



## Revolutionizing Smart Cities, Agriculture, and Healthcare with IoT

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### Abstract:

The Internet of Things (IoT) technology has transformed various aspects of human life, enhancing convenience. IoT involves connecting a wide range of physical objects to the Internet, creating a self-configurable network without human intervention. This trend enables organizations to automate processes and enhance service delivery through Internet technology and cloud-based data transfer. Today, IoT is a prominent topic of discussion among researchers, specialists, and experts, representing the next phase in the Internet's evolution. This paper explores the application of IoT technology in smart cities, healthcare, and agriculture.

**Keywords:** Smart agriculture, Smart Healthcare, Internet of Things, Smart City, Smart Parking,

### 1. INTRODUCTION

The term Internet of Things (IoT) was first introduced by British engineer Kevin Ashton in 1999 to describe a system where physical objects are connected to the Internet. Since then, the concept has evolved to encompass a wide range of connected objects, sparking discussions among researchers and experts as the next phase in Internet evolution. The IoT enables seamless communication between all elements of our environment with minimal human intervention, utilizing both wired and wireless networks to create innovative applications like smart homes, cities, energy networks, transportation systems, and more. By leveraging sensors and software tools, individuals can enhance their living environments, optimize resource utilization, and automate daily tasks. The IoT offers numerous benefits in managing public services, improving agriculture practices, and enhancing healthcare services. Through remote monitoring and control, IoT technologies streamline processes and reduce the need for constant human oversight. In the realm of smart health, IoT applications facilitate patient monitoring and treatment observation, empowering healthcare professionals and patients with timely and accurate information. This article delves into various IoT applications in smart parking, agriculture, and healthcare, highlighting their strengths and weaknesses while proposing enhancements to drive technological advancements and support researchers in leveraging the latest tools and techniques.

## 2. RELATED WORKS

In the IoT field, significant advancements have been made, particularly in areas like smart parking, smart cities, agriculture, and health monitoring. For instance, smart parking solutions leverage IoT technology to address parking challenges in urban areas. Researchers like Wang, Pham, Fraifer, and Khanna have contributed to developing smart parking systems using IoT and cloud services. In agriculture, Thakur et al. have proposed devices for measuring temperature, soil moisture, and enabling automatic irrigation. Similarly, in health monitoring, researchers like Acharya, Trivedi, Gregoski, and Kumar have introduced IoT applications for monitoring vital health parameters using sensors and devices like Raspberry Pi and Arduino. These innovations showcase the potential of IoT in improving various aspects of our daily lives.

## 3. SMART PARKING

In the realm of smart cities, Balhwan et al. [19] introduced a smart parking system to locate available parking spaces in parking areas without requiring manual

intervention. This system aims to reduce the time and fuel spent on searching for parking spots. By deploying various sensors in the parking area, the system can determine the availability of parking spaces. Users can conveniently access this information via the Internet. The smart parking prototype can detect whether a parking area is free or occupied, and the data collected by the sensors is transmitted to the cloud. Users can then access this information using an Android device.

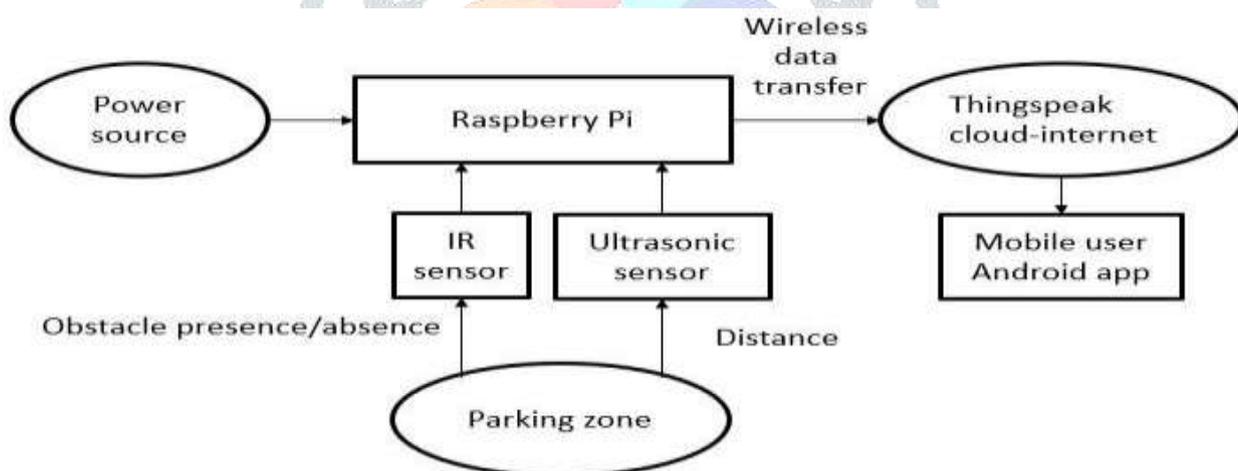


Figure 1: Architecture of smart parking system [19]

Balhwan et al. [19] conduct the following steps:

- ✓ Utilize sensors (ultrasonic sensor and IR Sensor) with Raspberry Pi to measure parking space occupancy.
- ✓ Transmit the data to "Thing Speak" via Raspberry Pi's internal Wi-Fi after detecting the presence or absence of an obstacle.
- ✓ Store the data on the ThingSpeak cloud and display it graphically.
- ✓ Enable a user's mobile application to connect to the cloud and access information on parking space availability (free or occupied).
- ✓ Utilize sensors (ultrasonic sensor and IR Sensor) with Raspberry Pi to measure parking space occupancy.
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- ✓ Store the data on the Thing Speak cloud and display it graphically.
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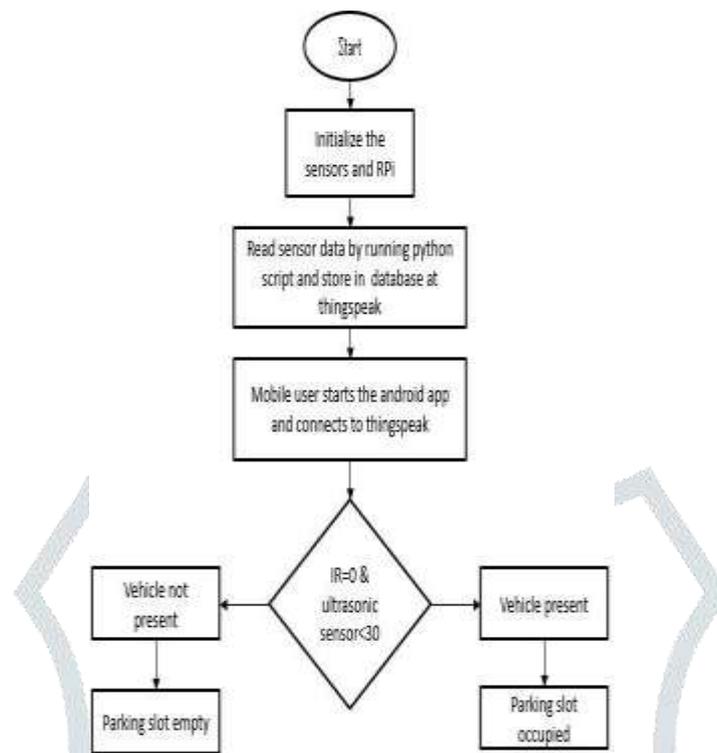


Figure 2: Diagram of smart parking system [19]

### 3.2 Discussion

The proposed IoT application by Balhwan et al. focuses on a Smart parking system that efficiently locates vacant parking spaces without manual effort, saving time and fuel. However, it lacks online reservation with payment functionality. To enhance this prototype, users can query the system for available spaces, select a slot, proceed to payment, receive a generated barcode for entry, and update the database. Offline reservation is also available for manual payment at the gate. The system includes a display screen, barcode reader, and DC motor for door access. Adding GPS can further improve efficiency by indicating free parking spots. Transitioning from smart city to agriculture domain, studying IoT applications by Krishnan et al. is recommended for further insights.

### 4. SMART AGRICULTURE

The system designed by Krishnan et al. aims to address the challenges faced by farmers in managing their agricultural fields efficiently. It consists of four main units: the end device node, coordination node, webserver node, and mobile control unit. The end device node includes various sensors like soil moisture, temperature, and humidity sensors, along with an Arduino controller, GSM, and motor. Data collected from these sensors is transmitted to the coordinator node, which then communicates with the web server for real-time monitoring. The system allows for remote monitoring and control of irrigation processes using fuzzy logic for motor control. It also incorporates solar power and battery backup for uninterrupted operation. The system automatically adjusts water pumping based on soil moisture levels and stops pumping during rainfall to conserve electricity. Overall, this innovative system enhances farm management and crop protection through advanced technology.

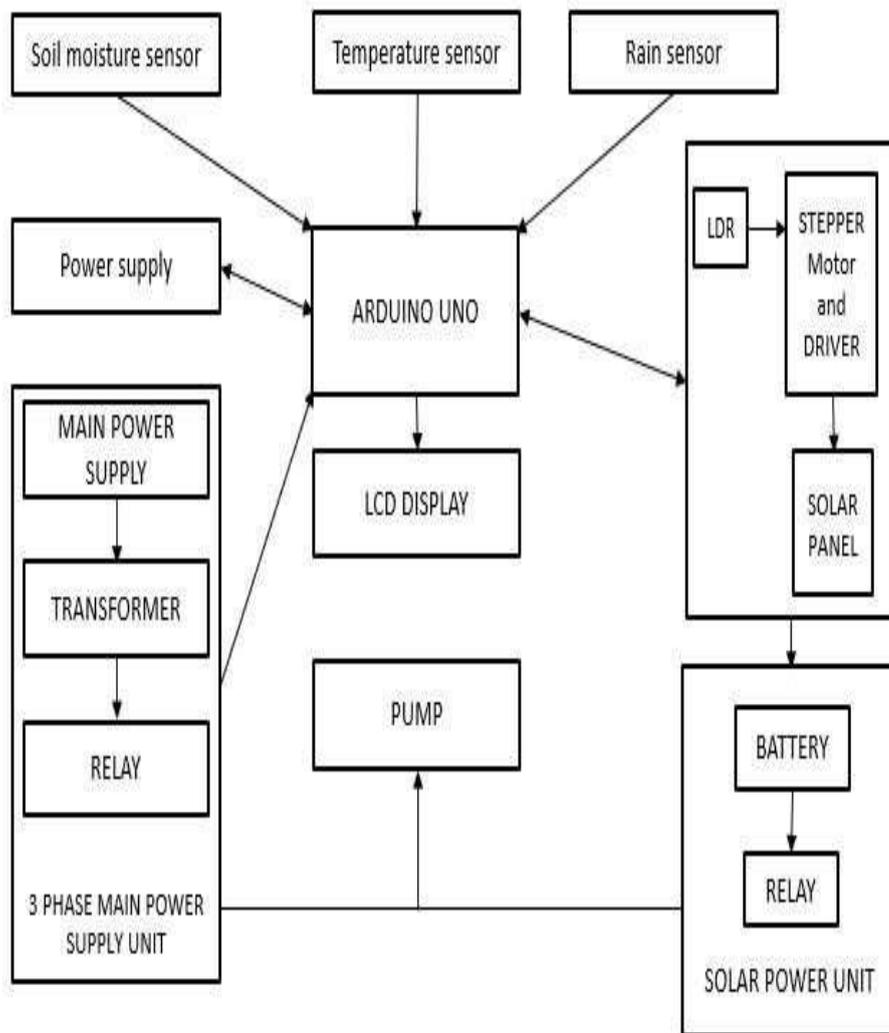


Figure 3: Architecture of smart irrigation system [19]

- ✓ The GSM modem is initialized as soon as the power supply is turned on.
- ✓ Using AT commands, the GSM modem communicates with Arduino.
- ✓ The LCD screen is linked to Arduino so that the data monitored by the sensors is displayed correctly.
- ✓ First, the processor checks the availability of solar energy with the help of a light- dependent resistor (LDR) to detect sunlight. The solar panel is interfaced with the stepper motor, which in turn is linked to the stepper motor driver.
- ✓ The solar panel rotates both clockwise and counter-clockwise and stops where the maximum sun intensity is obtained and stores the energy in the battery.
- ✓ In the case of availability of solar energy, water is pumped to the agricultural field with the help of solar energy or with the help of mains (3 phase lines).
- ✓ The soil moisture sensor checks the soil moisture content, which is maintained at a maximum of 850 (indicating dryness) and a minimum of 500. When the soil moisture content is above 700, the engine will pump water to the agricultural field.
- ✓ The temperature sensor measures the ambient temperature of the farm.
- ✓ The rain sensor detects heavy rain and shuts down the engine to save electricity. It also shuts down the panel to protect the crop.
- ✓ All information collected from the sensors will be transferred to the user using GSM technology.

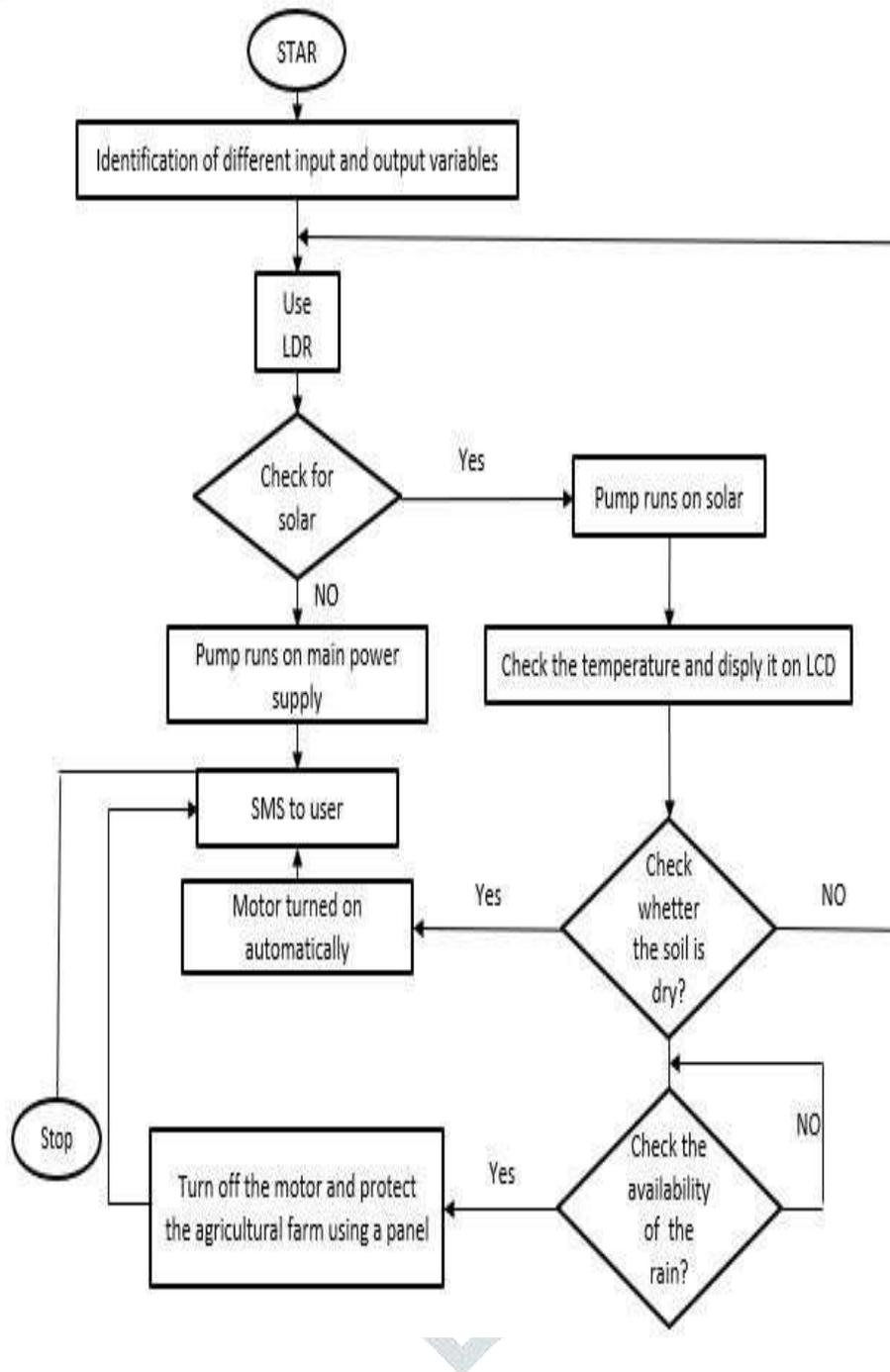


Figure 4: Diagram of smart irrigation system [19]

## 4.2 Discussion

Krishnan et al. [20] introduced a smart irrigation system designed to aid farmers in watering their fields efficiently. By utilizing a mobile application, this system addresses the energy-intensive nature of traditional agricultural watering methods. It delivers status updates on soil moisture levels, ambient temperature, and engine status in relation to power sources like mains electricity or solar energy. The smart irrigation system employs a fuzzy logic controller for computing input variables such as moisture, temperature, and humidity to determine engine status outputs. Furthermore, the system automatically switches off the motor during rainy periods to conserve energy. The outcomes demonstrate tangible water and energy savings resulting from this innovative irrigation approach. The flowchart illustrated in Fig. 4 and the schematic in Fig. 3 outline three primary functions: temperature monitoring, soil moisture assessment, and rainfall detection. However, a critical aspect missing from the prototype is field security. To enhance the system, it is imperative to incorporate field intrusion detection as an additional functionality to ensure comprehensive protection and monitoring of the fields. The system now includes intrusion detection, which utilizes a passive infrared (PIR) sensor. Whenever an intrusion is detected in the field, users will be promptly alerted via

GSM technology. This addition significantly enhances field security, a crucial aspect that had not been addressed by Krishnan et al. [20].

The study by Krishnan et al. [20] outlines a smart irrigation IoT application. Transitioning from smart agriculture to the smart health domain, we will now delve into the IoT application crafted by Islam et al. [21].

## 5. SMART HEATHCARE

Islam et al. [21] proposed a system focused on continuous online monitoring of patients and patient room status. The implementation involved assembling various hardware components, with all sensors connected to an ESP32 via physical pins. The ESP32, equipped with a built-in Wi-Fi module, serves as the processing device. The circuit diagram of the system is illustrated in Figure 5. In Figure 5, the user prototype demonstrates the system being tested with a user, and the data is showcased on the web server.

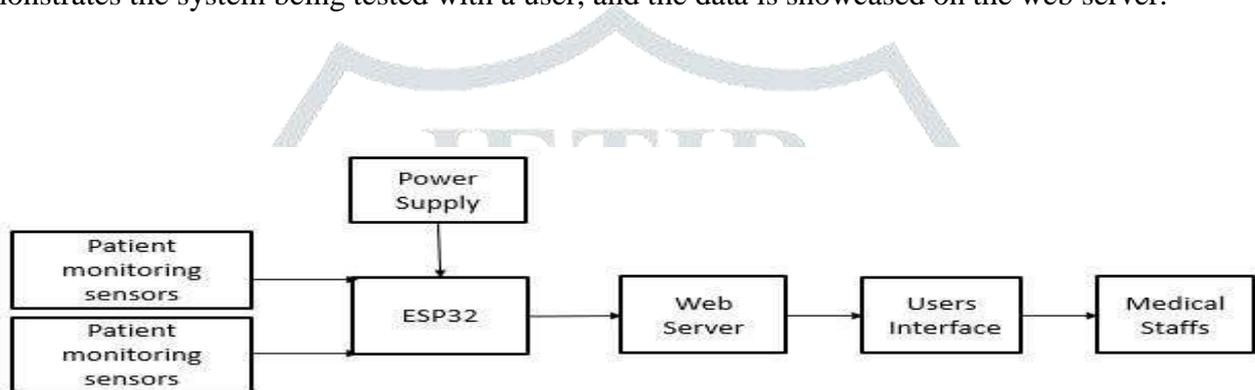


Figure 5: Architecture of smart healthcare system [21]

### 5.2 Discussion

Islam et al. [21] have proposed an arrangement of medical services checking in clinics. Medical services checking frameworks with arising innovations are currently turning into an extraordinary worry for some nations all over the planet. The appearance of the Web of Things (IoT) innovations is working with the advancement of medical services. The savvy wellbeing framework proposed by Islam et al. [21] in the IoT climate it can screen the wellbeing status of a patient as well as the situation with the room where the patients are continuously.

In this framework, five sensors are utilized to catch the information from the emergency clinic climate called pulse sensor, internal heat level sensor, room-temperature sensor, CO2 sensor and Co sensor.

The rate mistake of the created plot is inside a specific breaking point (<5%) for each case. The situation with the patients is sent through an entryway to the clinical staff, where they can process and investigate what is happening of the patients. The created model is appropriate for medical services checking which is demonstrated by the proficiency of the framework.

This framework conquers the downsides of the current component by making it a more productive technique for observing the wellbeing boundaries of patients. It enjoys the benefit of less expense, less time, low power. Precise estimation of pulse and other wellbeing boundaries of patients are conceivable and assume an imperative part in checking the wellbeing status of patients. The sensors send information remotely to the server utilizing IoT. The essential actual boundaries are estimated ceaselessly. It makes the patient more open to utilizing these convenient gadgets. The qualities recorded by this framework are more exact and exact. It diminishes the time consumed by the manual technique. As these values are recorded ceaselessly [22], the responsibility of the specialists is decreased. These qualities can likewise be shipped off different experts by email.

As indicated by the examination of the IoT application proposed by Islam et al. [21], it is observed that it is critical to keep the data of a patient's clinical measurements in the cloud [23], as it tends to be very valuable later on.

Keeping the records will permit the patient to go with large numbers of the decisions, for example, regardless of whether they need to get more fit, which drugs are basically adversely affected by the patient, and a lot other fundamental data [24]. This information base ought to likewise assist the specialist with interpreting the patient's actual issue and its starting point, to give a superior finding. To show the general work process, Fig. 6 is proposed

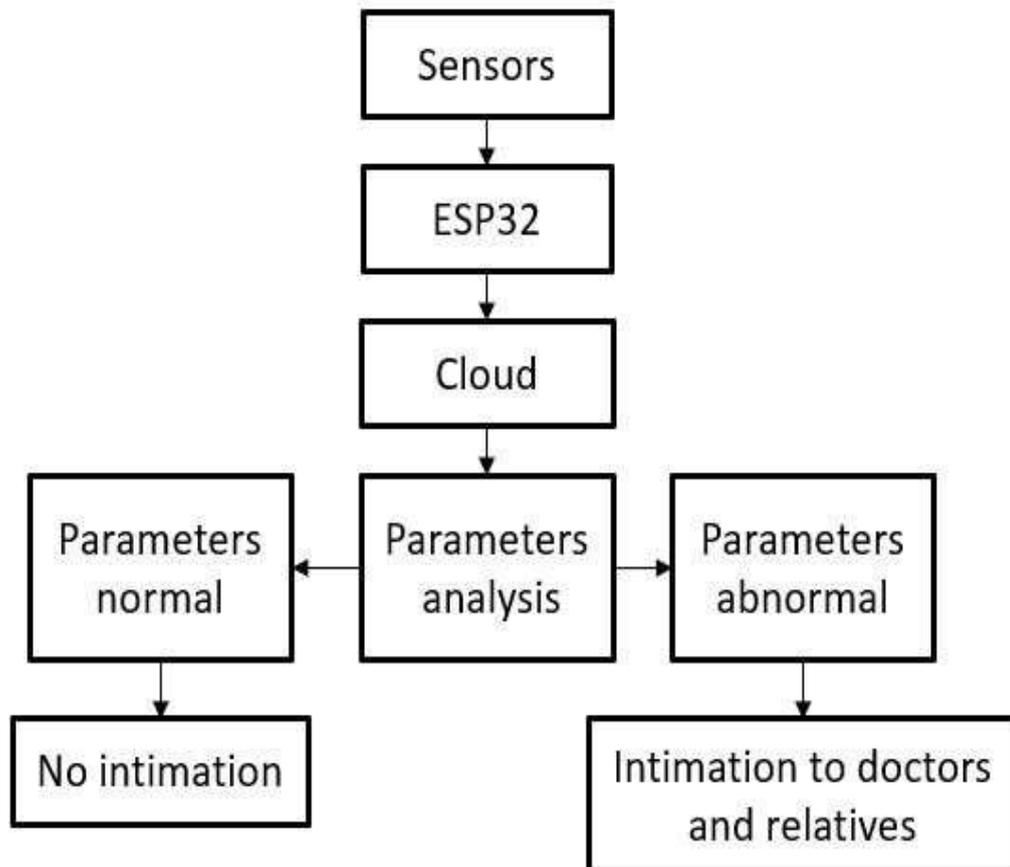


Figure 6: Diagram of smart healthcare system [21]

To work on this framework later on, the examination of a piece of the plan can be created by applying AI and man-made reasoning calculations.

### 6. ISSUES AND LIMITATIONS

As indicated by our investigation of the three areas of brilliant agribusiness, shrewd medical services, and savvy stopping, much has been finished and much still needs to be finished. The accompanying table sums up a portion of the inadequacies of the three models concentrated beforehand and proposes enhancements.

Article	Application IOT	Gaps	Improvements	Techniques and tools

## 7. ANALYSIS AND FRAMEWORK

In our recent study, we examined three IoT applications - Smart City, Smart Healthcare, and Smart Agriculture. We successfully highlighted the advantages and limitations of each application, proposing enhancements using cutting-edge technologies, tools, and techniques.

Balhwan [19]	Smart parking	The absence of an online booking system with payment.	Add an online booking system.	Develop a secure web application managed by the administrator.  Develop a secure mobile application managed by the user.  A barcode to get an entrance to the parking area.
Krishnan [20]	Smart agriculture	The lack of safety In agricultural fields.	<i>Detect instructions Into agricultural Fields.</i>	<i>Detect the intrusion using a passive infra-red(PIR) sensor.</i>
Islam [21]	Smart healthcare	The absence of Machine learning And Artificial Intelligence.	Analyzed the design part of the application	Using machine learning algorithms and Artificial intelligence.

## 8. CONCLUSION

In our study, we examined the Smart City, Health, and Agriculture domains of IoT, highlighting strengths and weaknesses in each area. We also suggested enhancements for these IoT applications. This research aims to assist future researchers in enhancing their work by leveraging the latest technologies, tools, and techniques. Future research should emphasize creating and deploying new IoT application models, incorporating the provided recommendations for each domain. The primary goal is to reduce errors and enhance the efficiency of IoT applications within Smart City, Health, and Agriculture sectors. In our upcoming project, we aim to introduce a novel IoT application model tailored to the agricultural sector to advance IoT utilization in fostering the development of Morocco.

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