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Article Title: Smart Village – A Digital Transformation of Modern Village Using ESP32 Microcontroller

Smart Village – A Digital Transformation of Modern Village Using ESP32 Microcontroller

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ABSTRACT

Now a day by the initiative taken by the Government of India in the scheme of "Smart India", all villages will soon transfer to Smart Villages. This will be achieved by the Information Technology Platforms. For converting the Villages to Smart Villages, the Internet of Things (IoT) plays a major Role in India. By using IoT everything in the village is connected to the Internet and it is controlled by the users anywhere by remotely. In our project we have taken the problems in Smart Garbage System and Smart Water Level Controller to distribute water from the common tank to all users. In Garbage System the wet and dry waste is identified separately and it regularly monitored whether the tank is full, then information given to municipality to clean that concern Garbage. In water level controller the utilization of water from common tank is controlled and managed by using the mobile application. Keep tracking of water level in the tank by float sensor and based on the water level it will be distributed to the users. The domestic public users also controlled by the user defined commands which is intercepted with the home of particular user**.**

Keywords: Smart Village, Internet of Things, Digitalization of Garbage system, Water level controller in tank, Dry and wet waste, smart controllers.

1 Introduction

IoT automates operations and cuts labor expenses. It reduces waste and enhances service delivery, making manufacturing and delivery cheaper and providing consumer transaction transparency. IoT is one of the most significant technologies of daily life, and it will continue to grow as more organizations grasp the potential of linked devices to stay competitive. IoT may improve production and distribution systems in enterprises as the internet did for knowledge work. Billions of embedded internet-enabled sensors globally give a wealth of data that firms can utilize to enhance safety, monitor assets, and decrease human procedures. Machine data may forecast equipment failure, allowing manufacturers to avoid lengthy downtime. Researchers may also utilize IoT devices to collect user preferences and behavior data, but that might compromise privacy and security. Data-gathering devices start an IoT

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system. These internet-connected gadgets have IP addresses. They vary from autonomous mobile robots and forklifts that transport items across factories and warehouses to basic sensors that detect temperature and gas leaks. Fitness trackers that count steps are also included. The IoT process continues by sending device data to a central location. Wireless or wired networks may move data. Internet data may be transmitted to a data center or cloud. Intermediary devices may aggregate, prepare, filter, and eliminate unnecessary or duplicate data before providing the critical data for analysis.

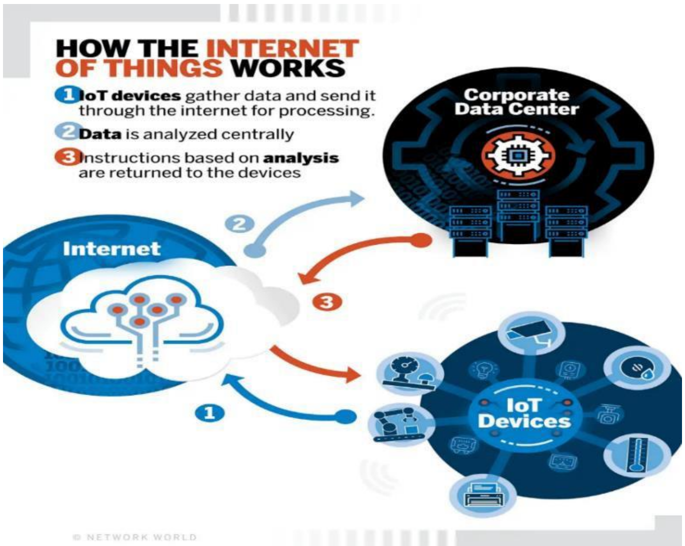

Figure 1: *IOT application diagram*

1.1 The Most Significant Advantages of IOT

1.1.1 Improve Customer Service and Experience

The IoT makes your consumers' everyday gadgets remarkable. Check whether IoT can enhance goods and services. IoT-integrated automobiles calculate travel duration, traffic, and fuel usage. A smart doorbell that shows visitors while you're away. Refrigerators detect low supply. A weather-responsive AC system.

1.1.2 Increase New Business and Revenue Opportunities

IoT offers new business possibilities by enabling new consumer and business flow interactions.

1.1.3 Enhance Business Safety and Security

IoT devices monitor buildings and businesses to safeguard people from physical hazards. Businesses can monitor office premises and secure assets using IoT devices including sensors, cameras, and smart locks. Track and warn high-risk workers in manufacturing, real estate, and construction.

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1.1.4 Improve Productivity and Competence

Smart IoT devices can do repetitive company duties better since they don't sleep, eat, have mood swings, or get sick.

1.1.5 Cut down Operational Costs

Improved productivity, process efficiency, and asset utilization will all contribute to cost savings. Predictive analytics and real-time diagnostics, for example, may assist reduce maintenance costs in a variety of businesses.

1.1.6 Collect Data for Business Decisions

Companies may use IoT to monitor and collect critical data sets that will help them enhance their services and products. This information may help with company analysis and decision-making.

1.1.7 Add Mobility and Agility to Business

IoT technology allows businesses to let their staff and workers conduct their work from literally anywhere. This flexibility can help many companies cost saving as office leases are expensive, hiring many remote employees.

2 Literature Review

"This paper elucidates the research and implementation of IoT based Smart Village. IoT (Internet of Things) is a structure which provides an exclusive identity and ability to relocate the data over a network without requiring two-way handshaking from human-to- human [1]. It enables the path to connect anytime, anywhere, with anything and anyone ideally using any network topology with a specify service. Hence the divergence on the scenario of a Smart Globe has emerged to mean many things to many people. Meaning of "Smart" utilizes sensitive information and communications technology (ICT) remains consistent with the Internet Technologies to address rural challenges [5]. To bifurcate the ideal scenario on the basic occupation of agriculture, the ecosystem control technology and system becomes mature having high level of intelligence [2]. This puts precise significance on efficiency, high-quality, secure and sustainable production of facility agriculture. That makes a glance of a smart irrigation as a smart farming, ultimately converging into a "Smart Village" [4]. This is all about the outsourcing application, technology and wonders of IoT (Internet of Things).The purpose of this project is the creation of a Smart Village. Model of a smart village following the concept of a smart city is presented in this manuscript as the effect of integrated technological changes which can be realized in a place which has none [3]. Thus, a remote and isolated village location is chosen where the modern civilization has not touched. The design makes the village self-sufficient with respect to electric power, water supply, street lighting, security, education and communication [7]. Application of non- conventional methods of energy generation is the key for betterment as discussed. Renewable and non-polluted power is generated from solar heat. The heat energy is captured and stored in water for use at night and in absence of sun. Internet of Things (IOT) is controlling embedded devices through Internet [6]. Energy efficient street lamps with controlled light intensity as per the requirement have been designed. Water is provided to houses in cold and hot forms. Computers, mobile application for individual. Village equipped with all the modern technology without destroying the nature can be defined as smart village [9]. The number of villages where proper and immediate care is not taken against abnormalities like garbage overflow, water supply problems, checking quality of water, the digital display of government offers and subsidies and also against electrical issues like street light monitoring [11]. Using the proposed system, the problems can be solved. The proposed system also aims at internet of Things (IOT) is a recent communication paradigm that envisions a near future [8], in which the objects of everyday life will be equipped with microcontrollers, transceivers for digital communication, and suitable protocol stacks that will make them able to communicate with one another and with the users, becoming an integral part of the Internet [10].In the above-mentioned papers, we notice different studies that emphasize on the need to be able to manage the amount of waste being generated and what percent of people take up the responsibility and take steps to ensure this [12]. Also, we can see how IOT modules are used to detect or track the waste for different waste bins or locations to be specific. We can also observe how with the use of IoT we can communicate between different devices and provide better solutions [14]. From and we can observe that a major percentage of waste is generated by building in different forms. This tends to put forward a simple observation that a very minor percentage of people take up the responsibility and regulate the amount of waste being generated from these main sources [16]. Therefore, this issue needs a proper solution. In and we can see how the IR sensors placed at appropriate position and ideal conditions can help detect the level of the waste generated and so be used to detecting the amount generated and equally take action on the same [13]. Also, in we can observe that minimal number of sensors placed at appropriate. Places can prove cost effective and very efficient but still a way for proper real time notification is not present. The paper explains us how the Wi-Fi chip can be used to communicate between different devices and therefore bring about many solutions in embedded systems. Therefore, our literature survey identifies [15].

3 Proposed System

The main aim of our project is to sense or detect the garbage in our surroundings. Here we are using IR sensor and Moisture sensor. In our daily life we are having dry wastage and wet wastage. In order to detect the wet waste, we are using moisture sensor and IR sensor is used to detect the dry waste. The total system is based on ESP32 Microcontroller. All the functions required for garbage detection can be done in ESP32 Microcontroller. Once, the

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garbage is detected it gives a message to authorized person through Blynk app. Through this Blynk app we can know that garbage is detected.

3.1 Smart Village Architecture

We are developing the two applications one is garbage management and next water level controller, in both we are uploading the values which are updating in the IOT app i.e., BLYNK which stores the information as a database, it is acts like a cloud storage system, as a new values are recording in the sensor it will upload to the blynk app, in this we are using the sensors like Ambient sensor for odour, PIR sensor to detect the level of wastage found in waste box, Moisture sensor is used to find the dry or wet levels of the waste, Liquid level sensor is used for level identification of water in the tank and float sensor used to open or close the value in the water tank. ESP32 this is a Wi-Fi module which is used to provide the internet to uploads the updated values, Motor driver was used to switch on or off the motor pump, all these works will be handled by the ESP32 micro controller which is works as a board but the input output pins are more, it has some conditions when those conditions are satisfied then it will moves for the next steps.

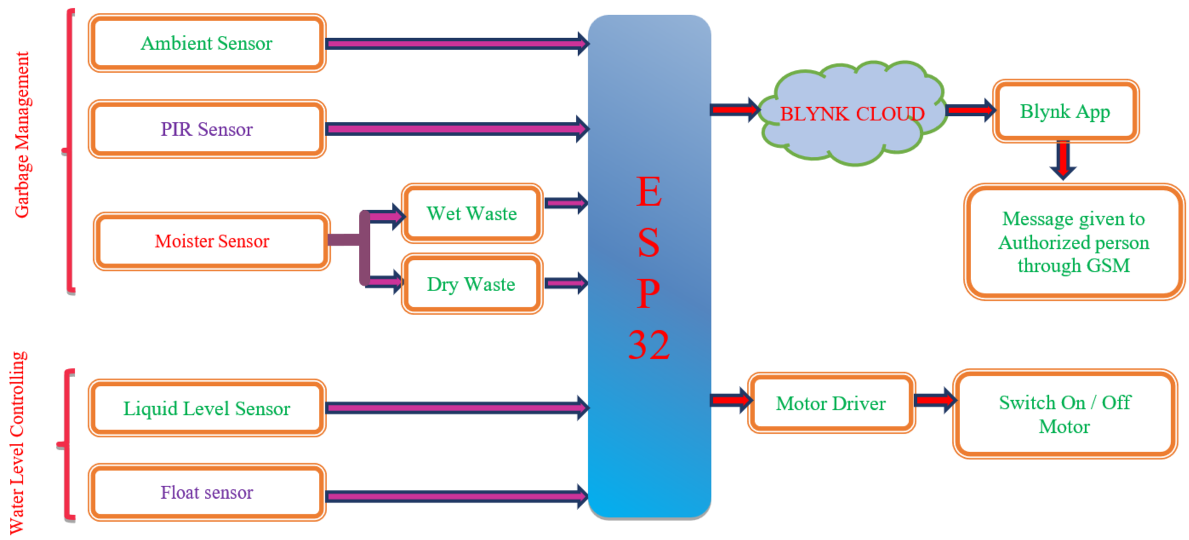

Figure 2: *Smart Village Architecture*

In these two applications after starting the device, after starting it display the garbage level in the waste box and water level in the tank values will be taken from the sensors and displays on the screen, when we put the waste in the waste bin it identifies the wet or dry condition then open one of the waste box, for example if the waste is dry then the dry tray is open and if the waste is wet then wet tray is open. The status is uploaded in the database by using the blynk app every time. The PIR sensor values are taken for identification of the filling level of waste in the waste bin. The ambient sensor values are taken for the odour level in the waste bin. Based on these levels if the tank is full 90% of the maximum level, then the

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alert msgs is given to the corresponding person to clean that waste bin. Although if it too bad smell, it can be identified by the ambient sensor then also the alert message is sent to the authorized person to clean the waste bin. In terms of water tank if the level is less than 10% of the maximum capacity it directly gives the trigger message to ESP32 to switch on motor pump. It gives the trigger signal to motor driver to switch on the motor. It will check for the water level using the float sensor if the water is available in sufficient level, then pump will be turn ON otherwise turn OFF the status of the pump was turn ON/OFF status will be uploaded into the cloud.

3.2 ESP32 Micro Controller

Few years back, ESP8266 took the embedded IoT world by storm. For less than $3, you could get a programmable, WiFi-enabled microcontroller being able to monitor and control things from anywhere in the world. Now Espressif (The semiconductor company behind the ESP8266) has released a perfect super-charged upgrade: the ESP32. Being successor to ESP8266; not only does it have a WiFi support, but it also features Bluetooth 4.0 (BLE/Bluetooth Smart) – perfect for just about any IoT project. When we think about using a microcontroller for a project, we usually consider an Arduino. It is inexpensive, easy to use and has a generous number of digital I/O ports, and a few analog inputs as well. But the Arduino, for all its wonderful benefits, is lacking in several areas. The first one is speed, the popular Arduino AVR series of boards run at 16 MHz. That is certainly fast enough to build thousands of applications, but it is a bottleneck for others. The Arduino certainly has enough digital outputs and inputs to satisfy most requirements, and its analog inputs are also useful. But adding features like WiFi and Bluetooth requires external components. Let us face it, the Arduino has been around since 2005. That is fifteen years, which in terms of technology is one. The ESP32 is a series of microcontroller chips produced by Espressif Systems in Shanghai. It is available in several low-cost modules.

Figure 3: *ESP-WROOM-32 Module*

The development board equips the ESP-WROOM-32 module containing Tensilica Xtensa Dual-Core 32-bit LX6 microprocessor. This processor is similar to the ESP8266 but

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has two CPU cores (can be individually controlled), operates at 80 to 240 MHz adjustable clock frequency and performs at up to 600 DMIPS (Dhrystone Million Instructions per Second). The development board equips the ESP-WROOM-32 module containing Tensilica XtensaDual-Core 32-bit LX6 microprocessor. This processor is similar to the ESP8266 but has two CPU cores (can be individually controlled), operates at 80 to 240 MHz adjustable clock frequency and performs at up to 600 DMIPS (Dhrystone Million Instructions per Second).

ESP32-WROOM-32 (ESP-WROOM-32) is a powerful, generic Wi-Fi+BT+BLE MCU module that targets a wide variety of applications, ranging from low-power sensor networks to the most demanding tasks, such as voice encoding, music streaming and MP3 decoding. At the core of this module is the ESP32-D0WDQ6 chip. The chip embedded is designed to be scalable and adaptive. There are two CPU cores that can be individually controlled, and the clock frequency is adjustable from 80 MHz to 240 MHz the user may also power off the CPU and make use of the low-power co-processor to constantly monitor the peripherals for changes or crossing of thresholds. ESP32 integrates a rich set of peripherals, ranging from capacitive touch sensors, Hall sensors, SD card interface, Ethernet, high-speed SPI, UART, I2S and I2C. The integration of Bluetooth, Bluetooth LE and Wi-Fi ensures that a wide range of applications can be targeted, and that the module is future proof: using Wi-Fi allows a large physical range and direct connection to the internet through a Wi-Fi router, while using Bluetooth allows the user to conveniently connect to the phone or broadcast low energy beacons for its detection. The sleep current of the ESP32 chip is less than 5 µA, making it suitable for battery powered and wearable electronics applications. ESP32 supports a data rate of up to 150 Mbps, and 20.5 dBm output powers at the antenna to ensure the widest physical range. As such the chip does offer industry-leading specifications and the best performance for electronic integration, range, power consumption, and connectivity. The operating system chosen for ESP32 is free RTOS with Lw IP; TLS 1.2 with hardware acceleration is built in as well. Secure (encrypted) over the air (OTA) upgrade is also supported, so that developers can continually upgrade their products even after their release.

3.3 PIR Sensor

An infrared sensor is basically an electronic device which is used to detect the presence of objects. PIR is emitted by this device. If this device does not detect any IR light reflected back that means there is no object present. If the light is detected by the sensor there is an object present. Its Range is up to 10 meters.

3.4 Blynk IOT

Blynk is a Server and APP Service providing Platform. It provides High Security Service and Server for IOT applications. This is easy to use and supports all advance Micro controllers. The focus of the Blynk platform is to develop the mobile phone application. Blynk is free to

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use for personal use and prototyping. Blynk also supports clients that are not a microcontroller.

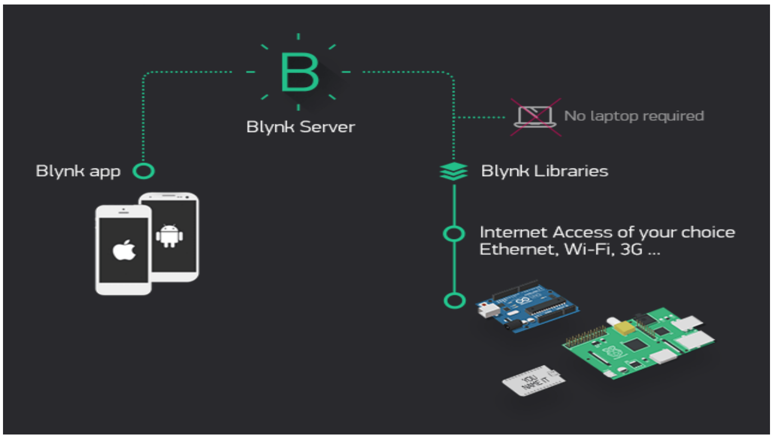

Figure 4: *Blynk App*

3.5 Float Sensor

The level of liquid in a tank may be determined via a float switch. The flipped switch might start a pump, activate an indicator, sound an alarm, or do anything else. Hydroponics, saltwater tanks, freshwater tanks, gardening, aquariums, pet bowls, fish tanks, filtration, heating, pumps, and ponds may all benefit from using them to regulate the power heads of their respective systems.

3.6 Water Pump

The R385 6-12V DC Diaphragm Based Mini Aquarium Water Pump is a great all-around non-submersible pump. With the addition of a nozzle, it may be utilised as a spray system due to its high pressure. This submersible pump may be used to water plants, build a waterfall or fountain, and even clean the water in a fish tank. It generates less than 30 decibels of noise when in operation. The pump is equipped with a filter and a suction cup for stable attachment to flat surfaces.

4 Working Principle

ESP8266 is a Wi-Fi module that links to a Wi-Fi/hotspot to provide an internet connection that connects to the Arduino board and uploads waste bin management, float sensor and pump switch ON/OFF state values to the IOT server (blynk). It will check the water level in the tank; if water is available, it will switch on the pump and water the plants. If the water level falls below a certain level or the earth becomes moist, the pump will be turned off. Garbage issues have become a serious thing in maintaining the cleanliness of the city. Many of the city areas are still without public garbage bins so the garbage is thrown at the roadside or at the corners in the locality, which creates ugliness at the corners. Due to no garbage bins,

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garbage is thrown in the small water reservoirs or the drainage water which creates blockages. In the rainy season, these blockages damage the water flowing system and then water overflows through the roads. In some areas the overflowed water blocks all the ways of transport or small floods within the city are generated. The open garbage containers pose problems for the people living in that vicinity as it becomes the breeding ground for insects like mosquitoes, germs, etc. which spreads numerous diseases. These open garbage areas create unhygienic conditions in those areas. In many of these areas, the garbage bins are not cleaned at regular intervals which means that no proper maintenance is kept in cleaning the bins. To avoid this, smart waste management and monitoring systems should be adopted. And for the adoption of these smart systems, there should be a paradigm shift towards the "Internet of things" i.e., IoT technology. This will help in optimizing the garbage management system and in reducing the consumption of the fuel by the current system. Some of the projects on smart garbage management and monitoring system have been implemented using IoT technology and has been proved to be very effective for environmental issues.

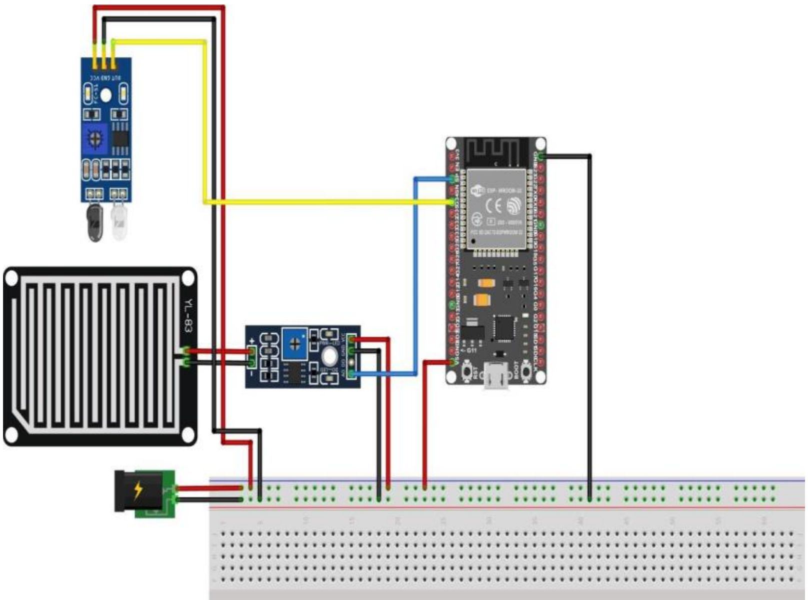

Figure 5: *Schematic Diagram*

The Internet of Things (IoT) is shaping and touching our lives in every sphere. IoT based garbage monitoring system is an innovative project idea for maintaining the clean environment of the city. The smart garbage bins have Ultrasonic Sensors placed on the lid which detects the garbage level in the bins. By this, the garbage bins can be monitored and the monitoring information can be obtained through the webpage. The level of the garbage is compared with the depth of the bins. This system comprises of an AVR family Microcontroller, Wi-fi modem, LCD display along with a buzzer & also a 12V transformer associated with it. The Wi-fi modem is used to send the data. The garbage status will be shown on the webpage. The level of the garbage collected in the bins will be shown on the

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LCD display. The webpage is quite useful, as the information is displayed in graphical representation & the garbage level will be displayed in different colors. The bins have been set with a limit after the garbage overflows the set limit the buzzer gets pressed which further sends alert to the user to empty the bin.

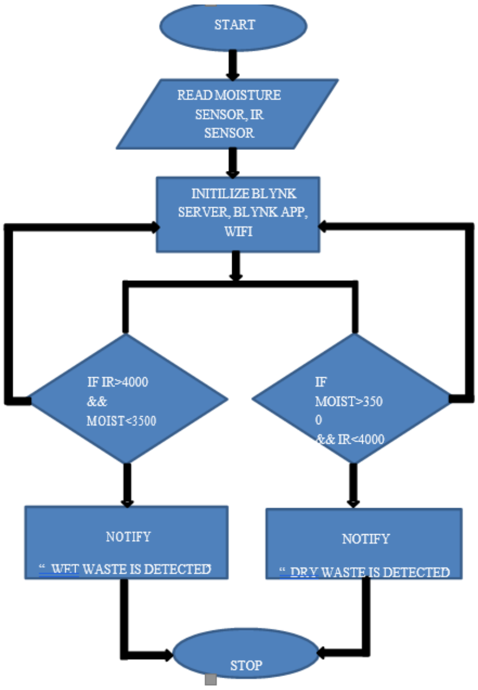

Figure 6: *Flow Chart for attendance*

If the moisture is more than 350, we may consider the waste bin to be dry. It then proceeds to the next stage, which is to check the water level in the tank. If the water level is below the minimum needed level, the controller will switch on the pump, and the float sensor value is 1. The pump will switch off automatically, and the status of pump turn on/off will be uploaded into the IOT app (blynk). If the moisture is less than 350, the pump will not check for water level and will not turn on. The flowchart will appear below. As per conditions, the water supply will be only turn ON when the water is sufficient and if the ground dryness is high as per, we programmed in the code.

5 Experimental Analysis

Here we see a true SMART VILLAGE: a Digital Transformation of Modern Village Using ESP32 Microcontroller in action. The BLYNK app, an IoT platform, will receive data from the sensors and monitored by the system that we developed.

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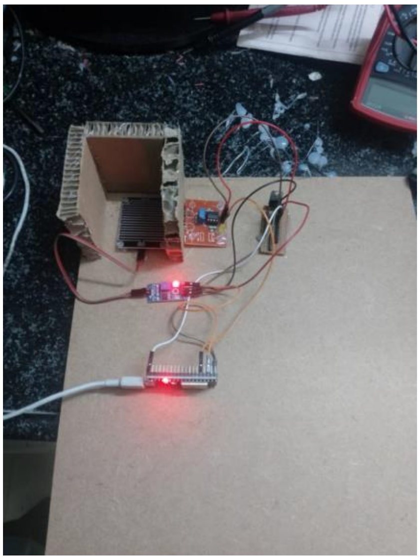

Figure 7: *Experimental Results*

5.1 Numerical Representation of Input Corresponding Output Element

Table 1: *Numerical representation of Results*

Component	Input	Output
Ambient Sensor	Check Odour	Verify the records and send the information to the server. Information sent via message to authorized person to clean.
PIR Sensor	Check the level in waste bin	Verify this with the data bank. Based on the level reached 80% of total capacity alert will be given to the authorized person.
Moisture Sensor	Moisture value>350	Based on moisture level the wet waste and dry waste is separated.
Liquid Level Sensor	Water Level >= 90%	The water level should be checked. When sensing an adequate water level, the pump will activate and a corresponding data set will be sent to the server.
Float Sensor	Open or close valve	It will stop pumping and send a file to the server.

6 Conclusion and Future Scope

The final goal of this paper was to evaluate and analyses the performance of the constructed system. We completed the testing and assessment, demonstrating the project's satisfaction. It also demonstrates how important it will be in villages by increasing handling of garbage and water tank. It can be observed that the initiative met its objectives with excellent results. The limits of this study were examined, as well as how they might be solved, as described in the recommendations and suggestions for future research. Lastly, in this project, a recognition sensor or camera may be utilised to detect waste management, which will be more advanced than these sensors. As a result, this technology may also be employed at all villages with minimum cost. In addition, I recommend including local hosting with internet since if the internet goes down, the local host can register the data's for smart villager. Future study will benefit from what built since it is likely to be more accurate by utilising additional sensors or a more complex algorithm, but this will only be achievable when microprocessors such as Arduino release new and more powerful variations with improved capabilities.

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