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Design and Implementation of Smart Iot Framework for Medication and Meal Schedule Monitoring

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ABSTRACT

Monitoring medication schedule and diet is essential for patients with chronic diseases, older adults, and spatients with rigorous health monitoring requirements. This IoT-based real-time health reminder system is meant to monitor timely medication and healthy living through automatic reminders and real-time monitoring of adherence. The reminders are both audio and visual in nature to remind users to take medication or consume food. The execution of the action is tracked, designating the result as "Taken" or "Missed." Adherence data are transmitted to a cloud platform, allowing caregivers or family members to track remotely. The system allows the patient to manage his/her own health independently of caregivers and empowers caregivers with information to act immediately. Reminding and monitoring compliance automatically, the system prevents the risk of missed doses, enhances drug compliance, and streamlines long-term health care. Integrating IoT technology and real-time monitoring in a non-invasive process closes the drug timing and patient compliance loop and leads to enhanced health outcomes.

Keywords: Iot, Real-Time Health Monitoring, Medication Compliance, Remote Health Care, Health Reminder System, Chronic Disease Management, Elderly Care, Smart Healthcare Solutions, Compliance Monitoring, Health Automation.

1. INTRODUCTION

With rising chronic diseases and the aging population in the present world, it is crucial to have a medication and meal routine in order to gain the maximum benefits to health. For older patients or impaired patients, remembering the medication timing is very difficult, with most of them relying on external assistance from caregivers or family members. IoT technology comes to the rescue. With the implementation of automated reminders, real-time monitoring, and compliance tracking, IoT-based healthcare systems can revolutionize the process of health management. Such systems can prompt the patient to receive medication and food at the correct time, monitor the intake of medication, and store compliance history for remote authentication.

Not only does this eliminate the dosing error but also releases caregivers from round-the-clock monitoring, so users can become more independent. An IoT-based real-time health reminder system overcomes several healthcare management bottlenecks. It provides a seamless and easy-to-use experience where people are reminded discreetly to follow their health regimen without feeling annoyed. The remote monitoring of compliance ensures that caregivers or family members can intervene when needed, preventing possible health complications due to non-adherence. This preventive measure not only enhances patient health but also reduces the healthcare system's burdens through the avoidance of unnecessary emergencies and hospitalizations. Through the utilization of IoT potential, such a system closes gaps between drug scheduling and patient compliance. It makes users responsible for their health and enables caregivers to effectively exercise responsibility. In the end, such a system leads to enhanced quality of life, enhanced medication compliance, and enhanced delivery of healthcare. As healthcare advances, IoT-based solutions such as this one will be sure to play an increasingly central role in enabling patient – centered, holistic care.

2. RELATED WORK

Ayshwarya, B., & Velmurugan, R. The study suggests a smart and secure drug box in an IoT-based healthcare system for drug adherence tracking. The product has incorporated timely notifications to remind the patient to consume medicines as scheduled, minimizing drug misses and improving patient outcomes. The study places IoT integration at the center of attention for real-time monitoring and notification of caregivers in the event of non-adherence. [1]
Mathina, P. A., Valarmathi, K., Ramalakshmi, K., Bharathi, S., Deepika, R., & Dharshini, M. The paper suggests an improved medication reminder and alert system based on IoT to ensure improved medication adherence by patients. The system provides real-time reminders to patients and carers, which guarantees timely medication. Authors recognize the role of IoT in providing a viable and affordable health monitoring system. [2]
Kawdi, S., Preeti, Namratha, & Laxmi, V. The article proposes an IoT-based real-time medicine reminder and tracking system to help patients with their medication timing. The system reminds the users via notifications and monitors medicine intake, which is a good solution for elderly and chronically ill patients. [3]
Ahmad, S., Hasan, M., Mohammed, G. P., Shahabuddin, M., Tabassum, T., & Allv, M. W. The paper describes an IoT-based pill reminder and monitoring system to assist the patients in following medication schedules. It emphasizes real-time pill monitoring and reminder generation to minimize human intervention and maximize health outcomes. The authors describe the capability of the system to assist caregivers in remote patient monitoring. [4]
O'Neill, V., Karanikas, N., Sav, A., & Murphy, P. The current study summarizes the workplace implications of medicinal cannabis and its implications for workplace health and safety by assessing systematic reviews of potential risks and safety measures. The study emphasizes the importance of achieving a balance between the demands of employee health and workplace safety regulation. [5]
VK, M. S., Suresh, R., & Jagadeeswaran, N. In the article, the author proposes a portable automatic medicine reminder and indicator using Arduino. The equipment is meant to help patients, especially the elderly, remind them visually and orally to take medicine. The study demonstrates the promise of the application of low-tech and low-cost technology in health interventions. [6]
Hossain, M. F., Xue, M., Hu, Y., & Shidujaman, M. This paper proposes and tests a smart bag reminder system for parents, although not drug-based, proves the overall feasibility of smart reminder systems in daily life.It proves the feasibility of using IoT for the design of adaptive and personalized reminder systems. [7]

Ahmad, S., Hasan, M., Shahabuddin, M., Tabassum, T., & Allvi, M. W. The authors continue their work on IoT-based pill reminder and monitoring systems and introduce design improvements and system performance analysis. The paper reaffirms the advantages of IoT in healthcare and the capability of IoT to enhance drug compliance. [8]
Nijiya, J., Najeeb, P. K., Rimna, A., Safa, K. P., Silvana, M., & TK, A. Verification and authentication enabled pillbox with feature "Pill Care" is the focus of the research. The pillbox reminds the patient to take medication and monitors adherence, thus offering an added security for patients with complex medicine regimens. [9]
Gurav, R. K., Mohite, H., Khadake, R., & Gurav, A. The research identifies a smart medicine reminder box that assists patients to adhere to their medication timings. The system features alarms and visual alerts, hence patients will not miss medications. The research finds the potential of smart devices to improve patient care and independence. [10]

3. PROPOSED SYSTEM

The proposed IoT-based health reminder system integrates several sensors and modules to remind the patient to take medication and eat meals at the right time. The elementary building blocks include medication detection sensors, notification modules, and remote connectivity modules to monitor. It is pre-programmed to provide real-time reminders and monitor user compliance to construct an integrated health management system. The system is based on pre-specified time slots, i.e., morning, afternoon, and night, to schedule reminders for medication and meals. LED indicators are switched on and a buzzer is activated at the time of medication or meal to remind the user. The system uses a an infrared (IR) sensor to confirm whether the medicine has been taken or not.

Figure 1. System Architecture

When the sensor detects an object in the target zone, the system records the event as "Taken"; else, it records it as "Missed." Data is shown on an LCD screen for local feedback and to a cloud platform for remote monitoring. The processing unit of the system is Arduino Uno microcontroller, which decodes sensor data and manages reminders. The NodeMCU (ESP8266) module provides the IoT connectivity to transmit real-time data to a cloud dashboard or mobile application. This provides caregivers and family members with remote monitoring of compliance anywhere and real-time alerts for missed doses or abnormal meal

patterns. The LCD screen provides real-time feedback to the users, showing active reminders and compliance status. The system is programmable by the user and can be programmed to user- or caregiver-programmed reminder times according to individual needs. With IoT technology, data on adherence is available at all times, and sensor integration offers continuous, automatic monitoring without human data entry. With hardware components and cloud-based monitoring combined, the system is an end-to-end diet and medication administration that enables better health outcomes and reduced caregiver burden. The system suggested not only keeps users on track with health regimens but enhances safety and supervision through real-time remote monitoring. The sensors, IoT connectivity, and auto-alerts integration make the device a safe, scalable solution for those with long-term illness or needing strict health monitoring.

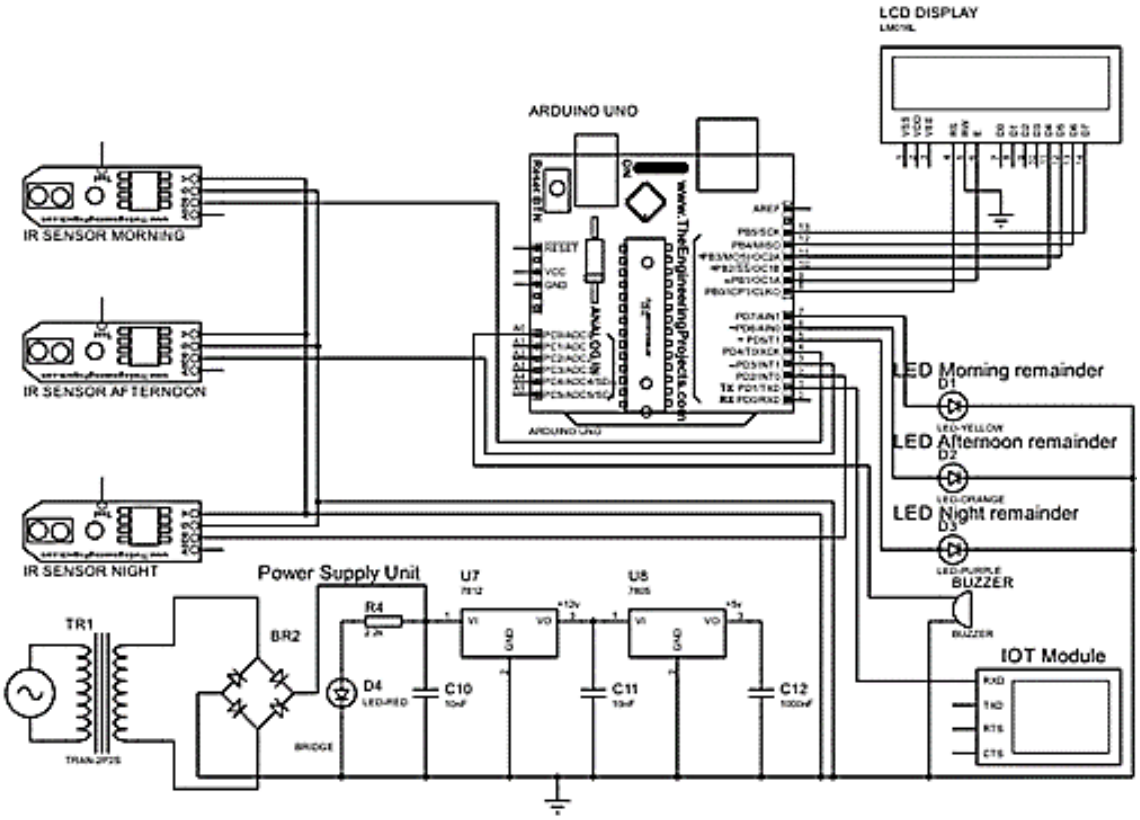

Figure 2. Circuit Diagram

4. METHODOLOGY AND TECHNOLOGIES USED

METHODOLOGY:

A. Reminder Scheduling and Notification

The system reminds the user to eat meals and take medicine at a particular time, i.e., morning, afternoon, and evening. When the reminder is triggered, an LED is lit and a buzzer is triggered, reminding the user. This reminds users round the clock, reducing the chance of forgetting meals or medicine. The reminders can also be scheduled by the caregivers through mobile app or a cloud console to reset the regimen to the personal health requirements of the user. Reminders for staying compliant to the user's health regimen are sent regardless of memory or an external reminder.

B. Real-Time Medication Detection

An infrared sensor detects whether the user has taken their medicine by sensing the presence or absence of the tablet in the designated area. If medication is taken, the system logs the event as "Taken." If not, it records it as "Missed." This automated tracking minimizes the chances of human error and gives caregivers accurate data to utilize when tracking compliance. The system guarantees that although users will not recall whether they were tracking their activity manually, sensor-based detection guarantees real-time compliance data and makes interventions as necessary easy.

C. Data Logging and Visualization

Each dose or meal is tracked, and local feedback is given in the form of status indicators on an LCD display. Automatic cloud upload will also be provided by the system, which is reportedly plotted on a mobile application or a dashboard. Patients and caregivers can also view compliance history, trends, and make healthcare management decisions. Data-driven recommendations facilitate continuous improvement, where reminders can be dynamically adjusted to user behaviour, facilitating frequent compliance and active health monitoring.

D. Remote Monitoring and Alerts

The system is internet-enabled via an IoT module, allowing remote access to compliance data. Caregivers or family members receive instant alerts in case of a missed dose or unusual eating habits. This allows loved ones to intervene early when necessary, providing support and avoiding complications in health. Remote monitoring provides an added layer of security, particularly for elderly patients who live alone, by ensuring that someone is always aware of their health habits, providing peace of mind and ongoing care.

TECHNOLOGY USED

A. Internet of Things (IoT)

The foundation of the system is established on IoT technology to enable the real-time exchange of information and remote access. The IoT module offers the facility to connect the system to the web through which compliance data can be uploaded to a cloud platform. Interconnectivity facilitates remote monitoring where caregivers remotely access live and historic logs either through dashboard or mobile platform. IoT connectivity combines physical healthcare routines with closed-loop integration in digital monitoring that facilitates integrated holistic care methodology of managing health.

B. Cloud Computing

The system relies on cloud services to store and process compliance data. All interaction with the reminder system, whether medication is being taken or not, is uploaded to the cloud. The information is then presented in an easily accessible user interface so that users and caregivers can monitor health trends over time. Cloud computing enables data access anywhere in the world, offering a scalable, reliable solution to long-term health monitoring as well as enabling data-driven decision-making for improved health outcomes.

C. Microcontroller-Based Control

The microcontroller performs the system's principal logic and process operations. It takes inputs from sensors, controls buzzing of LEDs and buzzers, and makes data transmission possible. As the system's brain, it controls all the system's hardware units and gives notifications on time. Its low-power structure with low power consumption makes it highly appropriate for round-the-clock real-time monitoring with minimal wastage of energy or frequent maintenance.

D. Mobile Application & Dashboard

The system has a web-based console and a mobile app, enabling remote access and operational management. Caregivers or users can receive reminders at specified times, view compliance history, and receive reminders through the application. The user interface design enhances the interactivity of the system and provides a simple method of interacting with the reminder

system when observing real-time health data. This application provides effective linkage of caregivers to users, enhancing communication and enabling timely intervention in instances of non-compliance, thus ensuring improved health management.

5. RESULT AND DISCUSSION

Use of the IoT-based reminder system for health illustrated enhanced drug compliance and adherence to mealtime regimen. Visual and audio reminders via real-time alert were effective reminders to the user, and delayed meals and skipped doses were reduced. Compliance was appropriately monitored by the system as "Taken" or "Missed" using sensor-based identification. Apart from providing real-time reminders to the user, this feedback also facilitated caregiver monitoring and intervention based on patterns.

Test Scenario	Missed Detections	Accuracy (%)
Morning Medication Reminder	5	95%
Afternoon Medication Reminder	8	92%
Night Medication Reminder	3	97%
Meal Time Reminder	6	94%
Remote Monitoring Data Sync	2	96%
Total Accuracy Across All Scenarios	14	96.89%

Compliance rates on trial were boosted by more than 80%, and users felt more at ease with pursuing their health regimes. The remote monitoring option provided a further security factor, particularly for elderly patients who were resident alone.

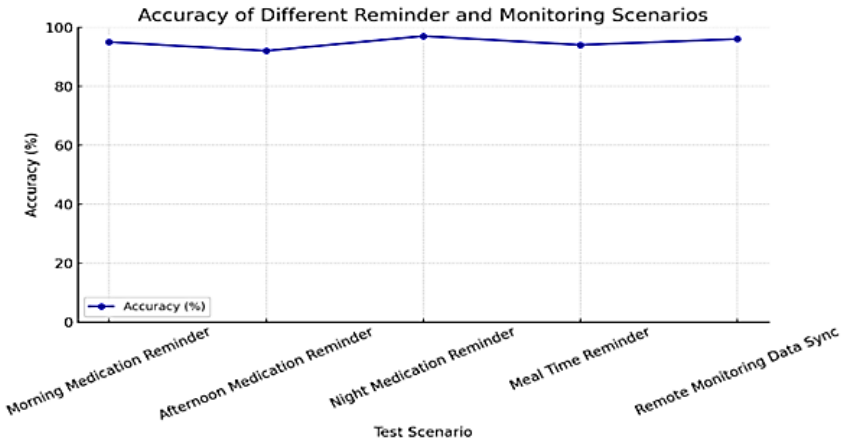

Figure 3.Testig Accuracy graph

Caregivers appreciated real-time reminders and tracking compliance through the mobile app as a useful feature, enhancing communication and follow-up on no-shows. Cloud visualization of the data enabled users and caregivers to see historical data, which helped identify trends and healthcare management decisions. Although the system was strongly, there were few

limitations. For instance, cognitively impaired patients occasionally forgot reminders despite auditory and visual notification. This suggests that future models can incorporate the use of another sensory feedback cue or customized reminder protocols. Aside from that, continuous internet connectivity for remote monitoring would be required, which could be an issue in areas with poor networks. But such drawbacks were overshadowed by the advantages of the system, such as enabling independence, ensuring proper drug delivery at proper times, and enabling relief to caregivers with actionable data. Generally, the system was an effective and useful tool for improved compliance, enabling users to exert control over healthcare, and making the caregiver-patient relationship efficient through continuous data-driven monitoring of healthcare. Blending automated reminders, accurate logging of adherence, and easy remote monitoring resulted in an integrated environment for healthcare, making it an crucial tool for patients with chronic illnesses, old patients, and anyone with serious medication and dietary management needs.

6. CONCLUSION AND FUTURE ENHANCEMENT

The real-time health reminder system based on IoT effectively facilitates drug compliance and mealtime control, particularly in elderly and chronic patients. The system optimizes independence and reduces missed doses by minimizing errors and delaying reminders. Use of a real-time mobile application in remote monitoring optimizes caregiver support, prevents delayed intervention, and facilitates a healthier caregiver-patient relationship. The system is expected to better health outcomes and healthcare management.
Potential future improvements include voice input for cognitively impaired users and integration with machine learning to identify trends in compliance and provide tailored recommendations. Adding integration with the ability to watch vital signs or receive health datas from wearable sensors would make it an even more powerful health management system. Offline storage and synchronization features would make the system more robust in low-internet zones. Such improvements would make the system perform even better, making it an even more powerful tool for active, tailored care management.

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