IOT-DRIVEN INTEGRATED SMART LAB PREDICTIVE POWER AND AUTOMATION

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ABSTRACT:
Integrated Smart Laboratory with IoTenabledPredictive Power and Automation, which aims to impro ve laboratory operations with Internet of Things (IoT) technologies. The system includes realtime att endance, health monitoring, automatic operations, energy usage tracking and machine learning algori thms. It is also equipped with a smart waste disposal system to improve cleanliness, all devices are c onnected to a central platform that can be connected to a dashboard via a network interface for remot e control. light monitoring and control. The system promotes efficient energy use and minimizes ope rational interruptions by predicting energy consumption patterns and analyzing energy consumption. The focus of the project is to transform the test environment and provide smarter, safer and more effi cient solutions to increase productivity, energy efficiency and safety.
Keywords: - Automation, Internet of Things (IoT), Laboratory, Sustainability.

INTRODUCTION:
Integrating IoT and sensor automation in technological innovation is vital to enhance operations and control. Our challenge "included IoT-primarily based smart Laboratory Predictive capabilities and Automation" utilizes the capabilities of numerous sensors consisting of ultrasonic sensors, node microcontrollers, EM18, cutting-edge sensors, and PIR sensors to perform movement tracking and cargo manage [3]. The device makes use of RFID generation to accurately and appropriately tune humans entering and exiting the laboratory, presenting correct attendance records. Integrating these sensors now not handiest helps the gadget, but also improves power efficiency and cargo control, ensuring the performance and productiveness of smart laboratories [3]. advanced energy optimization strategies for microwave radar sensors. at the same time as traditional sensors track strength intake and enable records-pushed choices to improve power performance, radar sensors permit smart asset control based on occupancy ranges, thereby growing electricity financial savings. This integration allows create a good running environment in clinical laboratories [4]. The device may be controlled and monitored through the Blynk cellular app, which offers customers with a simple tool to control their checking out workflow. This mission has proven the power of electric force systems to reach the degrees of performance, reliability and productiveness required via modern laboratories [4].

LITERATURE:
The integration of IoT into smart laboratories has been really significant in the past few years, enhancing automation, monitoring, and predictive capabilities. Various research studies have been

conducted on different aspects of IoT-based smart systems such as waste management, energy optimization, and health monitoring. Mohamed et al. [1] present the idea of an intelligent trash bin system, which can be used for smart cities through IoT and sensor-based automation to improve waste disposal efficiency. Their work emphasizes the importance of automation in waste management, reducing the manual intervention of people and keeping track of the waste levels in real time. Similarly, Srinivas et al. [2] developed an IoT cloud-based smart bin, which depicts how connected waste bins improve the cleanliness of urban areas and optimize waste collection. Their research also emphasizes the importance of IoT in making waste disposal systems more sustainable and efficient. Many research studies in the field of energy management have used IoT-based load automation to avoid unnecessary power consumption. In a study by A. V et al. [3], the authors designed a movable smart bin with WiFi-based control for remote operation and monitoring. The results of this research show that real-time control and automation are potential means for the optimization of system operations. Research studies are also prominent for IoT-enabled health monitoring systems. Several projects used wearable or contactless sensor-based systems that were implemented for the tracking of parameters like heart rate, SpO2, and temperature. They provide real-time monitoring and access from anywhere as well as predict analytics in detecting early health issues. The proposed IoT-Driven Integrated Smart Lab for Predictive Power and Automation uses these existing technologies, integrating smart attendance tracking, load automation, waste management, and health monitoring into a single system. Using real-time data acquisition and machine learning algorithms, this project aims to enhance energy efficiency, safety, and lab automation. The review of existing literature shows that although individual components like smart waste bins, load automation, and health monitoring have been extensively studied, an integrated approach combining all these elements within a smart laboratory setup remains an area of active research. This study aims to bridge this gap by developing a holistic IoT-based solution to improve lab efficiency and sustainability.

METHODOLOGY :

Components Specifications

Servo Motor

Function: **It is the mechanical power used in** automation **work.**

Specifications: 5V or 6V operating voltage, 180-degree rotation, 1.2 kg-cm torque. Role:
Controls the movement of the smart bin lid.

MAX30102

Function: Measures blood oxygen (SpO2), **temperature** and pulse **rate.**

Specifications: I2C communication, 1.8V to 3.3V operation, integrates LEDs and photodetector.

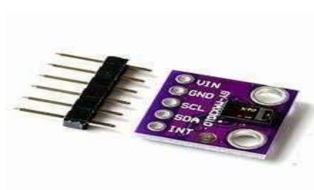

Fig.2.1 MAX301002 Sensor :

RCWL Microwave Radar Sensor Function: Detects motion using radar waves.

Specifications: 5V operating voltage, microwave frequency, 7-meter detection range. Role:
Detects human presence for load automation and smart attendance.

Fig.2.2 RCWL Microwave Radar Sensor

ESP32 CAM
ESP32CAM can capture images or videos **in real time** and **transmit** them wirelessly for remote m onitoring and **control.**
Equipped with 2MP camera.

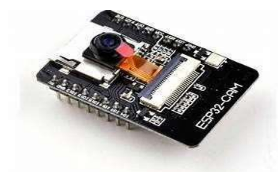

Fig.2.3 ESP32 CAM

Hardware Implementation Smart Attendance System:
EM18 RFID module is **used** to read RFID cards or **tags for personal** identification **at attendance system**.

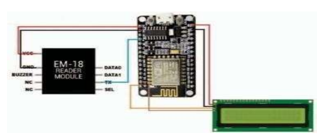

Fig.2.4 Attendance Circuit

When an RFID card or tag is placed near the EM18 module, it reads the **card** ID and sends **the** data to a connected microcontroller such as a Node MCU. The LCD screen then displays the successful c ompletion of the transaction.

Loads Automation:

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The images below show a loading automation system that uses RCWL microwave radar sensors for motion detection, allowing equipment to be operated as effortlessly as humans. This configuration in creases efficiency by controlling the load only when needed. RCWL microwave radar sensors detect motion and enable smooth and efficient automation of connected devices.

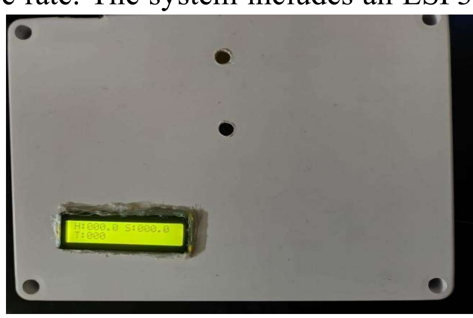
Movable Smart Bin:

The figure above shows the hardware configuration of a smart mobile device. Designed to open its d oors when it detect movement nearby, the system can be controlled via the Blynk app, allowing for easy, hands-free disposal.

Fig 2.7 Movable smart bin

Health Monitoring System:

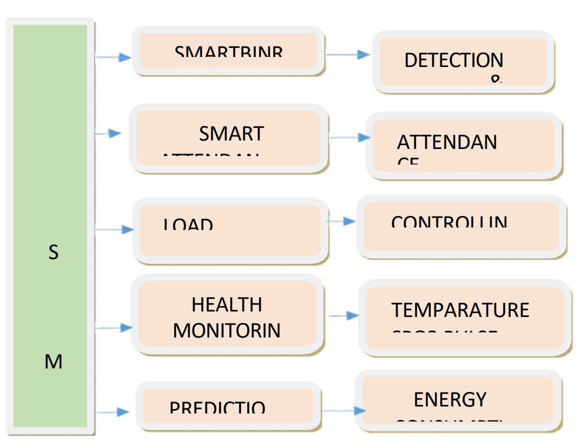
The hardware devices represent a health monitoring system designed to measure vital signs such as t emperature, SpO2, and pulse rate. The system includes an ESP32CAM module that captures images,



provides visual updates, and writes text and sends it to email.

Fig:2.8Health monitoring system

I. BLOCK DIAGRAM



Thisblockdiagram shows a multisensor smart lab with four key features designed toimprove automation, health monitoring, and energy efficiency. Smart trash cans can detect people, be moved, moved, and opened to dispose of trash, allowing for handsfree use. Smart attendance can track attendance to ensure accurate data and efficient operations. Load Automation provides remote control and monitoring of home appliances, improving comfort while reducing energy consumption. Health monitoring systems measure vital signs such as body temperature, SpO2, and pulse rate, and have the potential to predict early health problems. Finally, monitoring energy consumption and improving the overall energy efficiency of the system promotes sustainable energy use [4]

RESULTS

Smart Attendance System:

1	Date	Time	Card ID	Name	Roll No
2	2024-11-04	13:17:46	55005A1BF6E2	MD Wasim Akhram Ali	22E55A0211
3	2024-11-04	13:19:01	550039617D70	V.Akhilsai	22E55A0221
4	2024-11-04	13:19:11	550039617D70	V.Akhilsai	22E55A0221
5	2024-11-04	13:19:27	55005A1BF6E2	MD Wasim Akhram Ali	22E55A0211
6	2024-11-04	13:20:57	4C00D74F01D5	Unknown	Unknown
7	2024-11-04	13:21:48	4C00D74F01D5	MANIK MANOHAR	23E51A0207
8	2024-11-04	13:22:05	4C00D5E9E999	Unknown	Unknown
9	2024-11-04	13:22:30	4D00870DC007	Unknown	Unknown
10	2024-11-04	13:23:26	4D0087B05F25	Unknown	Unknown
11	2024-11-04	13:23:45	4D0087B05F25	VEMULA ASHRITHA	23E51A0216
12	2024-11-04	13:24:23	4C006763EFA7	Unknown	Unknown
13	2024-11-04	13:30:10	4C00D75EBF7A	Unknown	Unknown
14	2024-11-04	13:30:24	4C00D75EBF7A	Unknown	Unknown
15	2024-11-04	13:30:55	4C0067CC6483	Unknown	Unknown
16	2024-11-04	13:31:04	4C00D75EBF7A	ERUKALA VAMSHI	23E51A0203
17	2024-11-04	13:31:13	4C0067CC6483	Unknown	Unknown
18	2024-11-04	13:31:45	4C0067CC6483	RAMAGIRI CHANDRA SAI CHARAN	23E51A0210
19	2024-11-04	13:32:24	5500378E42AE	Unknown	Unknown
20	2024-11-04	13:33:16	5500378E42AE	NALLAGONDA PRUDHVY NARAYANA	22E51A0221
21	2024-11-04	13:33:27	4C0067D0BD46	Unknown	Unknown
22	2024-11-04	13:33:49	4C0067D0BD46	KOPPULA PRANEETH	23E51A0206
23	2024-11-04	13:39:11	55005A1BF6E2	MD Wasim Akhram Ali	22E55A0211
24	2024-11-04	13:39:28	55005A1BF6E2	Unknown	Unknown
25	2024-11-04	13:45:00	4C0067D0BD46	KOPPULA PRANEETH	23E51A0206

fig.1: Retrieving data from the Attendance System to Google Sheets

The presentation includes basic information such as ID number, name, time and date, ensuring that all participation is recorded accurately. This information is reflected on both the LCD screen and Google Spreadsheets anddashboards with real-time updates, providing efficient tracking and access.

Loads Automation:

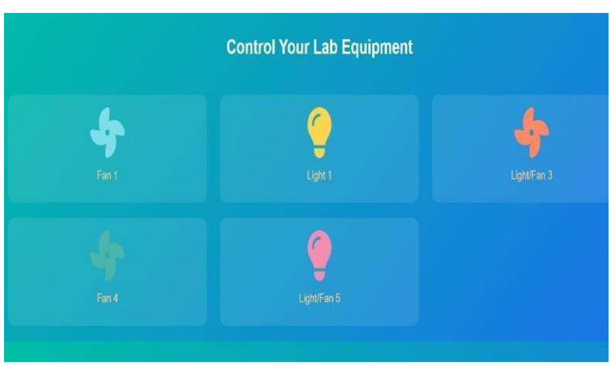


Fig. 2: Dashboard controlling diagram.

The visuals below show how automation enables seamless data management by processing both onli

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ne and offline data. This ensures continuous data ingestion and synchronization, operating reliably re gardless of network connectivity.

DATE	ON TIME	OFF TIME
04-09-2024	01:04 AM	01:46 PM
05-09-2024	09:06 AM	10:05 PM
06-09-2024	10:34 AM	11:48 PM
09-09-2024	09:14 AM	11:51 PM
10-09-2024	09:09 AM	12:43 PM
11-09-2024	09:39 AM	10:46 AM
12-09-2024	08:17 AM	05:55 PM
13-09-2024	09:06 AM	10:43 AM
16-09-2024	09:37 AM	12:22 PM

Table 1: loads dashboard data

Plug load monitoring

Fig 3: Retrieving current data from the loads to thing speak

Fig.4: Retrieving Power from the loads to thing speak

Fig.5: Retrieving KWH from the loads to thing speak

Movable Smart Bin:

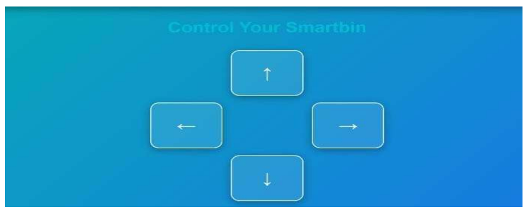

Fig.6 Controlling the smart bin by the blynk

The images below show the forward and backward movement of the bin controlled by the Blynk app .This setup allows the base station to be controlled remotely, while Blynk provides instant movement control to the desired location. The system can also collect and update information on the status of w aste disposal sites, improving remote monitoring and operational accuracy

The image above shows the motor control used by Blynk that controls the forward and backward mo vement of the bin. This setting allows remote control of the bin movement via the Blynk app.

The image above shows how Thing Speak displays the data displayed on the screen, providing realti me monitoring and visualization. This allows users to track and analyze the status and performance o f their bins through the Thing Speak platfom

Fig.7 Data receiving from the Smart bin

The above diagram illustrates Thing Speak displaying the bin's wastage level data results.

Health monitoring system:

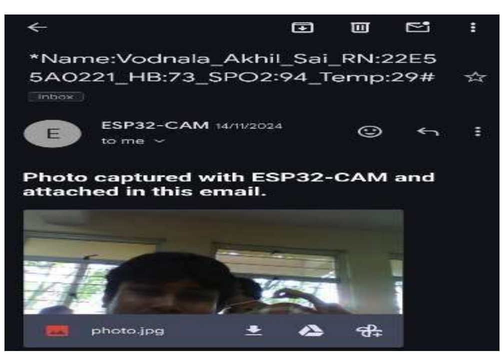

Fig:8 Body parameters& picture sent to the admin mail

Experimental results show that the health monitor can measure vital signs such as heart rate, SpO2, and body temperature and send them directly to the administrator via Gmail. The system also captur es live images of the human body using ESP32CAM and sends them as email notifications. The addition of attendance tracking further enhances monitoring capabil ities.

CONCLUSION :

The Internet of Things (IoT)powered smart laboratory integration and automation project successfull y combines healthcare, smart attendance, and transportation automation to create a more efficient an d intelligent laboratory environment. Load automation helps improve energy efficiency and sustainab ility by optimizing energy consumption by dynamically adjusting energy usage based on data. By int egrating these resources into a unified system, the system increases operational efficiency, safety, an d convenience, demonstrating Yam's vast potential in transforming traditional laboratories into smart , connected, and sustainable facilities.

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