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Smart Watch for Elderly Using Microcontroller with Voice Recognition

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Abstract

This study focuses on the development of a simple health monitoring and alert system for basic vital signs. The main problem is that many people do not receive early warnings when heart rate or body temperature reaches unsafe levels. This issue can cause late action and increase health risks. The objective of this research is to design and test a system that can monitor heart rate and body temperature in real time and send alerts when values exceed set limits. The methodology uses sensors to measure heart rate and temperature, a microcontroller to process data, and the Blynk platform to display data and alerts on a mobile device. The system is tested under normal and abnormal conditions to check accuracy, response time, and stability. The results show that the system can detect changes in vital signs and send alerts clearly to the mobile application. The local display updates faster than the cloud display, but a small delay appears during internet transmission. Some issues such as sensor instability and connection loss occur, but troubleshooting improves performance. The study recommends improving sensor quality, network stability, and system calibration for better reliability in future use.

1. Introduction

To date, research on ageing and health had gained great momentum as the global population continued to age [1]. Decades of research had focused on the question of how to support elderly people to live safely and independently for longer periods [2]. It was widely assumed that ageing increased the risk of chronic diseases, reduced mobility, and sudden health events such as abnormal heart rate and body temperature changes [1]. There had been a long-standing interest in using technology to monitor elderly health because early detection could reduce complications and healthcare burden [2]. In this context, wearable devices such as smartwatches became important tools. A smartwatch was a wearable electronic device worn on the wrist that could measure health data such as heart rate, which referred to the number of heart beats per minute, and body temperature, which referred to the level of heat produced by the body.

Previous studies had shown that smartwatches and Internet of Things systems were useful for continuous elderly health monitoring [3][4]. The Internet of Things, or IoT, referred to a network of devices that collected and shared data through the internet. Many systems measured heart rate and temperature and sent the data to mobile applications for caregivers to view in real time [5][6]. Research also showed that smartwatch adoption among older adults improved when devices were simple and comfortable to use [7][8]. However, many existing smartwatches relied on touch screens and complex menus, and this made them difficult for elderly users with poor eyesight or weak motor control [5][9]. Voice recognition was introduced in some studies to reduce physical interaction. Voice recognition referred to a technology that converted spoken words into commands that a system could understand [10]. Even so, many systems still lacked simple control design, integrated alerts, or real testing with elderly users [11][12].

Despite these advances, a clear gap still existed in providing a simple, low-cost, and voice-controlled smartwatch designed specifically for elderly users. Many systems were complex, required constant touch interaction, or failed to deliver timely alerts to caregivers, and this could delay medical response [5][12]. If this gap was not addressed, elderly users might continue to avoid health monitoring devices, and health risks could remain undetected. Therefore, this study was needed to design a more user-friendly solution. This study asked the following research question: how could a smartwatch with voice control and IoT features be designed to support simple and continuous health monitoring for elderly users? The main objective of this study was to develop a smartwatch system that monitored heart rate and body temperature, supported voice commands, and sent alert notifications to caregivers through an IoT platform to improve elderly safety and independence [3][4].

2. Methodology

The methodology section explained the system design, hardware and software components, and the testing procedures used to develop and evaluate the smartwatch system.

2.1 Materials

Table 1 shows the component used in this project.

Table 1 *List of Component*

Component	Quantity
ESP32	1
MLX90614 Temperature Sensor	1
OLED 12C 128x32	1
Breadboard	1
MAX30100 Heart Rate Oxygen Pulse Sensor	1
Jumper Wires 40- Female to Male/ Male to Male	3

2.2 System Block Diagram

Fig. 1 showed the system block diagram of the proposed smartwatch system. The system was divided into three main parts, which were the input side, the processing unit, and the output side. The input side included a smartphone application, a MAX30100 pulse oximeter and heart rate sensor, and an MLX90614 non-contact infrared temperature sensor. The smartphone application was developed using MIT App Inventor and was used for voice control input. The ESP32 acted as the main processing unit of the system. It received voice commands from the smartphone and sensor data from the MAX30100 and MLX90614 sensors. ESP32 processed the received data based on the given command. An input power supply provided the required electrical power to ensure stable system operation. The output side consisted of an OLED display and the Blynk application. The OLED display showed the measured heart rate and body temperature values clearly. The ESP32 sent the processed data to the Blynk application through a wireless connection. The Blynk application allowed remote monitoring of the health data by caregivers.

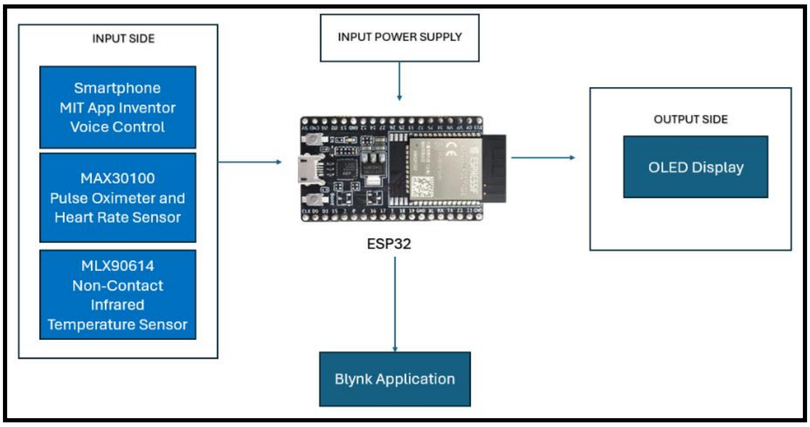


Fig. 1 *System Block Diagram*

2.3 System Flowchart

Fig. 2 showed the working process of the smartwatch system. The process started with system initialization. The ESP32, sensors, OLED display, Bluetooth, and Wi-Fi modules were initialized. The system powered on after initialization.

The system waited for a voice command from the mobile application. The temperature and pulse sensors remained idle during this stage. The system checked the received command. If the command was TEMP, the system read the body temperature from the MLX90614 sensor. If the command was HEART, the system reads the heart rate from the MAX30100 sensor.

The system displayed sensor data on the OLED display. The system checked the internet connection status. If the internet connection was not available, the system checked the Wi-Fi connection again. If the internet connection was available, the system sent the sensor data to the Blynk application.

The system checked whether the temperature or heart rate value was higher or lower than the preset limit. If the value exceeded the limit, the system triggered an alert notification.

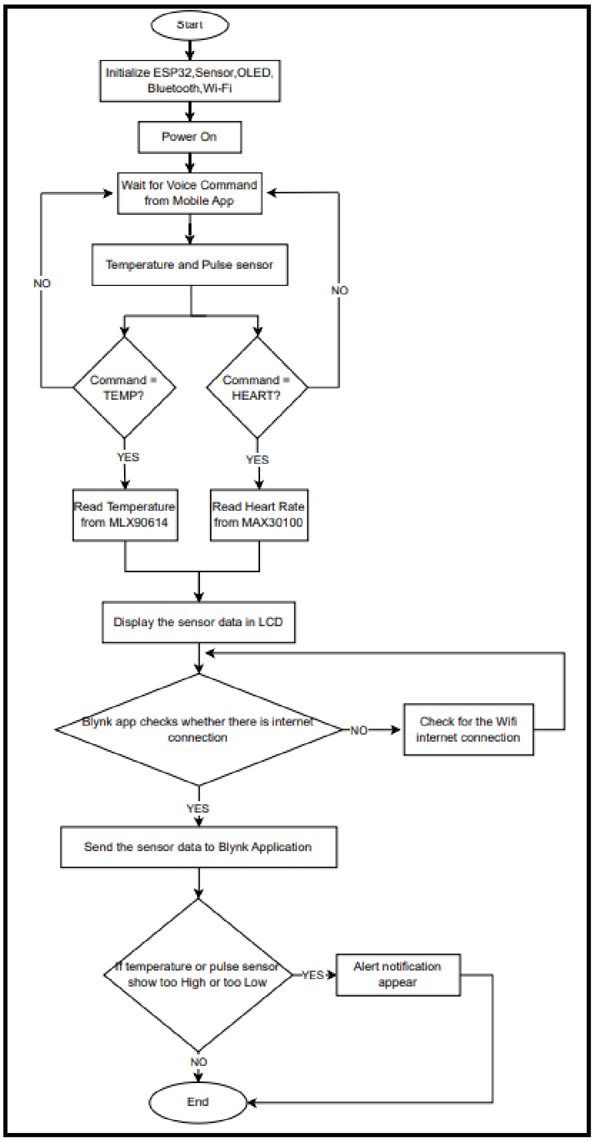
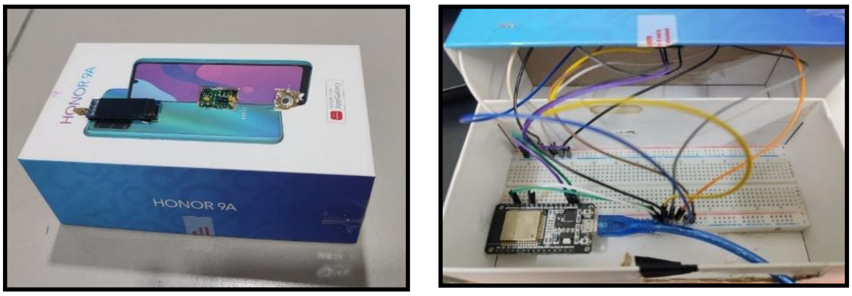


Fig. 2 *System Flowchart*

3. Results, Analysis & Discussion

Fig. 3 showed the hardware prototype of the system. Fig. 3(a) showed the outer view of the prototype. The components were placed inside a box to protect the hardware and support easy handling. Fig. 3(b) showed the inner part of the prototype. The ESP32 microcontroller was connected to the sensors and other parts using jumper wires on a breadboard. The wires allowed power and data to flow between the components.



(a) **(b)**

Fig. 3 *Hardware Prototype (a) Appearance of Prototype; (b) Internal Part of Prototype*

3.1 Results

3.1.1 Voice Control Mobile Application Development Using MIT App Inventor

The voice control mobile application, which was the system's initial activation component, was described in this section. MIT App Inventor was used to construct the application. The application's primary goal was to enable senior citizens to use voice commands to operate the smartwatch. Simple buttons and legible language were employed in the program interface. The user interface was simple to comprehend. The mobile application's primary interface was displayed in Fig. 4.

There was a Bluetooth connection capability in the application. A list of local Bluetooth devices was displayed on Fig. 5. From the list, the user chose the ESP32. The ESP32 was then connected to the application. The screen displayed the connection status. The Bluetooth connection status was displayed in Fig. 6. The status text said "Connected" and the color was green when Bluetooth was established. The status text displayed "Not Connected" and was red when Bluetooth was not connected.

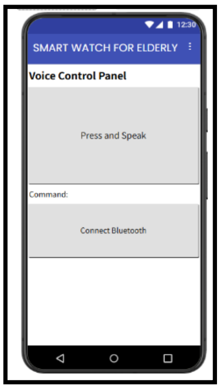


Fig. 4 *Voice Control App main screen*

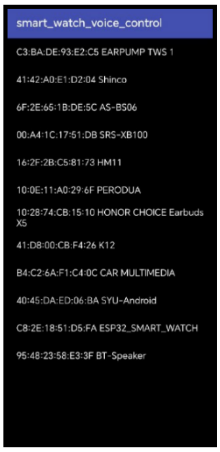
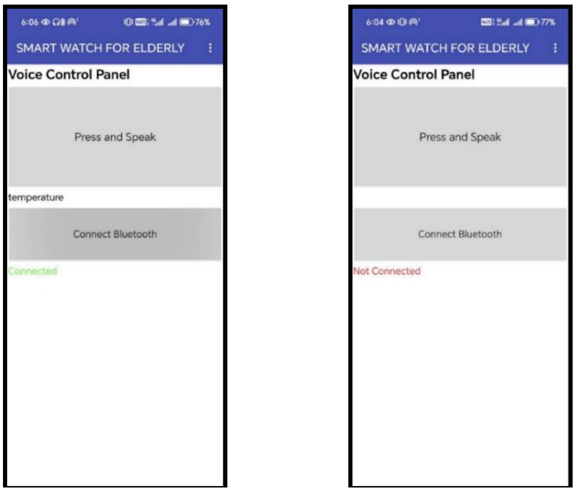


Fig. 5 *Nearby Bluetooth Devices*



(a) **(b)**

Fig. 6 *Bluetooth Status (a) Connected; (b) Not Connected*

The application had a voice recognition feature. To start voice input, the user pressed the voice button. The application received the spoken command. The detected word appeared on the screen. The word "temperature" was shown after voice recognition in Fig. 7. The application used Bluetooth to send a text command to the ESP32. The ESP32 received the command and performed the required action.

Fig. 7 *Voice Detected*

3.1.2 Hardware Functionality and Sensor Output Results

To confirm the function of the ESP32 and the attached sensors, several tests were carried out. The ESP32, MAX30100 sensor, MLX90614 sensor, and OLED display were connected on a breadboard and were initialized after the system was turned on. The I2C interface was used for communication between the ESP32, the sensors, and the OLED. As shown in Fig. 8, the OLED displayed the body temperature and heart rate readings clearly. The ESP32 sent real-time heart rate and temperature values to the serial monitor. The values on the serial monitor matched the OLED output, as shown in Fig. 9.

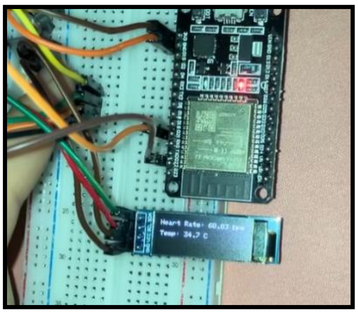


Fig. 8 *OLED output*

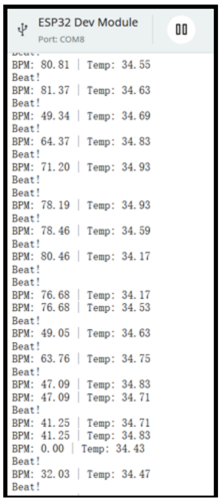
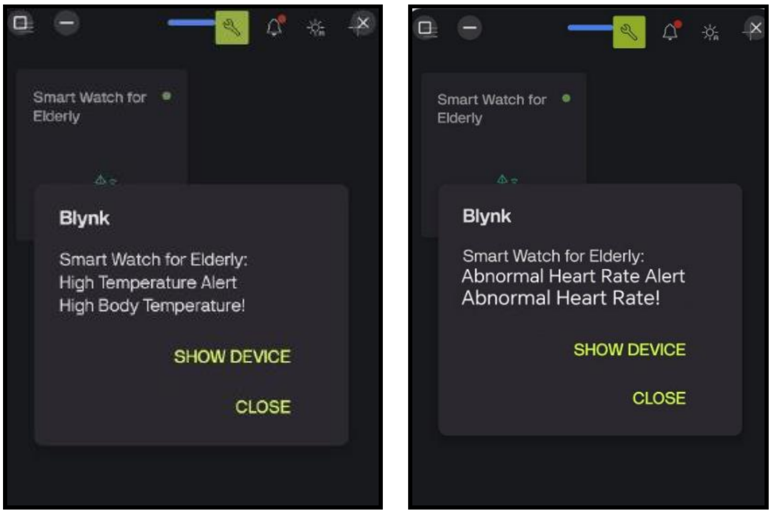


Fig. 9 *Serial Monitor Output*

3.1.3 Alert Notification Results

This section described the alert feature of the system. During operation, the ESP32 checked sensor readings and compared them with preset threshold values. The temperature threshold was set at 38 °C. The heart rate threshold was set below 50 bpm and above 120 bpm. The ESP32 detected the value from the MLX90614 sensor when the temperature rose above 38 °C and sent an alert message to the Blynk application through Wi-Fi. The ESP32 detected the value from the MAX30100 sensor and sent an alert message to the Blynk application when the heart rate was too high or too low. Fig. 10 showed the alert messages for high body temperature and abnormal heart rate.



(a) **(b)**

Fig. 10 *Alert Notification (a) High Body Temperature; (b) Abnormal Heart Rate*

3.1.4 Functionality of Hardware Prototype

Based on the findings in Fig. 11, this section provided an overview of the hardware prototype function. The voice control application, OLED display, MLX90614 temperature sensor, and MAX30100 heart rate sensor were tested in five trials. In all experiments, the Bluetooth connection and the voice control application were active. This result showed that the communication between the mobile application and the ESP32 worked properly during testing.

The OLED display was active in Experiments 1, 3, and 4, and it was inactive in Experiments 2 and 5. This result showed that the display module was enabled only when output was needed. The MLX90614 temperature sensor was active in Experiments 2, 4, and 5, and it was inactive in Experiments 1 and 3. This result showed that the temperature sensor was triggered based on system commands. The MAX30100 heart rate sensor was inactive in the first four experiments, and it was active in Experiment 5. This result showed that the heart rate sensor operated only when selected.

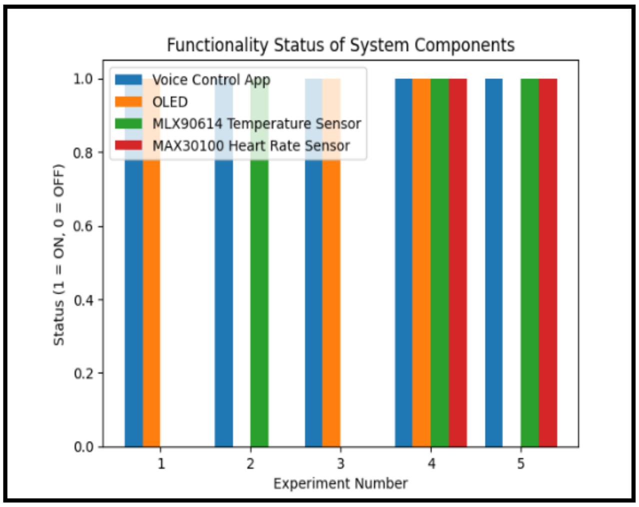


Fig. 11 *Graph of Functionality Status of System Component*

3.1.5 System Response Time Analysis

Fig. 12 displayed the response time of the smartwatch system for five test cases. The results showed that the OLED display responded faster than the Blynk application because the OLED used local output while the Blynk application used cloud communication. The heart rate function showed longer response times than the temperature function because the MAX30100 sensor needed more data samples to produce stable readings. Under the same hardware and network settings, the response times remained consistent across all tests

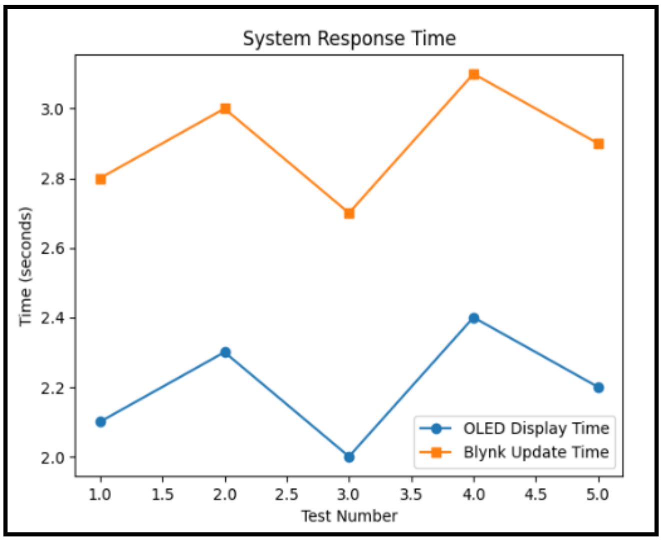


Fig. 12 *Graph of Response Time Measurement*

3.1.6 Voice Recognition with Incorrect Pronunciation

Table 2 and Fig. 13 summarized the voice recognition test results for six experiments. The results showed that the voice control application correctly recognized correct words and several incorrect pronunciations for the TEMP and HEART commands. Words such as “Demperature,” “Temperator,” and “Hart” were mapped to the correct commands because their sound patterns were close to the predefined keywords. This result was important because elderly users often spoke unclearly due to weak speech control, dental problems, or health conditions. The system tolerance to small pronunciation errors reduced user frustration and improved ease of use.

The failure in Experiment 6 showed that the system did not respond when the spoken word was very different from the defined commands. This behavior was important because it prevented wrong system actions caused by unrelated speech. The incorrect pronunciation test helped identify the balance between flexibility and control in the voice recognition design.

Table 2 *Voice Recognition Test Results*

Experiment	Spoken Word	Recognized Command	System Response
1	Temperature	TEMP	Successful
2	Demperature	TEMP	Successful
3	Temperator	TEMP	Successful
4	Heart	HEART	Successful
5	Hart	HEART	Successful
6	Hurt	none	Failed

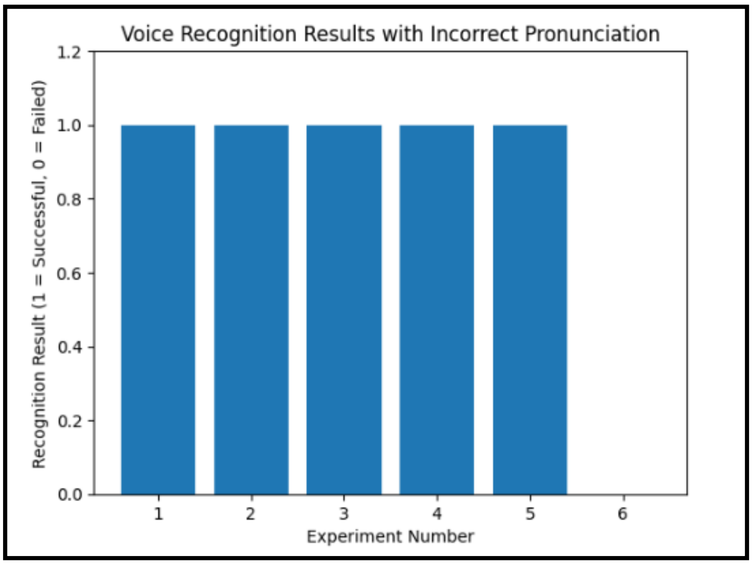


Fig. 13 *Graph of Voice Recognition Results with Incorrect Pronunciation*

3.2 Discussion

The results show that the smartwatch system can monitor heart rate and body temperature in a stable way during normal use. The MAX30100 sensor gave consistent heart rate values when the user stayed still and followed correct placement. This result answers the research question on whether a low-cost sensor can support basic health monitoring for elderly users. The MLX90614 sensor also showed stable temperature readings without skin contact, and this supports ease of use for elderly people. The OLED display clearly showed the values, and this helped users read the data without confusion. But the results also show that sensor accuracy can drop when the user moves too much. This raises a question about real daily use, since elderly users may not always stay still. So, the system works well in controlled conditions, but it may need filtering methods for better reliability in daily life.

The voice control results show that the system can respond correctly to simple voice commands like “heart” and “temperature.” This supports the idea that voice interaction can reduce the need for touch input. This is important for elderly users with weak eyesight or hand control. The response time from voice command to display output was acceptable, and the delay was small during Bluetooth communication. But the test with incorrect pronunciation shows a clear limitation. The system failed to recognize some commands when pronunciation changed. This suggests that voice control depends strongly on clear speech and stable mobile app processing. Previous studies on voice-based wearable systems also reported similar issues, where recognition accuracy dropped for elderly users with unclear speech. So, the findings match earlier research that voice control is helpful but still limited by speech variation and noise.

The IoT alert results show that the Blynk platform can receive data in real time and send alerts when values cross preset limits. This meets the research question on remote monitoring and caregiver notification. The alert delay was longer than local display updates, and this shows the effect of internet speed and network stability. Similar delays were also reported in earlier IoT-based elderly monitoring studies, where cloud updates depended on Wi-Fi quality. So, the findings align with previous research that IoT systems improve safety but rely on stable connections. The results also show that the system can support early warning for caregivers. But the system still depends on external platforms and smartphones. This raises concern about usability for elderly users who do not own or understand smartphones.

4. Conclusion

The results show that the smart watch system works as planned and meets the main project goals. The system can monitor heart rate and body temperature and can respond to simple voice commands. The ESP32 processes sensor data correctly and sends the data to the OLED display and the Blynk platform. The alert system works and can notify caregivers when values are not normal. This achievement shows that a simple and low-cost device can support elderly health monitoring. Some improvements are still needed to improve system performance. The system should have better voice recognition accuracy, especially when pronunciation is unclear. The battery life should be improved for longer daily use. The sensor stability should be enhanced to reduce noise during movement. One limitation of this study is that testing was done in a limited environment and not over a long period. The system was also tested with a small number of users. Future studies should focus on long-term testing with real elderly users. Future work should also add more health parameters such as fall detection or oxygen level. Researchers should focus on making the device smaller, more comfortable, and more reliable for daily use.

Acknowledgement

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