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IOT-BASED INPLANTABLE AI PILLS(TABLET) DEVELOPMENT FOR USING MEDICINE TRACKING

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Abstract : The rapid advancement of healthcare technology, there is a growing demand for smart systems that can monitor health in real-time and provide personalized care. This project proposes an IoT-based implantable AI pill system for continuous health monitoring and medicine tracking. The system employs the MAX30102 sensor, which is capable of measuring key health indicators such as heart rate, SpO_2 (oxygen saturation), and body temperature. These values are acquired through an ESP8266 microcontroller, which acts as a driver for the sensor and transmits the data to a Raspberry Pi 3B+ using serial communication. Once the data reaches the Raspberry Pi, it is processed using multiple machine learning algorithms, including SVM, KNN, Random Forest, Logistic Regression, LSTM, and XGBoost to predict whether the user's health condition is normal or abnormal. In addition to health prediction, the system incorporates an intelligent medicine reminder module. The user can predefine time slots morning, afternoon, and night for medication intake. At each time slot, an alarm is triggered on the Raspberry Pi, and a Telegram alert is sent to the concerned person. To enhance reliability, the system captures a live photo using a connected camera at the time of the alert, providing evidence of medicine intake. It also sends a message indicating whether the medicine was taken or missed, ensuring full transparency and accountability. By integrating IoT, AI, and cloud communication, the system enhances personal healthcare by making it predictive, proactive, and connected.

Keywords: AI-Based Algorithms, Raspberry Pi, Remote monitoring, Wireless Health Monitoring.

I.INTRODUCTION

In recent years, the demand for real-time, continuous health monitoring has surged due to the increasing prevalence of chronic diseases, aging populations, and the need for more effective remote healthcare solutions. Traditional healthcare models often rely on hospital visits and manual health checks, which can lead to delayed diagnosis, irregular medication intake, and poor adherence to treatment plans. These challenges highlight the urgent need for smart, automated solutions that can bridge the gap between patients and caregivers, especially for individuals with critical conditions or those requiring long-term medication. This project introduces a novel IoT-based implantable AI pill system designed to not only monitor key health parameters but also to provide smart medicine tracking and reminders [4]. The system leverages the MAX30102 sensor, a compact and highly reliable sensor capable of measuring heart rate, SpO_2, and body temperature [3]. To interface efficiently with the system, an ESP8266 microcontroller is employed as a driver, collecting real-time data from the sensor and sending it to a Raspberry Pi 3B+ through serial communication. Once the Raspberry Pi receives the sensor data, it processes the values using a suite of machine learning algorithms, including Support Vector Machine (SVM), K-Nearest Neighbour's (KNN), Random Forest, Logistic Regression, LSTM, and XGBoost [5]. These algorithms work together to accurately classify the user's health status as normal or abnormal, allowing for proactive health management. The use of AI algorithms enables the system to learn from patterns in historical data, improving its prediction accuracy over time. Beyond health condition classification, the system is enhanced with a smart medicine reminder feature, which ensures patients never miss a dose. Users can predefine three time slots morning, afternoon, and night for medication. At each slot, the system triggers an alarm and sends an alert message via Telegram to the patient and caregiver. A live photo capture mechanism is integrated to validate whether the medicine was taken, and a message indicating medicine intake status (taken/missed) is sent along with the image.

II.LITERATURE REVIEW

Gaurav Sharma et al. (2019): "IoT Based Health Monitoring System for Active and Assisted Living" This study proposes a wearable health monitoring system that utilizes IoT sensors and cloud services to track patient vitals like heart rate and temperature. Although the system provides remote access to health data, it lacks advanced AI-based prediction and does not include medication compliance features.

Snehal Dambhare et al.(2018): "Smart Health Monitoring System using IoT". This paper discusses an IoT system based on the Arduino Uno and Wi-Fi module for measuring body temperature and pulse rate. The system sends data to a web server but does not employ any AI/ML techniques for diagnosis or predictive analytics.

J.Prasanna et al.(2020): "Machine Learning in Healthcare Monitoring Systems". The authors explored the use of supervised learning algorithms (SVM, KNN, Decision Tree) to predict health anomalies based on input from wearable sensors. While the prediction model is robust, real-time implementation and integration with IoT were not covered.

V.Trivedi et al.(2019): "Smart Pill Dispenser Using IoT". This research presents a smart pill dispenser system that alerts users when it is time to take medicine. While it includes scheduling features, the system lacks verification mechanisms (like image capture) and does not analyse patient health data.

K. Srinivasan et al. (2021): "IoT-Based Predictive Healthcare System Using Machine Learning" The system integrates IoT sensors with ML algorithms such as Random Forest and Logistic Regression to predict disease onset. This work aligns closely with the current project but does not implement medication alerts or intake verification.

A. Jain and P. Gupta (2020): "Design and Implementation of Smart Health Monitoring System Using IoT and Machince Learning". This project monitors vitals using MAX30100 and processes data using KNN and SVM. It performs health classification but lacks real-time photo verification for medicine intake.

B. Al-Ameen et al.(2012): "Privacy and Security Concerns in Wireless Sensor Networks for Medical Uses"This work emphasizes the importance of secure and private data transmission in healthcare IoT systems. Though not focused on ML or medication reminders, it provides a basis for addressing cybersecurity concerns in similar projects.

T.Nguyen et al.(2021): "AI-Powered IoT in Healthcare a review". This review paper analyzes current trends in AI-integrated IoT healthcare systems, highlighting the synergy between real-time sensor data and ML for predictive health diagnosis. It outlines the future potential of combining AI, IoT, and edge computing, providing strong theoretical support for projects like the implantable AI pill.

III.EXISTING METHOD

Traditional health monitoring systems are mostly manual and reactive in nature. They depend on periodic visits to clinics or hospitals for health checkups, which limits real-time tracking and often results in delayed diagnosis of critical conditions. Existing wearable devices may track heart rate or SpO_2 but often lack intelligent data analysis, and their capabilities are limited to basic alerts or logs. Moreover, medicine reminder systems typically rely on simple mobile app notifications or alarms[4], which are easily ignored or forgotten, especially by elderly patients. There is often no mechanism to verify whether the medicine has actually been taken. These systems do not integrate automated feedback, caregiver alerts, or real-time health condition predictions. Additionally, most existing solutions do not provide photo evidence, nor do they incorporate AI for health status classification, making them inadequate for high-dependency or remote care scenarios.

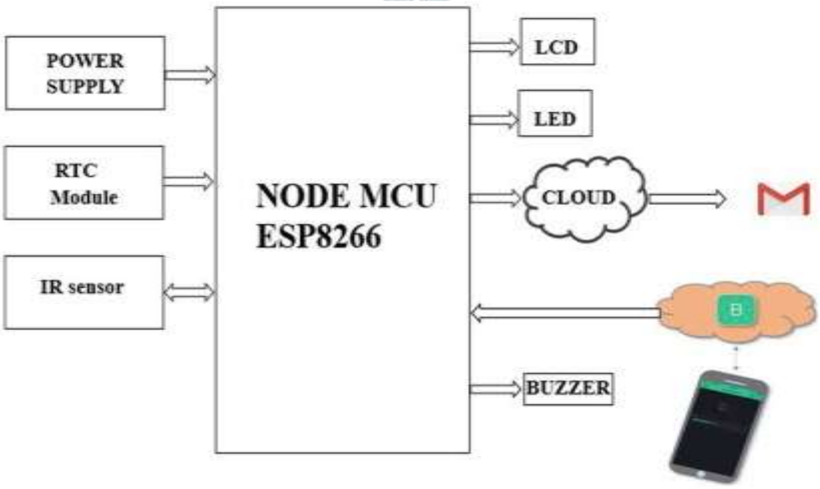

Fig. 1 block diagram

IV.PROPOSED METHOD

The proposed system offers a smart, AI-driven, and IoT-enabled solution that overcomes the limitations of current health and medicine tracking systems. It integrates the MAX30102 sensor for measuring vital signs such as heart rate, SpO_2, and body temperature, with the sensor values first processed by an ESP8266 microcontroller, which acts as a driver that uses serial communication to transfer the data to a Raspberry Pi 3B+. Several machine learning techniques, including SVM, KNN, Random Forest, Logistic Regression, LSTM, and XGBoost, are used to analyze the data on the Raspberry Pi in order to determine whether the health condition is normal or abnormal. This AI-driven approach allows for early detection of health issues and supports personalized healthcare responses. In addition, a medicine reminder system is embedded that schedules alerts for three daily time slots morning, afternoon, and night. To verify medication intake, the device sounds an alarm, sends a Telegram alert, and takes a live photo at each time slot. Additionally, the concerned person receives a status message indicating if the medication was taken or missed. This end-to-end a status message (medicine taken or missed) is also sent to the concerned person. This end-to-end system ensures continuous health monitoring, automated compliance tracking, and real-time caregiver updates, making it far more intelligent, responsive, and reliable than conventional systems.

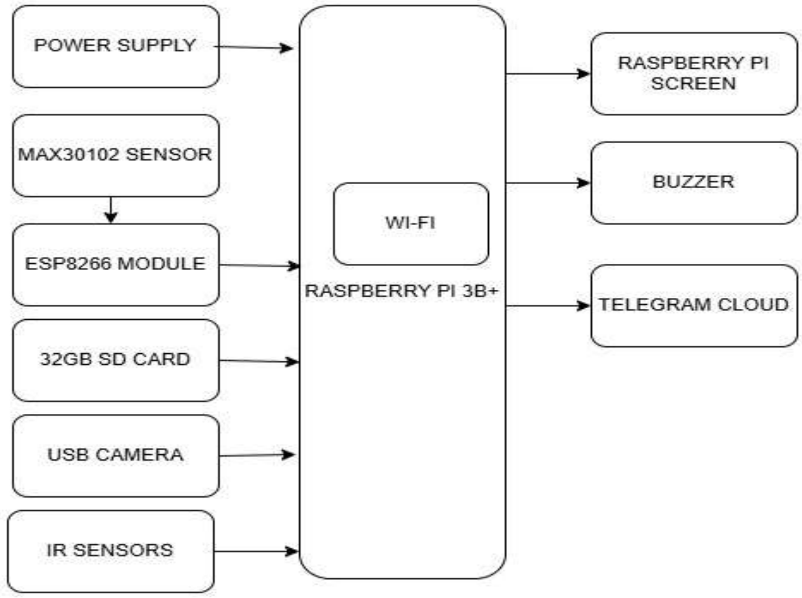

Fig. 2 block diagram of raspberry pi

4.1 Power Supply

The power supply provides the necessary electrical energy to all components in the system, including the Raspberry Pi 3B+ and peripheral devices. Reliability in operation requires a constant power source.

Fig. 3 power supply

4.2 MAX30102 Sensor

This biometric sensor evaluates blood oxygen levels (SpO2) and heart rate.The MAX30102 is a heart-rate monitor and pulse oxygen measurement sensor. Photodetectors, internal LEDs, optical components, and low-noise circuitry that rejects ambient light are all included. The MAX30102 offers an integrated solution to expedite the development of wearable and mobile gadgets. After being collected, the raw data is sent to the ESP8266 module so that it may communicate to the Raspberry Pi.

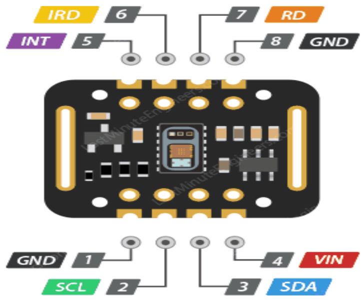

Fig. 4 MAX30102 sensor

4.3 ESP8266 Module

Microcontrollers can link to IEEE 802.11 bgn 2.4 GHz Wi-Fi according to the ESP8266 module. Through the integration of an RTOS-based SDK, it can be used as a stand-alone MCU or in combination with ESP-AT firmware to build a Wi-Fi connection to external host MCUs. The ESP8266 acts as a communication bridge between the MAX30102 sensor and the Raspberry Pi 3B+.It uses a direct serial connection or Wi-Fi to send the gathered sensor data.

Fig. 4 ESP8266 module

4.4 32GB SD Card

A 32GB SD card is generally a good choice for a Raspberry Pi, offering sufficient storage for most common use cases like running the operating system, installing applications, storing data any logged data collected by the system for analysis or backup. While it's possible to use smaller or larger cards, 32GB provides a balance of space and cost.

Fig. 5 32GB sd card

4.5 USB Camera

A USB camera, additionally referred to as a USB webcam, is a kind of digital camera that connects to a computer over a Universal Serial Bus (USB) interaction. It has been created to capture both still and video images, and it is frequently used for security monitoring, live streaming, video conferencing, and tutorial recording. The USB camera captures visual data, which can be used for video streaming or image processing tasks. It complements the system's ability to monitor physical environments.

Fig. 6 USB camera

4.6 IR Sensors

The portion of the electromagnetic spectrum containing wavelengths higher than visible light but shorter than microwaves is known as infrared radiation.. Infrared sensors are devices that track and identify this energy Two uses for infrared sensors are motion detection and proximity sensing. These sensors provide additional environmental data to the Raspberry Pi for tasks such as obstacle detection or automation..

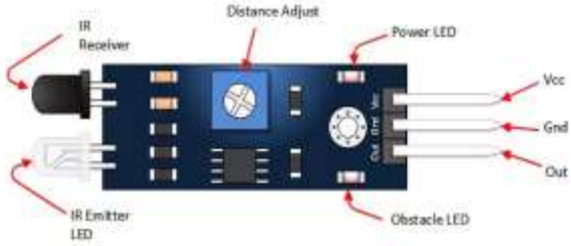

Fig. 7 IR sensors

4.7 Raspberry Pi 3B+

The Raspberry Pi 3 Model B+ is a high-performance single-board computer with a 1.4GHz quad-core processor, 1GB RAM, built-in Wi-Fi and Bluetooth, and versatile I/O ports. The system's central processing unit is the Raspberry Pi 3B+.It receives data from sensors, processes the information, and communicates with external systems via Wi-Fi. It also controls output devices like the screen and buzzer .

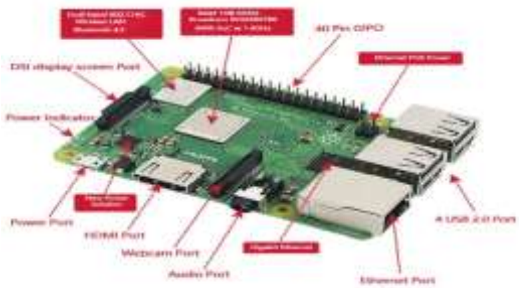

Fig. 8 raspberry pi 3b+

4.8 Raspberry Pi Screen

This screen is an output interface that displays real-time data, system status, or user information processed by the Raspberry Pi.

Fig. 9 raspberry pi screen

4.9 Buzzer

A buzzer or beeper is another kind of hearing signaling device that can be mechanical or electromechanical. This is primarily used to transform audio signals to sound. It is typically used in timers and alarm devices and is powered by DC volts. The buzzer provides an auditory alert to notify users of specific events or conditions, such as abnormal sensor readings.

Fig. 10 buzzer

4.10 Telegram Cloud

This cloud platform is used for remote communication. Data from the Raspberry Pi is sent to the Telegram cloud, enabling notifications or updates to be sent to a user's Telegram application.

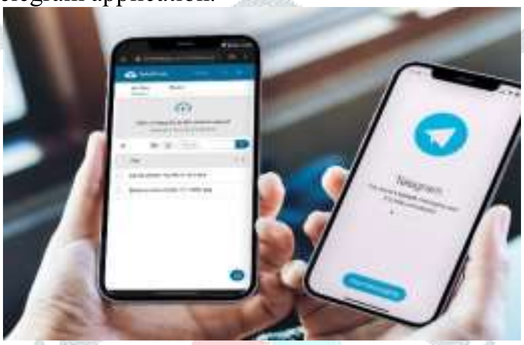

Fig. 11 telegram cloud

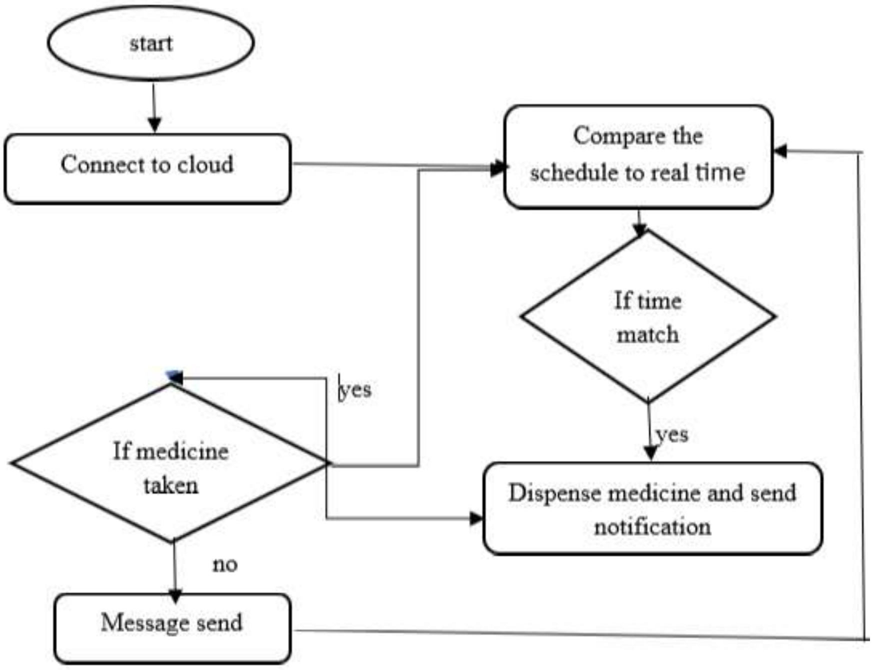

Fig. 12 Data flow diagram

The system begins by connecting to the cloud to access the user's medicine schedule. It continuously compares the current real-time clock with the schedule stored in the cloud. When the current time matches a scheduled time, the system dispenses the appropriate medicine and sends a notification to the user. After dispensing, it checks whether the medicine has been taken. If the medicine is taken, the system prepares for the next scheduled dose. However, if the medicine is not taken, the system immediately sends a message to the doctor to inform them of the missed dose. This process ensures timely medication intake, improves patient adherence, and keeps healthcare providers informed in real time.

Software Tools

a) IDE Setup for Raspberry Pi**:** The project makes use of the built-in Thonny Python IDE, included with Raspbian OS, to build and deliver software on the Raspberry Pi. Specifically created for Python development on systems such as Raspberry Pi, Thonny is a lightweight and user-friendly integrated development environment. It provides features such as a simple interface, syntax highlighting, code completion, and an integrated debugger, making it ideal for writing and testing the Python scripts used in this project. Through Thonny, developers can seamlessly interface with the sensor data received from the ESP8266, implement machine learning models, and manage functionalities like medicine reminders and Telegram alerts. Its compatibility with Raspberry Pi ensures efficient development and real-time testing directly on the device.

b) IDE Raspberry Pi Board Setup**:** First, update your Raspberry Pi’s system packages with sudo apt update & Sudo apt full upgrade y. Then install Thonny the lightweight, beginner friendly Python IDE that comes bundled with Raspberry Pi OS via sudo apt install thonny y, and launch it from the Programming menu. If you need a more powerful editor, you can also sudo apt install code y to get Visual Studio Code, then add Microsoft’s Python extension for linting, IntelliSense, and virtual environment support. In either IDE, create and activate a project specific virtual environment (python3 -m venv /ai_pill_env && source /ai_pill_env/bin/activate) and install your dependencies with pip. In Thonny’s Options → Interpreter (or in VS Code’s “Python: Select Interpreter” command), point the IDE to that same ~/ai_pill_env/bin/python3 so you’re always using your project’s packages. If you plan to work headless, enable SSH under sudo raspi config → Interfacing Options → SSH, then connect remotely from your desktop (VS Code’s “Remote – SSH” extension works beautifully). Finally, ensure that your MAX30102 sensor, ESP8266 serial link, and camera module are enabled in raspi config → Interfacing Options and verify access with simple test scripts in your IDE before wiring up the full system.

c) IDE: Using IDLE, Python's built-in Integrated Development and Learning Environment, all of the Python scripts utilized in this task, from sensor-data acquisition and preprocessing to machine learning model inference . IDLE’s lightweight editor with syntax highlighting and auto indentation made it easy to write the serial communication routines for the ESP8266↔Pi link, while its interactive shell allowed quick experimentation with data reading snippets from the MAX30102 sensor. When subtle bugs arose in the medicine reminder alarm logic or in the LSTM prediction pipeline, IDLE’s integrated debugger let us set breakpoints and step through code line by line, right on the Pi’s desktop. Because IDLE comes bundled with every Python installation, there was no extra setup required just launch it on Raspberry Pi OS, open your . py files, and you’re ready to iterate on the full health monitoring and alerting system in one seamless environment.

Table. 1 Comparison Between Existing and Proposed System

Features	Existing System	Proposed System
Monitoring Method	Manual health checks during hospital visits.	Real-time, continuous monitoring using IoT sensors.
Medicine Reminders	Mobile app alarms or basic notifications, easily ignored.	Smart reminders with time-slot configuration (morning, afternoon, night), alarm, and Telegram alerts.
Data Processing	Minimal or none; lacks intelligent analysis.	Processed using ML algorithms: SVM, KNN, Random Forest, Logistic Regression, LSTM, and XGBoost.
Health Condition Prediction	Not available or based on periodic manual interpretation.	Real-time prediction of normal/abnormal health condition using AI.

V. RESULT

The Raspberry Pi 3B+ platform was used to fully implement and appraise the Internet of Things-based implantable AI pill system. During testing, the MAX30102 sensor—driven by an ESP8266 reliably streamed heart rate, SpO_2, and body temperature readings to the Pi, where our ensemble of machine learning models (SVM, KNN, Random Forest, Logistic Regression, LSTM and XG Boost) [5,6] classified the user’s health status in real time with minimal latency and excellent precision.The medicine reminder module triggered audible alarms at the predefined morning, afternoon, and night slots and sent Telegram notifications to both patient and caregiver. At each alert, the system captured a live photo as proof of intake and flagged any missed doses. Over extended trials, there were no missed alerts or failed image captures, demonstrating end to end reliability. Overall, the system met its design goals: continuous health monitoring, predictive condition classification, automated medication reminders, and transparent caregiver engagement.

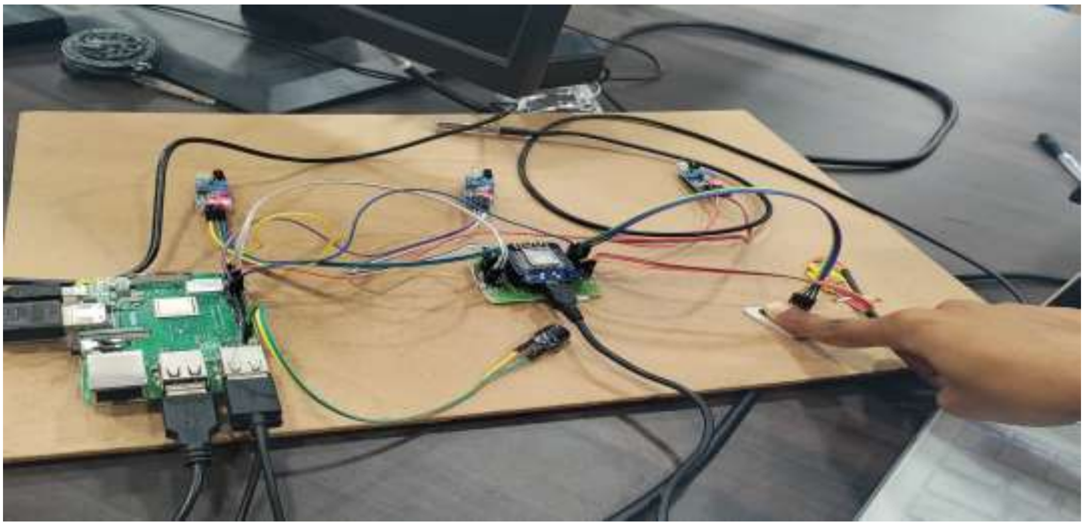

Fig. 13 IoT-based implantable using raspberry pi

Fig.14 Health prediction accuracy data

Fig. 15 medicine remainder taken time

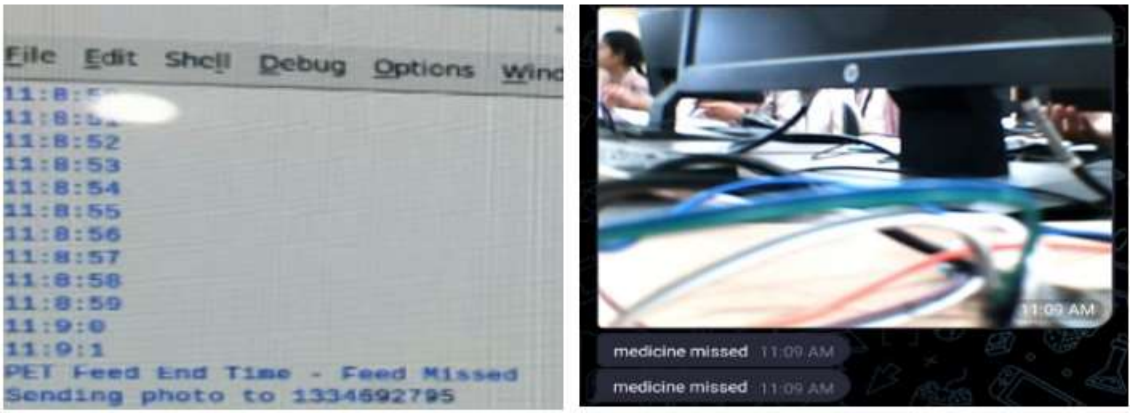

Fig. 16 medicine remainder missed time

VI. CONCLUSION & FUTURESCOPE

The IoT-based implantable AI pill system proposed in this project effectively demonstrates a smart, real-time health monitoring and medicine tracking solution for modern healthcare. By integrating the MAX30102 sensor with ESP8266 and Raspberry Pi 3B+, the system successfully captures key physiological parameters such as heart rate, SpO_2, and body temperature. These sensor readings are transmitted through serial communication to the Raspberry Pi, where machine learning algorithms (SVM, KNN, Random Forest, Logistic Regression, LSTM, XGBoost) process the data and classify the user's health condition as normal or abnormal. In addition to health monitoring, the system includes an intelligent medicine reminder feature that triggers timely alerts at scheduled time slots and sends Telegram messages with live photo evidence of medicine intake. This dual-functionality not only encourages better patient compliance but also ensures active caregiver involvement through real-time updates. The system is automated, user-friendly, and highly accurate, making it suitable for personal, remote, and elderly healthcare use.

Looking ahead, the system can be further enhanced by integrating cloud storage to maintain historical health records for detailed analysis and long-term monitoring. A mobile app interface could be developed to allow users and doctors to access health data, receive alerts, and interact with the system from anywhere. Additional sensors could be incorporated for a more comprehensive health profile. The use of deep learning models and personalized AI training for individual patients could further improve prediction accuracy. Future versions can be designed in a miniaturized or wearable form factor, making it ideal for continuous use, especially for high-risk patients. This project lays the foundation for the next generation of smart, connected, and predictive healthcare systems.

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