IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 1, June 2024

IoT Based Hydroponics System

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Abstract*: Agriculture has the significant impact on the economy of the country. With the practice of modern farming techniques where plants can be grown without the need of soil by means of nutrient solution, Hydroponics and Aeroponics are in the rise. Now towards controlling the hydroponic plant growth, some amount of research has been done in applying internet of things Internet of Things allows for Machine to Machine interaction and controlling the hydroponic system autonomously and intelligently.*

Keywords: Hydroponics, IOT, Automated agriculture, Tensor flow , Real time data

I. INTRODUCTION

Indian economy is strongly dependent on agriculture. Because of the increase in food demand, labor cost, unpleasant environmental conditions and less area for agriculture, there is an increase in motivation for indoor farming such as hydroponics and Aeroponics.

So, based on the traditional method of growing plants, there is no mention about soil. That means as long as these requirements are fulfilled,plants can grow. This brings the idea of hydroponics farming.

This technique uses mineral nutrient solution in a water solvent which allows plant intake of nutrients in a more efficient way than soil. Monitoring of water level, pH, temperature,flow, and light intensity can be regulated by the use of IoT.

For e.g., during winter, water tends to freeze in some areas which in turn may hamper the cultivation process altogether. Water temperature sensors deployed over the hydroponics farm can sense the temperature

loss and alert the farmer accordingly. Similarly, the pH sensor can detect a change in nutrient levels and can pump in the minerals in suitable amounts. An assortment of sensors and controllers like ESP-8266,

Arduino can be used to instrument and automate a hydroponics farm. In addition to automating the hydroponics by employing IoT technology, there is a need for some intelligence for controlling the hydroponics

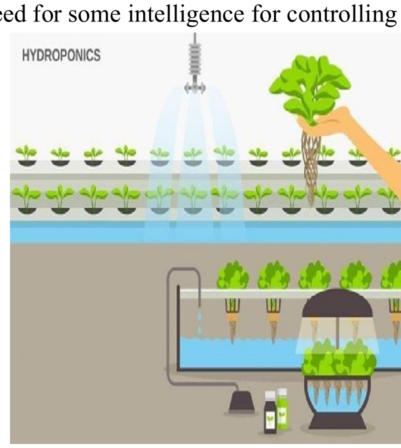

Fig 1.0 hydroponic system

II RELATED WORKS

IOT refers to the Internet of things towards connecting people ,things by means of the Internet and store the data in the cloud for analysis.

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The emergence of IoT has allowed farmers to automate the hydroponic culture. Monitoring of water level, pH, temperature, flow ,and light intensity can be done, and they can be regulated by use of IoT
So, with this in view, quite an amount of research been carried by employing IoT for monitoring and controlling the hydroponic system.
Gosavi have developed an IoT based hydroponic prototype where the pH, water conductivity and water luminosity monitored by employing sensors like pH, Electrical conductivity and Lumens meter.
This information captured by sensors are sent to ARM 7 Microcontroller continuousIn another research, **Pitakphongmetha et al** authors have deployed Artificial Neural Network (ANN) in predicting the potenz-
Hydrogen and Electrical Conductivity results of the hydroponic setup.
Feed forward neural networks developed with several inputs including pH, Electrical Conductivity, temperature, humidity, light intensity, plant age, added acid content and added base content, provides two outputs
outputs which are pH and Electrical Conductivity for automatic control
of the system.
The challenge with the above-mentioned system is that there has been no intelligence developed in an IoT based hydroponics system. In terms of intelligence in controlling hydroponic environment, these
machine learning algorithms were not able to achieve a high level of accuracy, and also these algorithms monitoring is done for the optimal growth of plants. In hydroponics, the plant needs to be under light for 16 h and in the dark for 8 h. So accordingly, microcontroller have Real Time clock which would control lighting by means of the relay switch. This information displayed on LCD panel connected to the microcontroller.
Peuchpanngarm et al. have developed an IoT based autonomous control android/iOS mobile application for the ease of hydroponics. Over here, different sensors are used which are water level sensor, ambient temperature sensor, humidity and light intensity sensor which is interfaced to Arduino. from sensors. In addition, the mobile application provided for monitoring remotely, reminding for harvest recording, and planning for hydroponic gardening

III. PROPOSED SCHEME

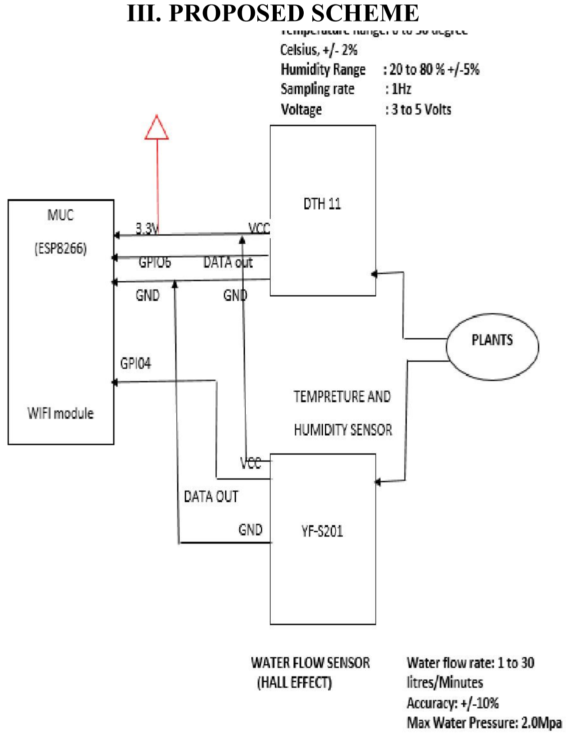

Fig 1.1 scheme of hydroponics

In this fig 1.1 the scheme of hydroponics will explain the internal process carried

Step 1. Data collection: Gather information from sensors and other sources throughout the hydroponics system. Temperature, humidity, pH levels, nutrient levels, and other environmental variables may be included in this data.

Step 2. Data pre-processing: Clean and pre-process the data to ensure that it is in a suitable format for machine learning algorithms. This may involve removing missing values, normalizing the data, and transforming variables as needed. Feature engineering: Identify and extract relevant features from the data, such as statistical summaries or timeseries features that can be used to train machine learning models.

Step 3. Model selection: Select an appropriate machine learning algorithm for the task at hand. For example,a decision tree algorithm may be suitable for predicting discrete control actions, while a regression algorithm may be better for predicting continuous variables such as nutrient levels.

Step 4. Model training: On the pre-processed data, train the chosen machine learning model. This entails dividing the data into training and validation sets, fitting the model to the training data, and assessing its performance on the validation data.

Step 5. Model evaluation: Evaluate the performance of the trained model using appropriate metrics, such as accuracy or mean squared error. If the model is not performing well, additional pre-processing or feature engineering may be necessary.

Step 6. Control action prediction: Once a satisfactory model has been trained and evaluated, it can be used to predict appropriate control actions based on input sensor data. These control actions can be communicated to the hardware components of the hydroponics system to regulate environmental conditions and optimize plant growth. Overall, predicting appropriate control actions in an IoTbased hydroponics system entails collecting and preprocessing data, identifying relevant features, selecting and training machine learning models, and evaluating and using the trained models to predict control actions based on the trained parameters . The main objective of the work was not to regulate the hydroponic environment.

As a result, the focus of this work is on creating an intelligent hydroponics system

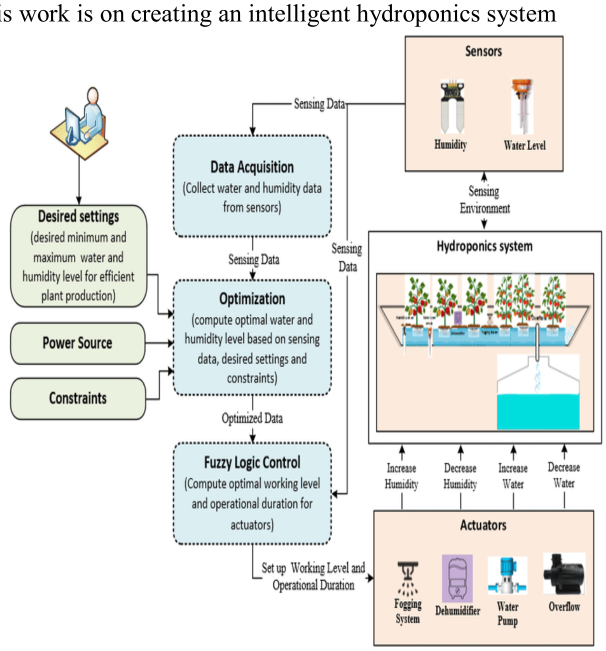

Fig 2 Flow diagram of system

The values of the parameters, Fig. 2. such as moisture, pH, temperature, light intensity, and water flow, are uploaded to the cloud using Node MCU. The parameters that are collected include: moisture, pH,temperature, light intensity, and

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waterflow. The human mind generates decisions for the future based on the past experiences and information that it has been exposed to, and these decisions are influenced by the past. In
the field of hydroponics, the algorithm for machine learning can be utilised in a variety of settings. ESP-01, DHT-11, and
Controller Mega 2560 are components of the smart fodder hydroponics system. Liquid PH value detection sensor module
(PH Board + PH Electrode Probe), DS1820 waterproof temperature sensor, photosensitive light LDR resistance
sensor, analogue TDS sensor (Board + Probe), LED grow light
hydroponics, fan, sprayer, pump, and value .
The Ardunio Mega 2560 and the Firebase real-time database are connected by ESP -01.

IMPLEMENTATION OF RNN

The only direction of mapping in a multi layered perceptron (MLP) is from input to output vectors. As a result of its unique structure, RNN is able to map each input to an output based on the entire history of inputs. Sequence predictions are built into RNNS's. RNNs can process a sequence of inputs thanks to their internal cell state memory. Humidity, temperature, and water level can all be predicted. In this fig 2.1 explains
with an RNN model. The accuracy of the Hydroponics system can be improved through the use of IoT to regulate the system
using the algorithm's output . To determine whether or not an event is normal or abnormal, the RNN takes as input the data collected by the sensors. RNNs are built from layers upon layers of nodes that resemble neurons. A real-valued weight
can be assigned to each connection. RNN generates a valueerror with every sequence it processes. In order to learn, RNNs
employ a method called Back-Propagation over time, which is enabled by the activation function.An algorithm called back propagation uses the model's output to determine the optimal weight for each neuron

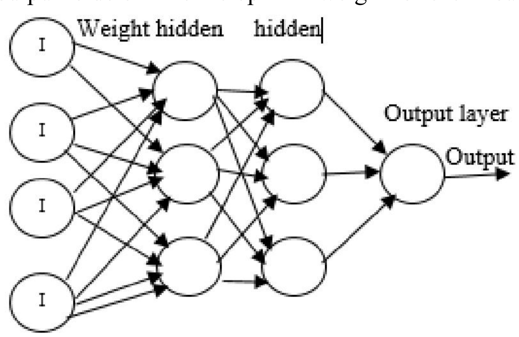

Fig RNN WITH 2 LAYERS

Each time step in the RNN is made up of a unit with afixed activation function. It is the job of the activationfunction to determine whether or not each neuron in the network should be activated in order to make predictions based on the information .

IV. IMPLEMENTATION

As explained in the fig 3 it includes the system setup The values of the parameters. such as moisture, pH, temperature, light intensity, and water flow, are uploaded tothe cloud using Node MCU. The parameters that are collected include: moisture, pH,temperature, light intensity, and waterflow. The human mind generates decisions for the future based on the past experiences and information . Inthe field of hydroponics can be utilised in a variety of settings. ESP-01, DHT-11, and Controller Mega 2560 are components of the smart fodder hydroponics system. Liquid PH value detection sensor module (PH Board + PH Electrode Probe), DS1820 waterproof temperature sensor, photosensitive light LDR resistance sensor, analogue TDS sensor (Board + Probe), LED grow light

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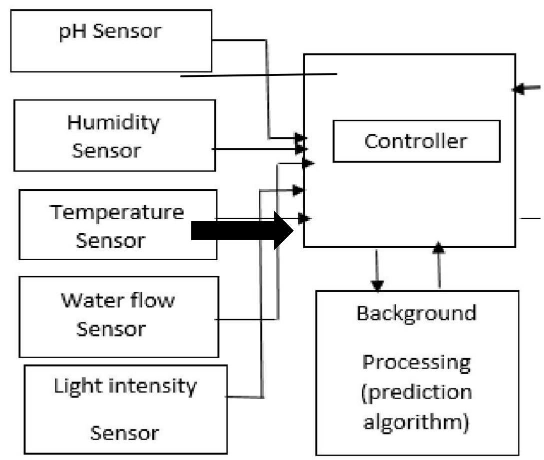
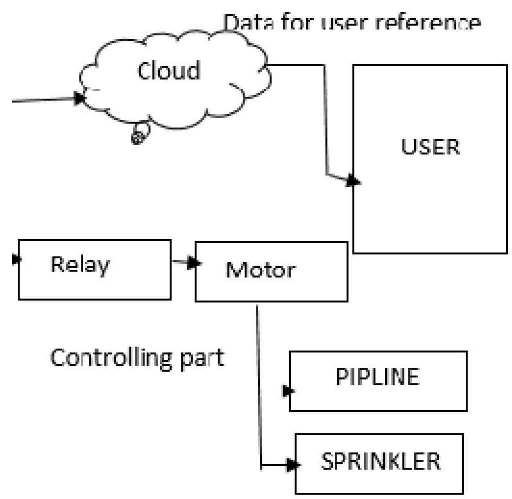


Fig 3 The hydroponic system setup

Two way communication



ARDUINO UNO:

The main hardware tool that we are using is Arduino Uno which is a microcontroller board based on the ATmega328. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

LCD Display :

LCD (Liquid Crystal Display) is a type of flat panel display which uses liquid crystals in its primary form of operation. LEDs have a large and varying set of use cases for consumers and businesses, as they can be commonly found in smart phones, televisions, computer monitors and instrument panels.

LCDs were a big leap in terms of the technology they replaced, which include light-emitting diode (LED) and gas-plasma displays. LCDs allowed displays to be much thinner than cathode ray tube (CRT) technology. LCDs consume much less power than LED and gas-display displays because they work on the principle of blocking light rather than emitting it. Where an LED emits light, the liquid crystals in an LCD produces an image using a backlight.

A display is made up of millions of pixels. The quality of a display commonly refers to the number of pixels; for example, a 4K display is made up of 3840 x2160 or 4096x2160 pixels. A pixel is made up of three sub pixels; a red, blue and green—commonly called RGB. When the sub pixels in a pixel change color combinations, a different color can be produced. With all the pixels on a display working together, the display can make millions of different colors. When the pixels are rapidly switched on and off, a picture is created.

Temperature sensor:

A temperature sensor detect the hotness and the coldness of the environment. The sensing of the temperature can be done with the directly contact or an indirect contact. The temperature sensor DHT11 is used to measure the temperature of the environment accurately. DHT11 sensor is an integrated circuit in which the voltage output is directly proportional to the temperature Celsius. Water level: The water level is always under observation by a float sensor, which work by opening and closing circuits (dry contacts) as water levels rise and fall. It normally rest in the closed position, meaning the circuit is incomplete and no electricity is passing through the wires yet. Once the water level drops below a predetermined point, the circuit completes itself and sends electricity through the completed circuit to trigger an alarm.

WI-FI Module:

WI-FI Module(ESP8266) Is used for wireless data transmission to the cloud(Thing speak).It continuously transfer the data to the cloud if and only if ARDUINO monitors the sensor data. It collects data from ARDUINO UNO. ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor. When ESP8266hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash.

PH sensor:

A pH sensor is one of the most essential tools that's typically used for water measurements. This type of sensor is able to **measure the amount of alkalinity and acidity in water and other solutions.** When used correctly, pH sensors are able to ensure the safety and quality of a product and the processes that occur within a wastewater or manufacturing plant.The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with arduino. The normal range of pH is 6 to 8.5 .

Moisture Sensor:

The soil moisture sensor is one kind of sensor used to gauge the volumetric content of water within the soil. As the straight gravimetric dimension of soil moisture needs eliminating, drying, as well as sample weighting. These sensors measure the volumetric water content not directly with the help of some other rules of soil like dielectric constant, electrical resistance, otherwise interaction with neutrons, and replacement of the moisture content.

LDR(Light dependent Resistor):

Photoresistors, also known as light dependent resistors (LDR), are light sensitive devices most often used to indicate the presence or absence of light, or to measure the light intensity. In the dark, their resistance is very high, sometimes up to 1 MΩ, but when the LDR sensor is exposed to light, the resistance drops dramatically, even down to a few ohms, depending on the light intensity. LDRs have a sensitivity that varies with the wavelength of the light applied and are nonlinear devices. They are used in many applications, but this light sensing function is often performed by other devices such as photodiodes and phototransistors. Some countries have banned LDRs made of lead or cadmium over environmental safety concerns.

RELAY MODULE:

It is an electric switch and it is operated by an electro magnet. A low power signal which is generated by a microcontroller activates the electro magnet. When electro magnet is activated it pulls and opens or closes a circuit.

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The single channel 5V relay module can be used to control a load such as a lighting system, motor, or solenoid. It can also be used to switch AC or DC voltages. The maximum voltage and current that the 5V relay module can control is dependent on the specifications of the relay.

Water Pump:

A **relay** is an electronic switch that can be controlled by an **Arduino uno** microcontroller to turn a **water pump** on and off. When the **relay** is energized, it closes an electrical circuit, allowing electricity to flow through the pump and turn it on. When the relay is de-energized, it opens the circuit, cutting off the electricity and turning the pump off.

To use a **relay** to control a **water pump** with an Arduino uno, you will need to connect the relay to the **Arduino uno**'s digital output pins. The **relay** typically has three pins, VCC, GND, and IN. VCC should be connected to 5V of the **Arduino uno**, GND to GND, and IN to a digital pin of the **Arduino uno**. Once the connections are made, you can use the **Arduino uno**'s digitalWrite function to turn the **relay** on and off, and thus control the **water pump**.

Specifications

V. RESULTS AND ANALYSIS

In this project arduino uno is used as a micro controller. All components are interfacing with arduino uno. Temperature sensor is used to measure temperature and humidity. Ph sensor is used to measure ph values of soil, moisture sensor is used to measure the moisture content in the soil, whenever moisture content is low on that time water pump will ON, Light sensor is used to detect the light intensity, this all sensors data is display on lcd and sensor's data stored in cloud using esp8266 wifi module.

Fig 4.0 Ph result is displayed

Graph and analysis of the data

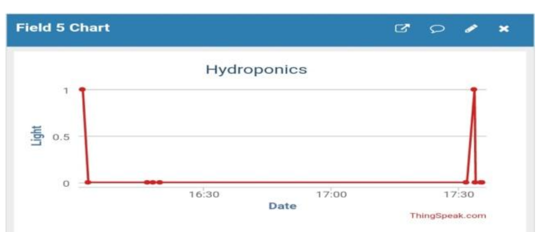

Fig 4.1 Graph of light with date

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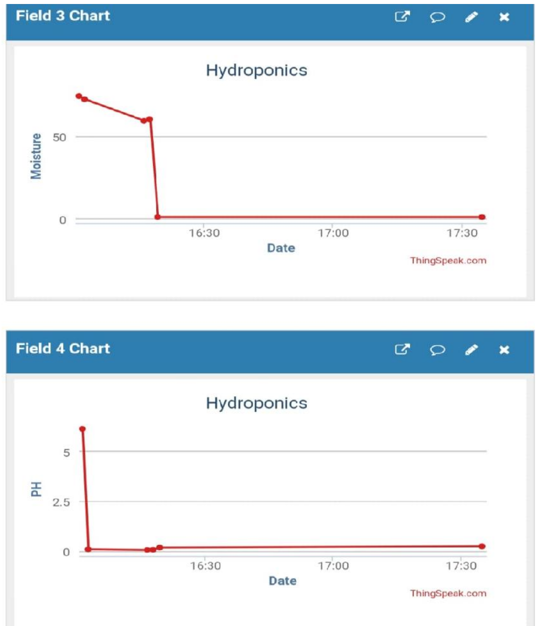

Fig 4.2 The graph of moisture and ph with date

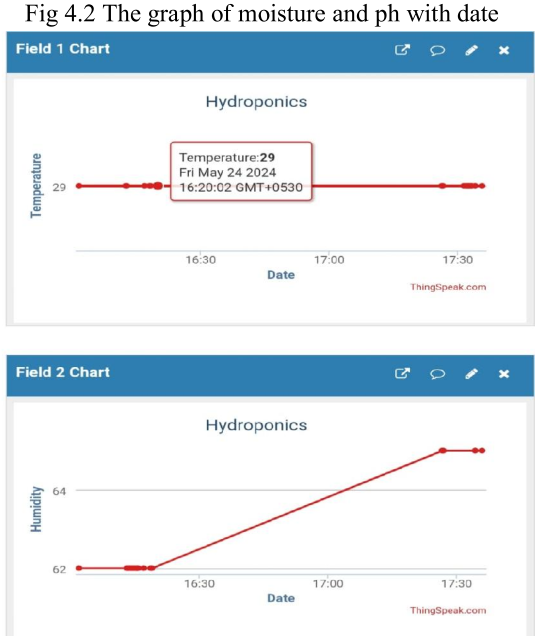

Fig 4.3 The graph of temperature and humidity with date

So, with the upcoming of IoT, quite amount of IoT based Hydroponic monitoring system developed with a mobile application for

controlling too. Now in terms of applying intelligence in terms of machine learning in analyzing the data set captured for controlling the parameters for proper growth of the plant in hydroponic, some amount

of research carried in applying Bayesian Network and Artificial NeuralNetwork.

So, with all these in mind for growing a proper plant in hydroponics,we need to control the parameters of hydroponic system autonomously without the need of human. So, we here have developed an intelligent

IoT based hydroponic system by taking the tomato plant as a case study.In here five parameters taken as input for controlling the hydroponic environment which is pH, temperature, humidity, level, lighting. These
parameters are trained using Deep Neural network towards providing the appropriate control action which is labeled. These parameters are collected in real time over weeks and trained 10,000 times towards
achieving the best-predicted output action with an accuracy of 88%.
The predicted control action for the real-time data is stored in the cloud. The Pi3 acts as the edge where the Deep Neural network model deployed for producing the predicted output and communicating with the Arduino. This has been developed as a prototype. In future, the system could be extended by deploying

VI. CONCLUSION

With the control being based on the prediction of future values of temperature, humidity, and light. This work contributes to an increase in productivity and helps to raise awareness among farmers about ways in which they can improve their farming in areas with fewer cultivable acres and fewer water resources. There is no requirement for the farmers to perform continuous monitoring of the cultivation process. This work can also be carried out on a terrace and turned into an activity for the household, in order to enable as many people as possible to participate in farming and benefit from it. The use of hydroponics has simplified the process of farming significantly. In conventional farming, more labour may be required, whereas in hydroponic farming, the only thing that is necessary is a vertical farming setup rather than labour. The error values generated by the deep neural network will be utilized in the upcoming work to automate the entire hydroponics farming process.

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