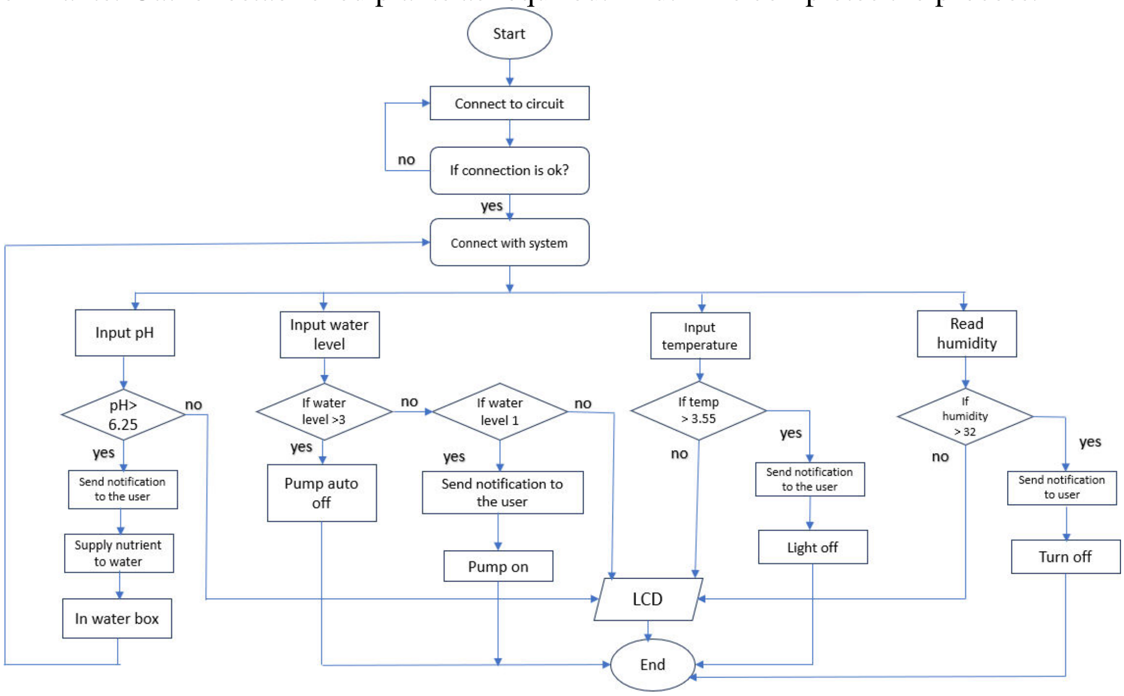
Activate Water Pump: The water pump is turned on to circulate the nutrient solution if all environmental factors are within the ideal range.

Nutrition Solution Circulation: The plants receive vital nutrients from the nutrition solution as it is circulated around them.

Track Plant Growth: Keeping an eye on a plant's growth helps make sure it's growing healthily.

Is Harvest Ready?: Using growth indicators, ascertain whether the plants are prepared for harvest. If not, keep an eye on things; if so, move on to the next action.

Gather Plants: Gather established plants as required. End: This completes the process.



8.Results

For hydroponic fodder production and growth to be optimized, environmental considerations are crucial. The typical range of environmental parameters, including temperature (19 to 22ºC), humidity (average 60%), light intensity (2000 lux), and pH(6.5 to 7.5).

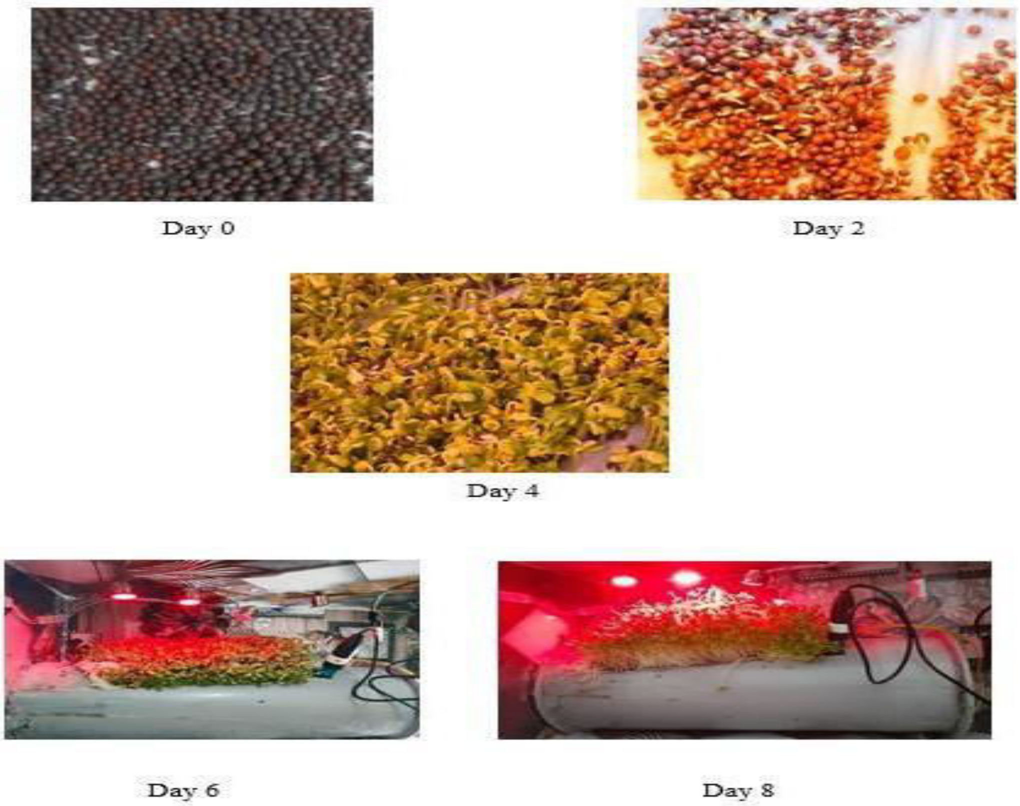


Fig: 2 Fodder Growth Observation

Table 1 – Observation of length of plant

Day’s	Height (Inch)
Day 0	0
Day 2	1
Day 4	2.8
Day 6	5.7
Day 8	7.5

Fig: 3 Observation of mustard plant

HYDROPONIC VEGETABLES TASTE

The short answer is that vegetables cultivated hydroponically do taste different from those grown on soil. To be more specific, the time of year and several factors such as soil type and quality affect plant flavors. The flavor of a tomato grown in your garden will differ somewhat from mine. The ability to regulate the growing environment for your plants is one of the best things about hydroponics. You can adjust temperature, moisture, and nutrient levels to get the flavor you want. on summary, there is no evidence to suggest that hydroponic plants taste any worse than those grown on soil, despite the possibility that plants produced in different environments have different tastes.

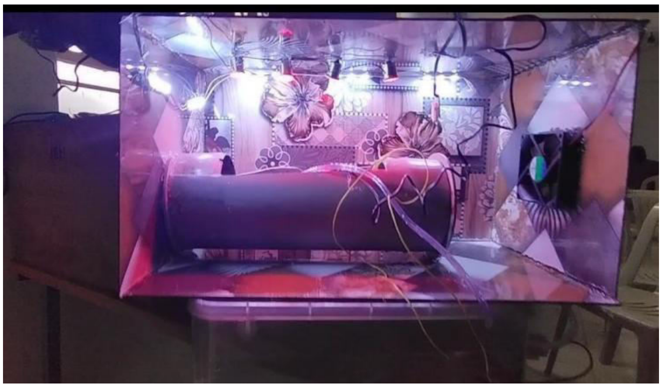


Fig: 4Automation hydroponic system

In general, following standard organic farming criteria can be difficult with hydroponic systems. The focus of organic farming is on using sustainable and natural methods, such as maintaining healthy soil and avoiding the use of artificial fertilizers, pesticides, and other chemicals. Synthetic nutrients may be used to feed plants in hydroponic systems, which grow plants in nutrient-rich solutions without the need for soil. The utilization of artificial ingredients may give rise to disagreements about the organic certification process.

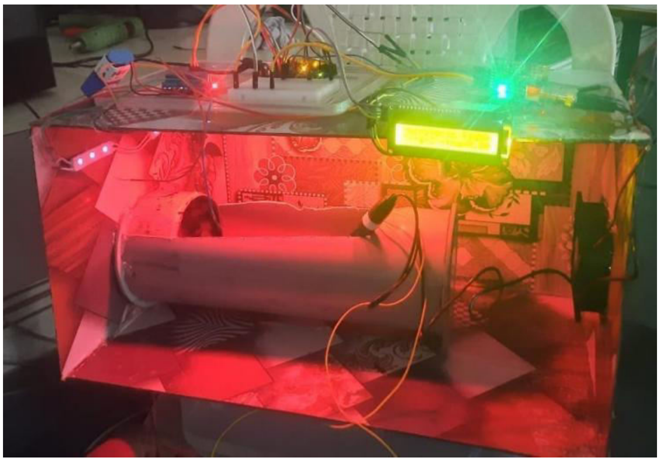


Fig: 5 Green vista hydroponic fodder grow hub

standardization of inexpensive hydroponic technology with resources that are readily available locally. germination rate estimation using seed soaking time and additional variables. Analysis of the production costs of several hydroponically produced feeds for animals. Evaluation of the immune system, growth potential, and fertility of young animals fed various hydroponic feeds.

Table 2- Hydroponic fodder nutrient comparison with traditional fodder farming

Nutrients	Traditional green Fodder (mustard)	Hydroponic green fodder (mustard)
Protein	10.69	13.59
Fibre	6.27	9.86
Nitrogen	51.79	66.78
Carbohydrate	25.97	30.27
Vitamins	22.03	29.24
Biotin	3.39	9.89
Insoluble Ash	1.42	0.35

From above we clearly observe that the hydroponic green fodder is highly nutritious than the traditional green fodder. In this, as the directly nutrients are supplied to the plants rather than the soil, so it gets highly nutritious fodder compared to the plants grown in soil. So, the hydroponic fodder is best choice to grow plants compared to the conventional farming.

Hydroponically grown fodder can be highly nutritious, providing essential vitamins and minerals for livestock. The controlled environment allows for optimized nutrient delivery to the plants, potentially resulting in higher nutritional content compared to traditional methods. Hydroponic systems often promote faster growth rates compared to traditional soil-based methods. This rapid growth can lead to a quicker turnover of fodder, allowing for more frequent harvests. Auto indoor systems can offer precise control over environmental factors such as temperature, humidity, light, and nutrient levels. Automation can streamline the growing process and reduce the need for manual intervention.

Fig: 6 Automation green vista hydroponic fodder grow hub

9.Conclusion:

Hydroponics is a type of agricultural technology that may be developed locally using inexpensive materials that produces more nutrient-dense, tasty, and digestible livestock feed. On a per kg dry matter basis, the technology is less competitive than traditional fodder production in industrialized countries where there is no shortage of high-quality feed and fodder. It provides a clever backup solution against land shortage and hinders climate change in India's various agroclimatic zones. Many nations are using it now for their sustainable cattle production.Hydroponic fodders are more profitable and beneficial than traditional feedings of cereal grains and concentrate mixture due to their higher palatability and digestibility. The net cost of producing hydroponically grown fodder increased significantly due to the large initial investment required for fully automated commercial hydroponic systems, as well as the high labor and energy costs associated with preserving the system's ideal environment. On the other hand, low-cost hydroponic systems have been created by leveraging locally accessible infrastructure in areas where there is a severe lack of fuel and fodder, excessive seasonal changes in fodder prices, and high transportation and fuel expenses.In these circumstances, the best option for sustainable livestock production is hydroponic fodder production, as the cost structure is frequently moved in its favor.

References

[1] Madhu Kumar Vanteru, K.A. Jayabalaji, i-Sensor Based healthcare monitoring system by LoWPAN-based rchitecture,Measurement: Sensors,Volume 28,2023,100826,ISSN 2665-9174,https://doi.org/10.1016/j.measen.2023.100826.

[2] Ramesh, P.S., Vanteru, Madhu.Kumar., Rajinikanth, E. *et al.* Design and Optimization of Feedback Controllers for Motion Control in the Manufacturing System for Digital Twin. *SN COMPUT. SCI.* **4**, 782 (2023). https://doi.org/10.1007/s42979-023-02228-8

[3] Madhu. Kumar. Vanteru, T. V. Ramana, *et al* , "Modeling and Simulation of propagation models for selected LTE propagation scenarios," 2022 International Conference on Recent Trends in Microelectronics, Automation, Computing and

Communications Systems (ICMACC), Hyderabad, India, 2022, pp. 482-488, doi: 10.1109/ICMACC54824.2022.10093514.
[4] Allanki Sanyasi Rao, **Madhu Kumar Vanteru** et al. (2023). PAPR and BER Analysis in FBMC/OQAM System with Pulse Shaping Filters and Various PAPR Minimization Methods. *International Journal on Recent and Innovation Trends in Computing and Communication*, *11*(10), 2146–2155. https://doi.org/10.17762/ijritcc.v11i10.8899.
[5] N. Sivapriya, Madhu Kumar Vanteru, et al , "Evaluation of PAPR, PSD, Spectral Efficiency, BER and SNR Performance of Multi-Carrier Modulation Schemes for 5G and Beyond," *SSRG International Journal of Electrical and Electronics Engineering*, vol. 10, no. 11, pp. 100-114, 2023. *Crossref,* https://doi.org/10.14445/23488379/IJEEE-V10I11P110
[6] Chandini Banapuram, Azmera Chandu Naik, Madhu Kumar Vanteru, et al, "A Comprehensive Survey of Machine Learning in Healthcare: Predicting Heart and Liver Disease, Tuberculosis Detection in Chest X-Ray Images," *SSRG International Journal of Electronics and Communication Engineering*, vol. 11, no. 5, pp. 155-169, 2024. *Crossref,* https://doi.org/10.14445/23488549/IJECE-V11I5P116.
[7] Madhu. Kumar. Vanteru, et al, "Empirical Investigation on Smart Wireless Autonomous Robot for Landmine Detection with Wireless Camera," 2022 5th International Conference on Contemporary Computing and Informatics (IC3I), Uttar Pradesh, India, 2022, pp. 200-205, doi: 10.1109/IC3I56241.2022.10072936.
[8] S. Bhatnagar, Madhu. Kumar. Vanteru et al., "Efficient Logistics Solutions for E-Commerce Using Wireless Sensor Networks," in IEEE Transactions on Consumer Electronics, doi: 10.1109/TCE.2024.3375748.
[9] V, Sravan Kumar, Madhu Kumar Vanteru et al. 2024. “BCSDNCC: A Secure Blockchain SDN Framework for IoT and Cloud Computing”. *International Research Journal of Multidisciplinary Technovation* 6 (3):26-44. https://doi.org/10.54392/irjmt2433.
[10] Madhu Kumar, Vanteru. & Ramana, T.. (2022). Fully scheduled decomposition channel estimation based MIMO-POMA structured LTE. International Journal of Communication Systems. 35. 10.1002/dac.4263.
[11] Vanteru. Madhu. Kumar and T. V. Ramana, "Position-based Fully-Scheduled Precoder Channel Strategy for POMA Structured LTE Network," 2019 IEEE International Conference on Electrical, Computer and Communication Technologies (ICECCT), Coimbatore, India, 2019, pp. 1-8, doi: 10.1109/ICECCT.2019.8869133.
[12] Madhu. Kumar. Vanteru, T. V. Ramana, A. C. Naik, C. Adupa, A. Battula and D. Prasad, "Modeling and Simulation of propagation models for selected LTE propagation scenarios," 2022 International Conference on Recent Trends in Microelectronics, Automation, Computing and Communications Systems (ICMACC), Hyderabad, India, 2022, pp. 482-488, doi: 10.1109/ICMACC54824.2022.10093514.
[13] Vanteru.Madhu Kumar,Dr.T.V.Ramana” Virtual Iterative Precoding Based LTE POMA Channel Estimation Technique in Dynamic Fading Environments” International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-6, April 2019
[14] Vanteru .Madhu Kumar,Dr.T.V.Ramana, Rajidi Sahithi” User Content Delivery Service for Efficient POMA based LTE Channel Spectrum Scheduling Algorithm” International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-9 Issue-2S3, December 2019.

[15] Vanteru.Madhu Kumar,Dr.T.V.Ramana" Virtual Iterative Precoding Based LTE POMA Channel Estimation Technique in Dynamic Fading Environments" International Journal of Innovative Technology and Exploring Engineering (IJITEE) ISSN: 2278-3075, Volume-8 Issue-6, April 2019

[16] Karthik Kumar Vaigandla and J. Benita, " PAPR REDUCTION OF FBMC-OQAM SIGNALS USING PHASE SEARCH PTS AND MODIFIED DISCRETE FOURIER TRANSFORM SPREADING," ARPN Journal of Engineering and Applied Sciences, VOL. 18, NO. 18, pp.2127-2139, SEPTEMBER 2023

[17] aigandla, Karthik Kumar and Benita, J. 'Selective Mapping Scheme Based on Modified Forest Optimization Algorithm for PAPR Reduction in FBMC System'. Journal of Intelligent & Fuzzy Systems, vol. 45, no. 4, pp. 5367-5381, October 2023, DOI: 10.3233/JIFS-222090.

[18] Vaigandla, K. K. ., & Benita, J. (2023). A Novel PAPR Reduction in Filter Bank Multi-Carrier (FBMC) with Offset Quadrature Amplitude Modulation (OQAM) Based VLC Systems. *International Journal on Recent and Innovation Trends in Computing and Communication*, *11*(5), 288–299. https://doi.org/10.17762/ijritcc.v11i5.6616

[19] Karthik Kumar Vaigandla, J.Benita, "PRNGN - PAPR Reduction using Noise Validation and Genetic System on 5G Wireless Network," *International Journal of Engineering Trends and Technology*, vol. 70, no. 8, pp. 224-232, 2022. Crossref, https://doi.org/10.14445/22315381/IJETT-V70I8P223

[20] Karthik Kumar Vaigandla and J.Benita (2022), Novel Algorithm for Nonlinear Distortion Reduction Based on Clipping and Compressive Sensing in OFDM/OQAM System. IJEER 10(3), 620-626. https://doi.org/10.37391/IJEER.100334.

[21] K. K. Vaigandla, "Communication Technologies and Challenges on 6G Networks for the Internet: Internet of Things (IoT) Based Analysis," *2022 2nd International Conference on Innovative Practices in Technology and Management (ICIPTM)*, 2022, pp. 27-31, doi: 10.1109/ICIPTM54933.2022.9753990.

[22] Vaigandla, K. K., Karne, R., Siluveru, M., & Kesoju, M. (2023). Review on Blockchain Technology : Architecture, Characteristics, Benefits, Algorithms, Challenges and Applications. *Mesopotamian Journal of CyberSecurity*, *2023*, 73–85. https://doi.org/10.58496/MJCS/2023/012

[23] Karthik Kumar Vaigandla, Allanki Sanyasi Rao and Kallepelli Srikanth. Study of Modulation Schemes over a Multipath Fading Channels. International Journal for Modern Trends in Science and Technology 2021, 7 pp. 34-39. https://doi.org/10.46501/IJMTST0710005

[24] Karthik Kumar Vaigandla, Bolla Sandhya Rani, Kallepelli Srikanth, Thippani Mounika, RadhaKrishna Karne, "Millimeter Wave Communications: Propagation Characteristics, Beamforming, Architecture, Standardization, Challenges and Applications". Design Engineering, Dec. 2021, pp. 10144-10169,

[25] Karthik Kumar Vaigandla, Radhakrishna Karne, Allanki Sanyasi Rao, "Analysis of MIMO-OFDM: Effect of Mutual Coupling, Frequency Response, SNR and Channel Capacity", YMER Digital - ISSN:0044-0477, vol.20, no.10 - 2021, pp.118-126, 2021.

[26] Karthik Kumar Vaigandla, Shivakrishna Telu, Sandeep Manikyala, Bharath Kumar Polasa, Chelpuri Raju, "Smart And Safe Home Using Arduino," International Journal Of Innovative Research In Technology, Volume 8, Issue 7, 2021,pp.132-138

[27] Karthik Kumar Vaigandla, Mounika Siluveru and Sandhya Rani Bolla, "Analysis of PAPR and Beamforming For 5G MIMO-OFDM", International journal

of analytical and experimental modal analysis, Volume XII, Issue X, 2020, pp.483-490.

[28] D. Priyanka, V. Karthik, " Wireless Surveillance Robot with Motion Detection and Live Video Transmission and Gas Detection," International Journal of Scientific Engineering and Technology Research, Vol.04,Issue.17, June-2015, Pages:3099-3106

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