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AI BASED HYDROPONICS IN IOT

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Abstract: This project focuses on the design and development of an intelligent hydroponic system that leverages machine learning algorithms, including Lasso's regression, K-Nearest Neighbors (KNN), and Artificial Neural Network (ANN) methods. The objective is to enhance the efficiency and precision of crop cultivation, ultimately yielding healthier and faster-growing crops. By integrating Internet of Things (IoT) technology, the system incorporates a sensor network to monitor and control crucial factors such as nutrient levels, pH, and humidity, surpassing the capabilities of traditional farming methods.

Index Terms: Artificial Intelligence (AI), Hydroponics Systems, Internet of Things, Real-time Data Acquisition.

I. INTRODUCTION

Hydroponics, an innovative and sustainable agricultural technique, involves cultivating plants without soil by utilizing nutrient-rich water solutions. This project aims to revolutionize traditional hydroponic systems by integrating advanced technologies such as machine learning algorithms (Lasso's regression, KNN, and ANN) and Internet of Things (IoT) devices. The goal is to create a smart hydroponic system that optimizes crop production by accurately monitoring and controlling crucial parameters like nutrient levels, pH, and humidity.

The proposed system leverages Lasso's regression, KINN, and ANN methods to develop intelligent algorithms capable of analyzing environmental data and providing real-time adjustments. These algorithms contribute to the precision and efficiency of crop cultivation, resulting in healthier and faster-growing crops compared to conventional farming methods.

To address the potential issue of water-borne diseases in hydroponic systems, a key drawback, the project proposes a strategic modification. An anti-bacterial setup will be integrated into the system, utilizing carefully selected chemicals that effectively combat pathogens without adversely affecting crop health. This innovative measure ensures a safer and more hygienic hydroponic environment, mitigating the risk associated with water-borne diseases.

II. LITERATURE SURVEY

G. LAKSHMI PRIYA [1] An IoT-based hydroponic system optimized for Holy Basil (Ocimum Tenuiflorum) growth utilizes ML algorithms, sensors for temperature, humidity, RGB color composition, and pH levels, along with nutrient control valves and a web-based monitoring portal. This system reduces manual monitoring, enhances plant growth, and integrates cloud technology for data-driven decision-making.

WALUYO [2] This research explored hydroponics and energy consumption using fuzzy logic and IoT. Sensors like BH1750, TDS, pH-4502C, ACS712, and 170640 were employed for monitoring various parameters. Three prototypes (fuzzy-based, schedule based, and natural methods) were tested with swamp cabbage plants, showing that the fuzzy-based method resulted in taller plants and energy savings of about 4.75% compared to the schedule-based method. The BH1750 sensor's illuminance readings influenced LED brightness and energy consumption in response to the plant's needs.

VU NGOC TUAN [3] This study developed a data fusion model using 70 calibration and 30 prediction samples to determine phosphate concentrations in an eggplant nutrient solution. Three methods, PLS, GPR, and ANN, were compared, with the best results coming from MSAM data collection and an ANN fusion model, achieving high R^2 values of 0.98 and 0.96, and RMSE values of 50 and 66 mg/L for calibration and evaluation, respectively. This outperformed conventional methods. MSAM-based sampling improved efficiency, reduced costs, and enhanced data accuracy, with promising results for phosphate concentration measurement in hydroponic solutions.

RAYNER ALFRED [4] This paper explores the integration of Big Data (BD), Machine Learning (ML), and the Internet of Things (IoT) in rice production, ushering in a new era of smart farming. It surveys recent research on intelligent data

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processing in rice agriculture, emphasizing the role of ML algorithms in various applications, including smart irrigation, yield estimation, disease monitoring, quality assessment, and sample classification. The paper also introduces a mapping framework for data modeling and ML algorithm use across production and post-production phases of paddy rice. The conclusion Hydroponic System Using IoT And Machine Learning underscores the importance of effectively integrating these technologies to revolutionize traditional rice farming into precision agriculture. Additionally, it highlights challenges and trends related to big data in agriculture.

JOE HENRY OBIT [5] This work explores the application of Digital Twins (DTs) in hydroponics, focusing on design, operation, monitoring, optimization, and maintenance. The paper reviews the use of DTs in smart farming and their potential to enhance efficiency in the face of challenges like natural disasters, urbanization, and changing climate conditions. DT technology, incorporating AI, IoT, AR, and more, is described as an adaptive model for improving physical systems throughout their lifecycle, including design, enhancement, and predictive maintenance. While DTs have made strides in manufacturing and aviation, their application in agriculture, due to resource mobility, communication gaps, and other factors, is still emerging.

PAUL D. ROSERO-MONTALVO [6] By using new technologies inside greenhouses, farmers can reduce the damaging effect of insects on plants and improve indoor cultivation through climate control. However, to efficiently manage agricultural fields and greenhouses today, farmers have to apply technologies in line with Industry 4.0, such as: robots, Internet of Things devices, machine learning applications, and so on. In this context, deploying sensors plays a key role in collecting data and finding information supporting the farmer's decision-making. As a feasible solution for small farms, this paper presents an autonomous robot that moves through greenhouse crop paths with previously-planned routes and can collect environmental data provided by a wireless sensor network, where the farmer does not have previous information about the crop. Here, an unsupervised learning algorithm is implemented to cluster the optimal, standard, and deficient sectors of a greenhouse to determine inappropriate growth patterns in crops. Finally, a user interface is designed to help farmers plan both the route and distance to be travelled by the robot while collecting information from the sensors to observe crop conditions disease. All of these experiments were done on a benchmark dataset. Hydroponic System Using IoT and Machine Learning

RAVIL I. MUKHAMEDIEV [7] This research addresses the challenge of coverage path planning for a group of diverse UAVs, particularly in agro-technical applications. It introduces a genetic algorithm-based method called mhCPPmp, which coordinates the flight of UAVs using a mobile ground platform for recharging and refueling. This approach optimizes coverage of fields with varying shapes, enabling the selection of the most efficient UAV subset. The modified algorithm accounts for mobile platform movement and heterogeneous UAVs, resulting in a 10-12% quality improvement over the use of a single UAV without a mobile platform, even on small fields.

III. PROBLEM IDENTIFICATION

Data Quality and Sensor Reliability: Existing hydroponic systems often encounter challenges in maintaining precise control over crucial environmental variables. Fluctuations in nutrient concentrations, pH levels, and humidity can occur, negatively impacting the health and yield of crops. The absence of precision control mechanisms contributes to inconsistencies in the growing conditions, affecting the overall success of hydroponic cultivation.

IV. OBJECTIVES

- **Efficient System Design:** Develop a deep-water culture hydroponics system that incorporates Internet of Things (IOT)

For real time monitoring.

- **Machine Learning Integration:** Implement machine learning algorithms, including Lasso's regression, KINN (K-Nearest Neighbors), and ANN (Artificial Neural Network), to enable data-driven decision-making. The goal is to optimize crop growth by analyzing environmental data and dynamically adjusting system parameters for enhanced efficiency.

V. METHODOLOGY

Begin by setting up the physical components of the hydroponic system, including the hydroponic tanks, nutrient delivery system, grow lights, and ventilation. Install sensors for monitoring key parameters such as humidity, temperature, water level etc. These sensors are properly calibrated and positioned within the hydroponic system for accurate data collection.

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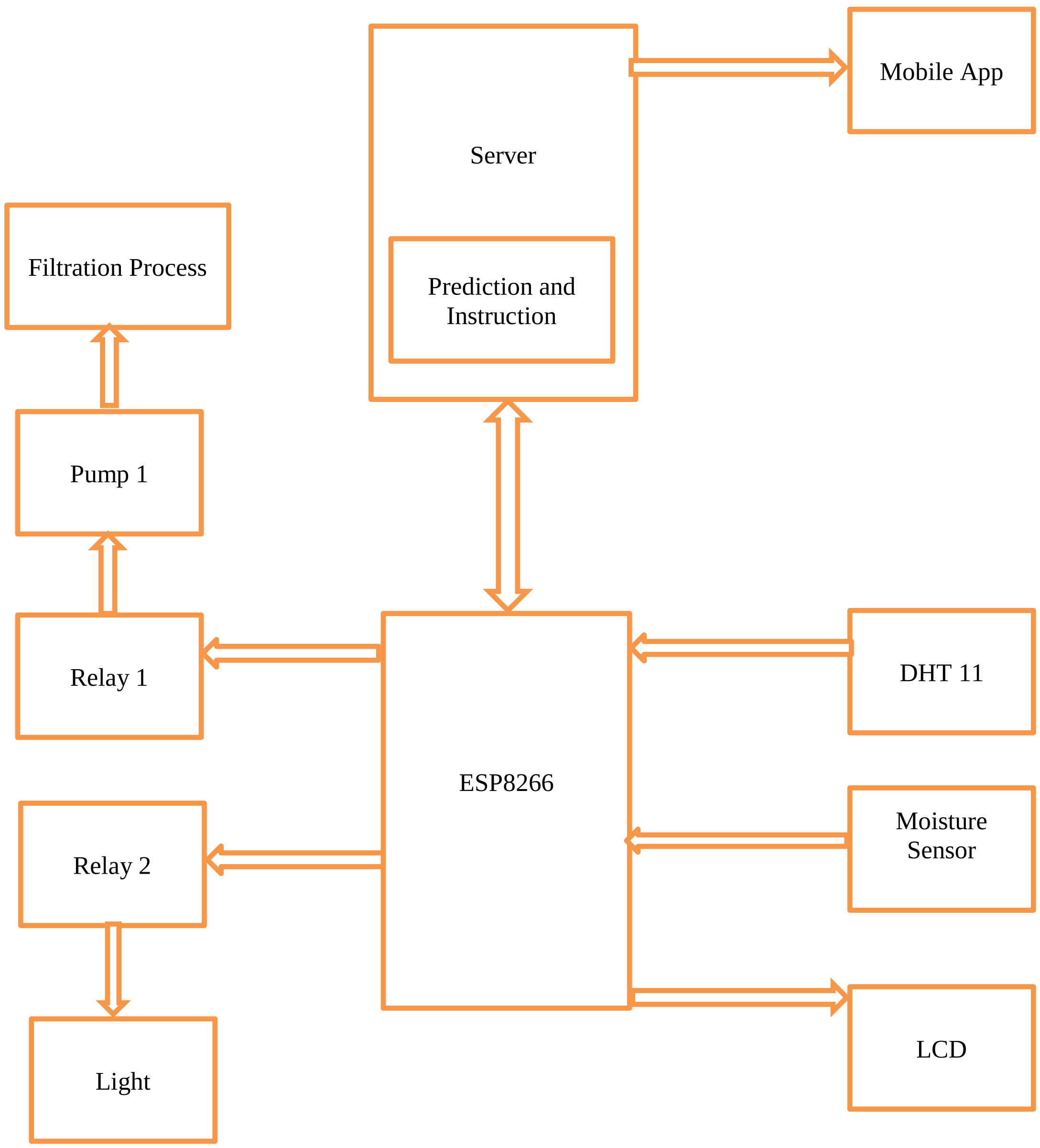
The system design incorporates components like an Arduino board for control, DC motors for propulsion, motor drivers for speed and direction control, fans or propellers for lift, and a flexible hovercraft skirt to maintain an air cushion. The methodology concludes with building the system, testing its performance under varying conditions, and analyzing results to refine the design and achieve project goals.

Develop a data acquisition system to collect data from the sensor network. This system may involve writing code to read sensor values, store them in a database, and transmit them to a central server for further processing. Ensure that data collection is continuous and reliable to provide real-time insights into the hydroponic system's performance.



A) Block Diagram

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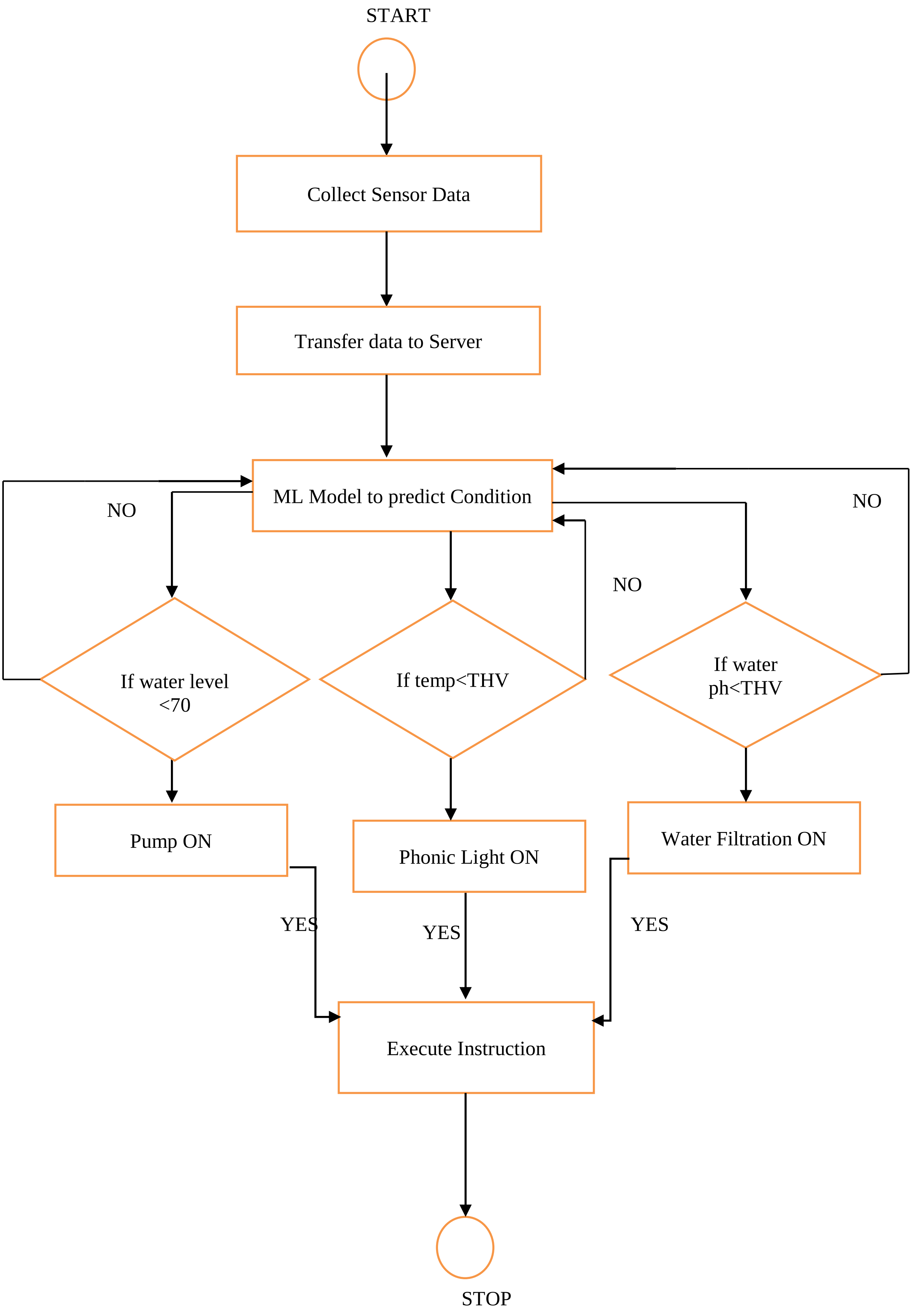

B) Flow Chart

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VI. APPLICATIONS

1. Automated Nutrient Management

AI analyzes plant growth data (collected by IoT sensors) to optimize the nutrient mix (NPK, pH, EC).

Real-time adjustment without human intervention, ensuring plants always get the ideal nutrition.

2. Smart Irrigation and Water Recycling

IoT devices monitor humidity, root moisture, and water quality.

AI predicts the precise water needs, reducing waste and enabling closed-loop water systems.

3. Climate Control Automation

Sensors track temperature, CO_2 levels, humidity, and light.

AI dynamically controls heaters, humidifiers, fans, and grow lights to maintain optimal conditions 24/7.

4. Predictive Crop Management

AI models use sensor data (e.g., plant height, leaf color via computer vision) to predict growth rates, yield times, and potential diseases.

Allows farmers to plan harvests and market supply in advance.

VII. CONCLUSIONS AND FUTURE SCOPE

AI-based hydroponics integrated with IoT technologies offers a highly efficient, sustainable, and intelligent solution to modern agriculture challenges. By enabling real-time monitoring, predictive analytics, and automated control over crucial parameters such as nutrient levels, water usage, and environmental conditions, AI and IoT together maximize crop yields while minimizing resource wastage.

This smart farming model reduces dependency on manual intervention, enhances scalability, and ensures consistent quality in crop production, making it ideal for urban farming, vertical farms, and resource-constrained regions. Overall, AI-driven hydroponics represents a major step towards future-proofing agriculture against climate change, labor shortages, and food security issues.

Advanced Predictive Models:

Development of more sophisticated AI models that can simulate plant growth stages, predict harvest times, and optimize conditions based on different crop types.

Integration with Robotics:

Robotic arms and drones integrated with AI and IoT could automate planting, pruning, and harvesting processes, further reducing human labour.

Blockchain for Supply Chain Transparency:

Combining IoT data with blockchain can ensure traceability of crops from seed to shelf, improving food safety and consumer trust.

Personalized Crop Cultivation:

AI could enable tailoring nutrient mixes and conditions for individual plants based on their specific growth behavior ("plant phenotyping" at scale).

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Scalable Urban Farming Networks:

Creating interconnected smart farms within cities that are managed remotely via AI, contributing to local food production and reduced carbon footprints.

REFERENCES

[1] Sharma, N., Acharya, S., Kumar, K., Singh, N. and Chaurasia, O.P., 2018. Hydroponics as an advanced technique for vegetable production: An overview. Journal of Soil and Water Conservation, 17(4), pp.364-371.
[2] Sardare, M.D. and Admane, S.V., 2013. A review on plant without soil- hydroponics. International Journal of Research in Engineering and Technology, 2(3), pp.299-304.
[3] Jensen, M.H., 1997, May. Hydroponics worldwide. In International Symposium on Growing Media and Hydroponics 481 (pp. 719-730).
[4] Asao, T. ed., 2012. Hydroponics: A standard methodology for plant biological researches. BoD–Books on Demand.
[5] Shrestha, A. and Dunn, B., 2010. Hydroponics. Oklahoma Cooperative Extension Service.
[6] Naik, P.K., Swain, B.K. and Singh, N.P., 2015. Production and utilization of hydroponics fodder. Indian Journal of Animal Nutrition, 32(1), pp.1-9.
[7] Adams, P., 1992, March. Crop nutrition in hydroponics. In Symposium on Soil and Soilless Media under Protected Cultivation in Mild Winter Climates 323 (pp. 289-306).
[8] Douglas, J.S., 1985. Advanced guide to hydroponics (No. new edition). Pelham Books.
[9] Nalwade, R. and Mote, T., 2017, May. Hydroponics farming. In 2017 International Conference on Trends in Electronics and Informatics (ICEI) (pp. 645-650). IEEE