



InSightHub: Intelligent Notification and Status Indicator for Streamlined Work-From-Home Environments

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Abstract. The rise in remote work has created a demand for innovative tools to assist telecommuters in managing their workflow and communications. This paper introduces the Smart Notification Bar, a device affixed atop computer monitors that employs IoT technology, facilitated by Raspberry Pi, to provide real-time visual and sound notifications from various platforms, including Gmail, Twitter, and Zoom. The system is designed to be reliable, easy-to-use, secure, and available 24/7. Utilizing LEDs and a buzzer, the device offers immediate visual and auditory cues for unread Gmail messages, pre-programmed Twitter notifications, and Zoom meeting statuses. Beyond enhancing personal productivity by consolidating notifications and reducing distractions, the Smart Notification Bar serves as a non-intrusive indicator for household members to know when the user is engaged in a video conference and should not be disturbed. This is particularly useful for remote workers with hearing challenges or sound phobias.

Keywords: Raspberry Pi · LED · Smart Notification System · API · Work from Home Employee

1 Introduction

The mobile phone is a significant source of distractions for work-from-home (WFH) employees [1]. The advent of the internet and advancements in communication technology have transformed the way people work. Over recent years, there has been a significant increase in the number of people working remotely. This trend was further accelerated by the COVID-19 pandemic, which forced companies and individuals to rapidly adapt to WFH arrangements. While WFH offers numerous benefits such as flexibility and reduced commute times, it also presents unique challenges in terms of managing communication and maintaining productivity in a domestic environment.

One of the common challenges faced by remote workers is the management of notifications from various communication platforms. The constant influx of emails, messages, and social media updates can become a source of distraction and reduce productivity. Moreover, when engaged in virtual meetings or calls, it is essential for

remote workers to communicate their availability to others sharing the living space, so as to minimize interruptions. People working remotely frequently receive notifications from email and social media applications from their smartphones, interrupting their workflow and diverting their attention from essential tasks during working hours [2, 3]. Although mobile phones help WFH employees to collaborate with co-workers remotely [4], they contribute to notification overload and allow employees working remotely to engage in multitasking activities, such as chatting with their friends while participating in Zoom meetings [3]. This multitasking can disrupt concentration and decrease productivity [5]. In Westermann et al. [6], users were advised to use sophisticated notification settings on their mobile phones to manage app alerts. This recommendation, however, may only be useful to remote workers who are savvy with phone settings. A better solution to the productivity or distraction issues associated with frequent mobile phone notifications is smart notification systems.

Technology advancements have contributed to the significant development of intelligent notification systems [7]. Today's smart alert systems leverage information technology not only to communicate with mobile devices and home appliances but also to provide timely alerts to users [8]. They can support multiple communication channels, including email, SMS, video calls, and in-app alerts. Smartphone notification systems are designed to collect and process data from various sensors, such as location, motion, light levels, air quality, humidity, or temperature data [7]. Depending on users' preferences, the processed data are then used to send specific notifications. Hence, smart notification systems are invaluable to WFH employees in reducing notification overload and enhancing employee engagement [8]. Like mobile phones, they can provide WFH staff with notifications on important meetings [9], natural disasters [10], product updates [11], and crucial deadlines [10]. Smart alert systems are more attractive to WFH employees because, unlike mobile phones, they do not send users unsolicited adverts or distracting messages. They can also be programmed to send automated alerts to remote workers based on their preferences [12]. Ultimately, smart notification systems have the potential to quickly identify and block disruptive notifications from mobile apps, ensuring that WFH workers' productivity is not compromised during working hours.

This paper addresses the distraction problems associated with mobile phones by designing a prototype smart notification system that can provide tailored visual or sound alerts for WFH employees. The prototype is designed with Raspberry Pi 3 Model B+ to allow WFH employees to receive email, Twitter, and Zoom alerts. This system aims to demonstrate the possibility of improving remote workers' productivity. By using this system, WFH staff members can receive a display of red, blue, green, or orange light-emitting diode (LED) signals depending on whether the notifications are from Gmail, Twitter, or Zoom. The Gmail LED lights up when a new email is received, the Twitter LED is activated when a tweet arrives, and the Zoom LED illuminates when the user is engaged in a Zoom call. The Zoom LED also serves a dual purpose, acting as a visual indicator for household members to know when the user is occupied and should not be interrupted. The proposed alert system can allow remote staff to receive various alerts associated with project deadlines, office meetings, potential environmental crises, and urgent tasks. Apart from WFH employees, companies can use the notification system to receive visual or sound notifications from their social media accounts.

In the subsequent sections, we will review the existing literature on notification management and remote work tools, detail the design and implementation of the Smart Notification Bar, present the findings of the implementation, and discuss the implications and future prospects of this innovative device.

2 Background

The work in [13] details a project from Instructables.com for the creation of a Work From Home Status Indicator using an ESP8266 and an LED strip. The author developed this system to help establish boundaries while working from home. The system uses different colors to indicate the user's availability status to family members. The implementation is quite simple, involving basic components like an LED strip, a 330 Ω resistor, a prototype board, and connector wire. The ESP8266 connects to the internet and waits for instructions, which are sent from a connected device. The status light can be activated through a web browser, with the choice of color signifying the user's current status. This project demonstrates a hands-on approach to managing work-life balance in a remote working context, and also shows how the ESP8266 can be used as a simple but effective tool for IoT applications in this space.

The authors in [14] discuss the integration of Augmented Reality (AR) and lighting systems in a WFH setting. It outlines eight use-cases, such as coloured lighting for status feedback, hot-desk personalisation, meeting room controls, teleconferencing lighting, energy management, gesture control, light tracking, and data-centre assistance. These features are achieved through a system comprising Raspberry Pi IoT control, Vuforia, Unity3D, Node-Red, Philips Hue Lightstrip, and Philips Bridge.

The literature is replete with numerous solutions aimed at managing smartphone interruptions. Much of the research effort to address digital disruption focuses on determining "when" smartphone users should receive notifications from mobile apps. Researchers have developed smart notification systems like Attelia [15], InterruptMe [16], and smartNoti [17] to predict opportune moments to send users phone notifications. While the solutions proposed in these studies are compelling, users cannot use them to receive email, tweet, or Zoom notifications.

Some scholars have extended their smartphone interruption solutions from phone calls to a wide variety of digital services. Context-aware notification management systems (CNMSs) have received significant research attention as they show promising results in determining (a) when users should receive incoming notifications, (b) the appropriate timing for sending notifications, and (c) which device(s) should receive incoming notifications [18]. For example, Roecker et al. [9] designed a context-dependent email notification system that allowed users to receive email messages relevant to them at a particular time. While this system is similar to the one proposed in this study, it cannot provide visual alerts of emails, tweets, or Zoom calls.

Furthermore, Leonidis et al. [19] presented AlertMe to provide customized notifications to graduate students. This semantics-based CNMS exploited semantic web technologies, helping users to receive reminders about canceled lectures, timetable changes, or campus-related events based on their preferences [20]. Although this software-based system could send SMS notifications, users could not use it to receive tailored notifications from social media apps, making it less useful for WFH workers who need to

receive only important messages from various social networking platforms. Most of the solutions proposed in the literature or the marketplace depend on users being in proximity to their smartphones, laptops, or computers to receive personalized notifications. Hence, there is a necessity to enable users who wish to disconnect temporarily from mobile devices yet receive alerts on simplified hardware dedicated to providing visual or audio notifications of incoming emails, tweets, or Zoom calls.

The Smart Notification Bar, as described, is designed to be an unobtrusive device that uses LED indicators to inform users about the status of various communication platforms such as Gmail, Twitter, and Zoom. There are many ways in which this device can be particularly beneficial for underserved areas.

Enhanced Focus and Productivity: In underserved areas, individuals may not have the luxury of separate workspaces and may need to work in shared or crowded environments. The Smart Notification Bar helps in reducing distractions by consolidating notifications. The visual cues allow users to quickly glance at the status without having to sift through multiple applications. This can lead to enhanced focus and productivity, which is crucial for individuals in these areas who might already be dealing with resource constraints.

Improved Internet Bandwidth Utilization: In underserved areas, internet connectivity might be limited or unreliable. By using LED indicators instead of pushing notifications through the internet, the Smart Notification Bar might reduce the bandwidth used by non-essential notifications. This can be beneficial for keeping the internet connection more stable and reliable for critical tasks.

Non-verbal Communication with Household Members: The device serves as a non-intrusive indicator for others in the household, signaling when the user is engaged in a video conference and should not be disturbed. In underserved areas, where households may be smaller and more crowded, this feature is particularly useful. It allows for a respectful and efficient way to communicate availability without interrupting the workflow.

Accessibility for the Technologically Less Proficient: Individuals in underserved areas might not be as technologically proficient. The simplicity of the Smart Notification Bar makes it accessible to a wide range of users. The visual cues via LEDs can be easily understood even by those who are not comfortable with sophisticated technology.

Potential Cost Savings: Depending on the implementation, the Smart Notification Bar could be a low-cost alternative to more expensive productivity tools. This is particularly beneficial for underserved areas where financial resources might be limited.

Encouragement for Remote Work: By enhancing productivity and minimizing distractions, the Smart Notification Bar can make remote work more feasible and attractive. This is particularly important for underserved areas, which may not have as many local employment opportunities. Encouraging remote work can lead to economic empowerment and improved standards of living in these areas.

Potential for Community Collaboration: In underserved areas, community collaboration can be a powerful tool for development. The Smart Notification Bar could potentially be used in community centers or shared workspaces to facilitate collaborative efforts among community members.

3 System Architecture

The proposed InSightHub prototype is a WFH smart notification system that allows staff working remotely to receive personalized alerts from Gmail, Twitter, or Zoom, depending on their needs and priorities. The system comprises a Raspberry Pi 3 Model B+, a buzzer, 4 LEDs, resistors, jumper wires, and Gmail, Twitter, and Zoom application programming interfaces (APIs) (Fig. 1). The Raspberry Pi 3 Model B+ is connected to the LEDs and buzzer with the jumper wires, resistors, and a 3D container. The single-board computer is also connected through the internet to Gmail, Twitter, and Zoom APIs. These components work as a unit to help users receive timely visual or audio notifications of incoming emails, tweets, or Zoom calls.

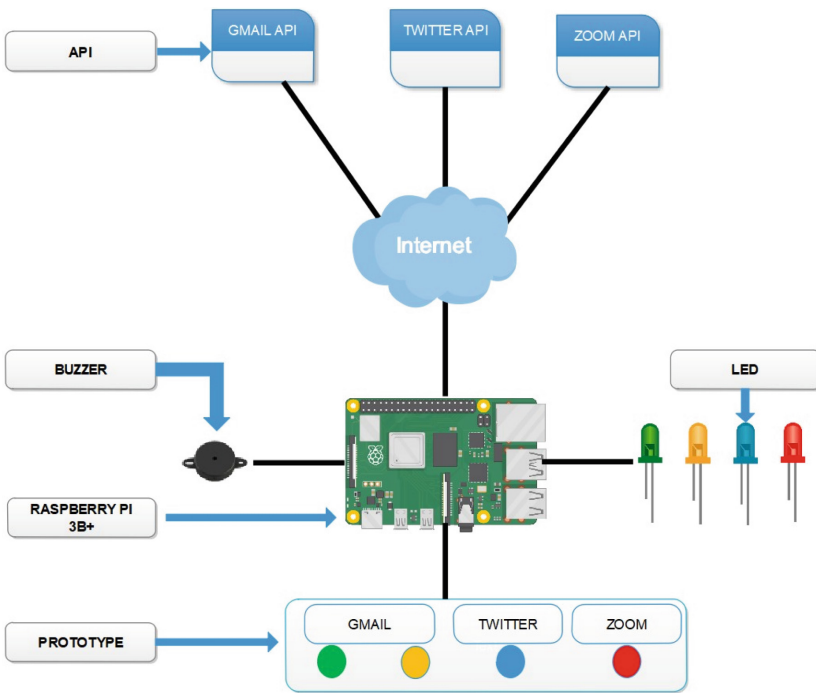


Fig. 1. System architecture of the proposed prototype

3.1 Raspberry Pi

Raspberry Pi 3 Model B+ is an upgraded version of the Raspberry Pi 3 Model B. This single-board computer is used as the central unit for the WFH smart notification prototype in this project. It features 1 GB LPDDR2 RAM, built-in Bluetooth 4.2 and dual-band Wi-Fi, Bluetooth 4.2, a microSD card, an HDMI output, a 40-pin General Purpose Input/Output header, and Broadcom BCM2837B0 quad-core ARM Cortex-A53

processor running at 1.4GHz. Raspberry Pi 3 Model B+. Several programming languages can be used namely Python, Java, C, C++, HTML and others. These features make this single-board computer ideal for automating incoming notifications from Gmail, Zoom, or Twitter.

3.2 LED

Four LEDs are used in this project to provide lighting signals depending on the nature or source of the notifications. The colors of the LEDs include red, blue, green, and orange. Each LED emits one of these colors when currents flow through it. For instance, the green or orange LED is expected to switch on when users receive incoming emails. The blue and red LEDs should be switched on when users receive incoming tweets and Zoom calls, respectively. Compared to traditional bulbs, these LEDs are energy-efficient, environmentally friendly, durable, and easy to control. Hence, the four LEDs are expected to last tens of thousands of hours, providing timely alerts to users.

3.3 API

Three APIs are used in the proposed prototype. They include Gmail, Zoom, and Twitter APIs. Each API allow the Raspberry Pi 3 Model B+ to communicate and interact with the LEDs and buzzer through Python scripts.

4 System Design

The design of the proposed system aims to provide effective visual and sound notification alerts to employees working remotely. The activity diagrams show how the alert system works (Figs. 2, 3, and 4). Raspberry Pi 3 Model B+ access Gmail, Twitter, or Zoom via their respective APIs. The Gmail API scans unread emails from a user's Gmail account, while the Twitter API and Zoom API search for users' incoming tweets and Zoom calls. If there are unread emails, the orange LED is turned on. However, the green LED is switched on if there are no unread emails. The script pauses its activities for some seconds and then scans the Gmail inbox again for unread emails (Fig. 2).

Similarly, the Twitter API searches predefined keywords associated with personalized notifications. The result is saved in a CSV file, and the blue LED is switched on if a desired keyword is found (Fig. 3). The Zoom API also triggers Raspberry Pi 3 Model B+ to switch on the red LED when a user is in a Zoom meeting. Like the Gmail APIs, the Zoom and Twitter APIs stay idle for some seconds and continue with the search (Fig. 4).

The functional and non-functional requirements of the prototype are considered during the design stage. The functional requirements indicate the essential functions that the WFH notification systems must have. In contrast, the non-functional requirements indicate the qualities or attribute the prototype should possess, even though they are not directly related to its specific functionalities. Tables 1 and 2 indicate the functional and non-functional requirements of the proposed alert system for WFH employees.

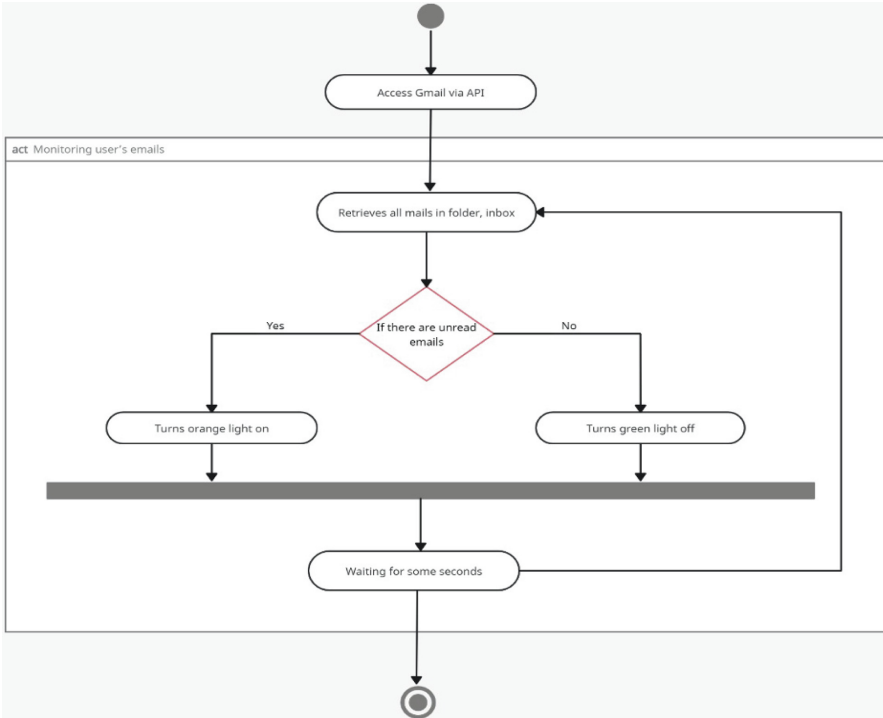


Fig. 2. Gmail activity diagram

Table 1. Functional requirements of the proposed WFH notification system

Applications	Functional Requirements
Gmail	• There must be light and sound alerts when there are unread emails
	• There must be light notification when all emails are read
	• The script should continue to scan the inbox for unread emails
Twitter	• There should be light alerts for incoming tweets
	• Users should be able to predefine keywords for search criteria
	• The number of adjusted search results should be displayed
	• All search results should be recorded
Zoom	• There should be LED notification when a user is in a meeting
	• The script should scan continuously to know if a user is in a meeting
	• The scan rate should be adjustable to check whether a user is in a meeting

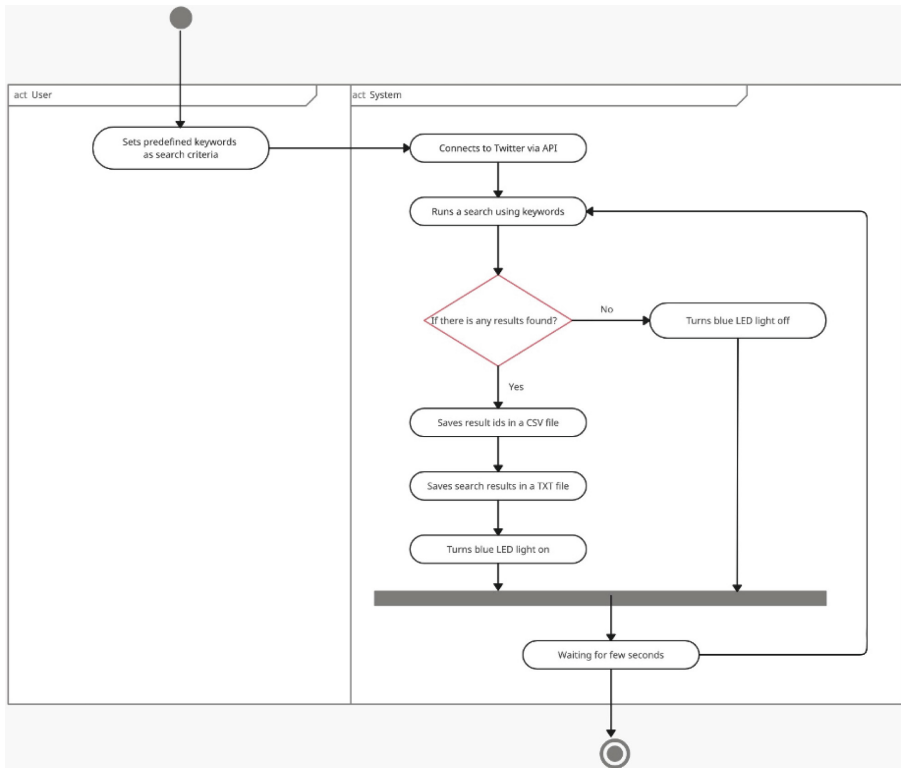


Fig. 3. Twitter activity diagram

Table 2. Non-functional requirements of the proposed WFH notification system

Features	Details
Reliability	<ul style="list-style-type: none"> It must produce the same result every time
Usability	<ul style="list-style-type: none"> It should be easy to use
Security	<ul style="list-style-type: none"> It should protect users' personal data and prevent security breaches
Performance	<ul style="list-style-type: none"> It should be able to provide notifications within a short time
Availability	<ul style="list-style-type: none"> It should be able to run 24/7
Operation	<ul style="list-style-type: none"> It should allow Twitter users to edit keywords for search criteria

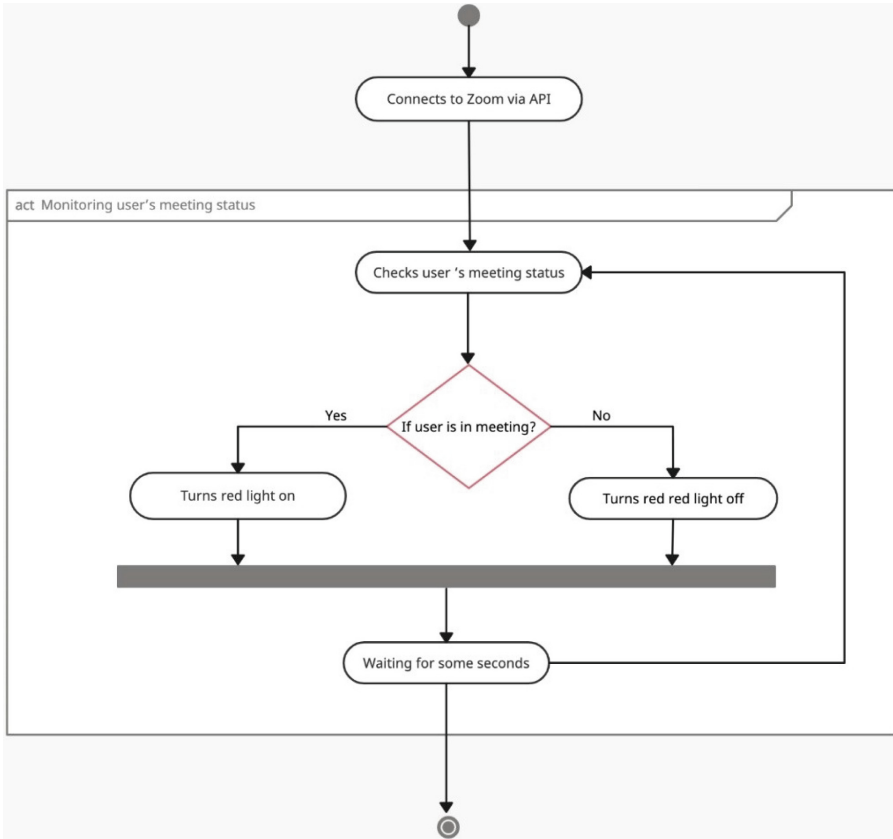


Fig. 4. Zoom activity diagram

5 Implemented System

Figure 5 illustrates the implemented WFH notification system and its components. The buzzer and the four LEDs are connected with jumper wires and enclosed in a container (Fig. 6).

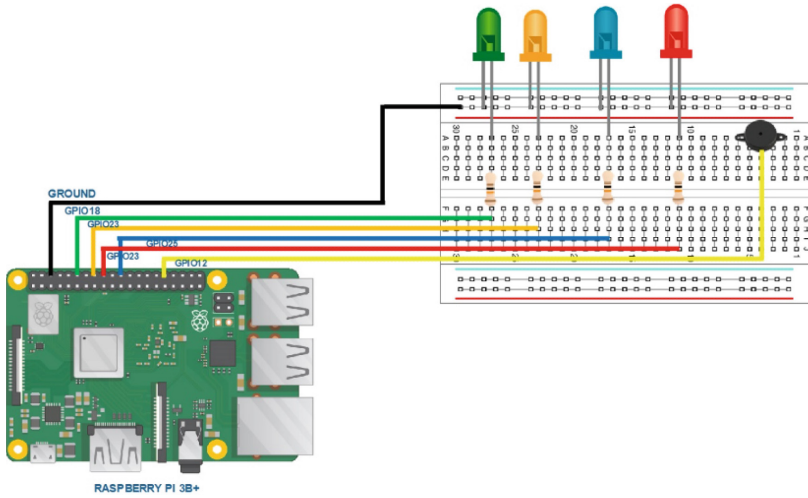


Fig. 5. System design of the prototype

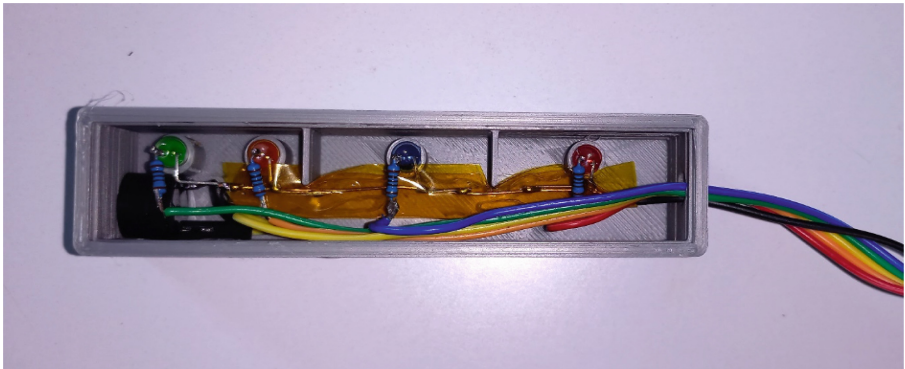


Fig. 6. A container with LEDs and a buzzer soldered with jumper wires

The outer part of the container is divided into three sections, and each section is labeled with Gmail, Twitter, and Zoom logos to enable users to recognize the meaning of the visual signal (Fig. 7).

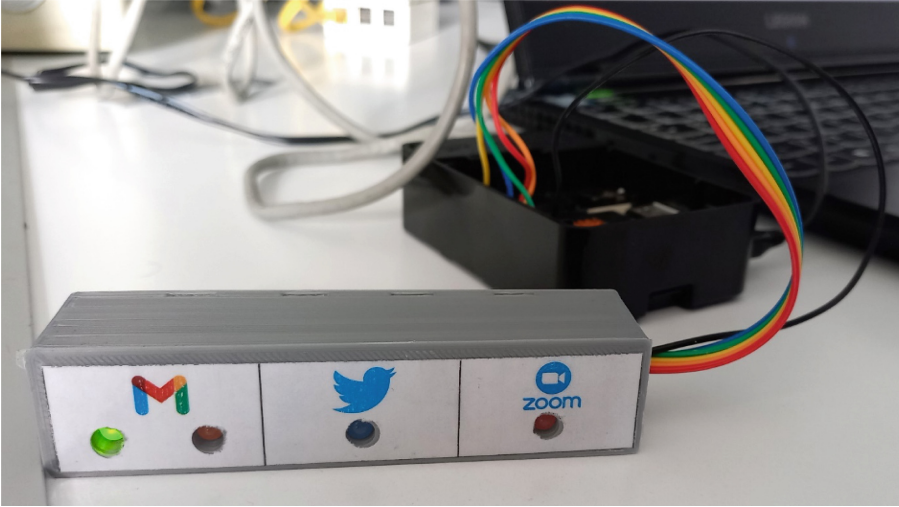


Fig. 7. A container connected to Raspberry Pi with jumper wires

In Fig. 8, jumper wires connect the buzzer and the LEDs to Raspberry Pi 3 Model B+. All LEDs are linked to their negative leg to connect to the ground GPIO of the Raspberry Pi. Each jumper wire is connected to the GPIO on the Raspberry Pi.

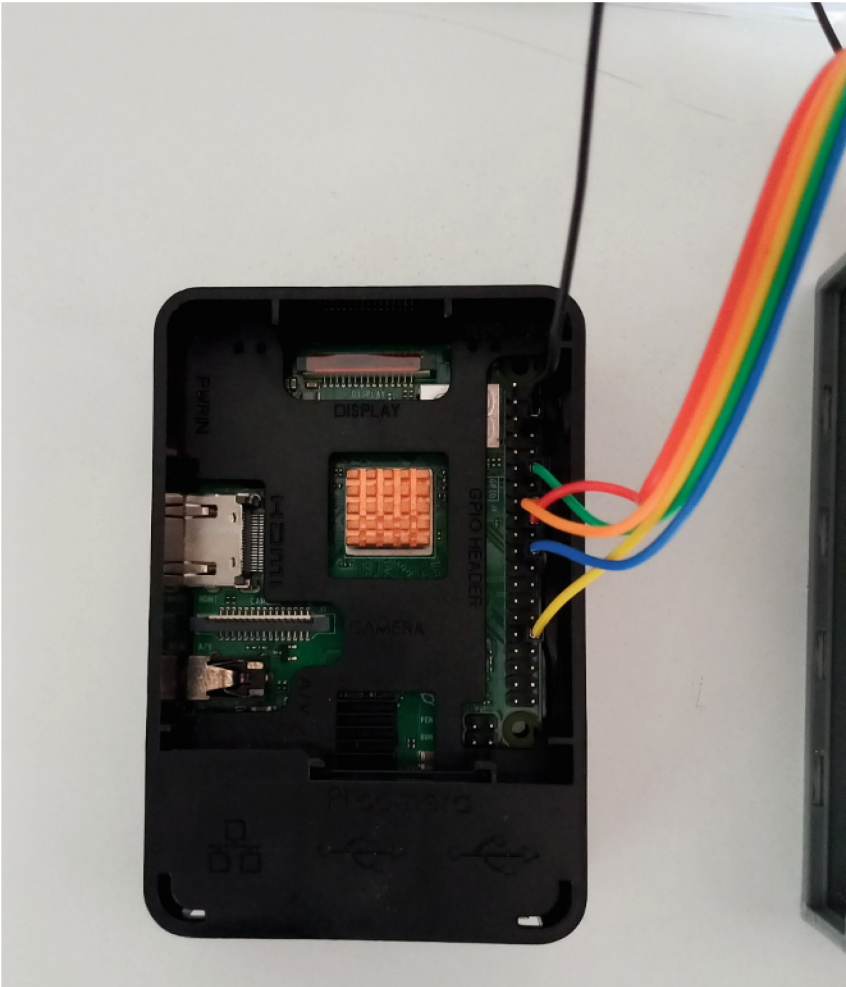


Fig. 8. Jumper wires connected to the GPIO pins on the Raspberry Pi

5.1 Gmail Testing

A new Gmail account is created to test the WFH notification system's ability to provide unread email alerts to users. As soon as the prototype is switched on, it checks the Gmail inbox and turns the green LED on if there are no unread emails (Fig. 9). However, if unread emails are in the inbox, the orange LED is switched on and the buzzer also is activated (Fig. 10).



Fig. 9. Green LED switches on when there are no unread emails



Fig. 10. Orange LED switches on when there are unread emails

5.2 Twitter Testing

A new Twitter account is created to test the prototype's effectiveness. A predefined keyword is entered into the keyword file, and the script can run. The prototype runs the script, searching for previous tweets with the targeted keyword. As shown in Fig. 11, the blue LED is switched on when the pre-programmed keyword is found.



Fig. 11. Blue LED switches on when a user receives tweet alerts

5.3 Zoom Testing

A new Zoom account is created to evaluate the performance of the proposed WFH alert system. As soon as the user joins a Zoom meeting, the red LED is switched on but turned off when the user leaves the meeting (Fig. 12).



Fig. 12. Red LED switches on when a user is in a meeting

6 Results

The results of each application and its functions are shown in Table 3. The Raspberry Pi 3 Model B+ triggered the LED bulbs to light up when users had unread emails (orange light) or all read emails (green light) in their inboxes. It also triggered the blue LED to switch on when users received incoming tweets, and the red LED turned on when users joined a Zoom meeting. As illustrated in Table 3, all the test results are positive.

LED bulbs to light up when users had unread emails (Orange light) or read emails (Green light) in their inbox. The blue LED bulb turned on when users received incoming tweets, while the red LED bulb turned on when they received incoming Zoom calls. Overall, all the test results are positive.

Table 3. Functional requirement results of the prototype

Applications	Functions	Actions	Results
Gmail	Unread emails	Trigger a LED to turn on	Yes
Gmail	Read emails	Trigger a LED to turn on	Yes
Gmail	Scan the email inbox	Adjust the refresh rate	Yes
Gmail	Scan the email inbox and adjust features	Do not trigger any LED to turn on	Yes
Twitter	No new tweets	Search for the pre-programed keyword	Yes
Twitter	Search functions	Modify the return of tweets from the search	Yes
Twitter	Return tweets from the search	Store all search results in a text file	Yes
Twitter	Record all search results	Do not trigger any LED to turn on	Yes
Zoom	In-meeting notifications	Trigger a LED to turn on	Yes
Zoom	Not in-meeting notifications	Do nothing, LED off	Yes
Zoom	Continuous scan	Continue to check users' meeting status	Yes
Zoom	Scan rate adjustments	Adjust the scan rate by seconds	Yes

Table 4 indicates the non-functional performance results of the proposed WFH notification system. The test findings indicate that the system can provide the same results at all times, that users need little programming knowledge to use the system, and that users' data are well-protected from cyber theft and threats. Overall, the prototype is reliable, easy to use, secure, and responsive 24/7.

Table 4. Non-functional requirements of the prototype

Functions	Actions	Test Result	Comments
Reliability	Must provide the same results every time	Yes	Users obtained the same results at all times
Usability	Should be easy to use and should power device and run script automatically	Yes	Users need little IT knowledge to use the system
Security	Should secure API scripts	Yes	Users' data cannot be easily compromised while using the system
Availability	Should be available 24/7	Yes	Users can run the notification system 24/7

7 Conclusion

This paper presents the design and implementation of a WFH smart notification system that provides remote workers visual and sound alerts of tweets, unread or read Gmail messages, and Zoom meeting status. The prototype exploits IoT technology to facilitate the communication between Raspberry Pi and notification indicators such as LEDs and the buzzer. The notification prototype is reliable, easy to use, secure, and responsive 24/7. It allows users to receive visual and sound notifications of unread and read messages from their Gmail inbox. Users can easily configure the WFH smart alert system to receive visual notifications of pre-programmed tweets. It is also possible for them to receive visual alerts when they join or leave a Zoom meeting. The apparent advantage of the alert-based system is its ability to help remote workers receive visual alerts without worrying about ads. Apart from this benefit, this alert prototype can be helpful to WFH employees with hearing challenges, including those with a phobia of sounds. Besides, remote workers can use this prototype to get warning alerts in real-time in the event of natural hazards. However, despite the numerous functionalities of the prototype, users cannot receive notifications from other social networking sites. Future research should demonstrate the feasibility of using this alert system to receive visual and sound alerts from Facebook, Instagram, YouTube, TikTok, and other social networking platforms. Furthermore, future studies should consider using other electronic boards with a simple microcontroller to explore this research topic, such as Arduino, Banana Pi, and Orange Pi. It would be interesting for future researchers to compare the performance of these microcontrollers in terms of their ability to provide users with visual and sound notifications.

References

1. Choy, M., et al.: Looking back on the current day: interruptibility prediction using daily behavioral features. In: Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing (2016)

2. Gallud, J.A., Tesoriero, R.: Smartphone notifications: a study on the sound to soundless tendency. In: Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct (2015)
3. Pielot, M., Rello, L.: Productive, anxious, lonely: 24 hours without push notifications. In: Proceedings of the 19th International Conference on Human-Computer Interaction with Mobile Devices and Services (2017)
4. Sahami Shirazi, A., et al.: Large-scale assessment of mobile notifications. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (2014)
5. Exler, A., et al.: Preliminary investigations about interruptibility of smartphone users at specific place types. In: Proceedings of the 2016 ACM International Joint Conference on Pervasive and Ubiquitous Computing: Adjunct (2016)
6. Westermann, T., Möller, S., Wechsung, I.: Assessing the relationship between technical affinity, stress and notifications on smartphones. In: Proceedings of the 17th International Conference on Human-Computer Interaction with Mobile Devices and Services Adjunct (2015)
7. Jin, J., et al.: An information framework for creating a smart city through internet of things. *IEEE Internet Things J.* **1**(2), 112–121 (2014)
8. Patel, S., et al.: A review of wearable sensors and systems with application in rehabilitation. *J. Neuroeng. Rehabil.* **9**(1), 1–17 (2012)
9. Saravanan, M., Das, A.: Smart real-time meeting room. In: 2017 IEEE Region 10 Symposium (TENSYP). IEEE (2017)
10. Sikder, M.F., et al.: Smart disaster notification system. In: 2017 4th International Conference on Advances in Electrical Engineering (ICAEE). IEEE (2017)
11. Halder, S., Ghosal, A., Conti, M.: Secure over-the-air software updates in connected vehicles: A survey. *Comput. Netw.* **178**, 107343 (2020)
12. Mongiello, M., et al.: A complex event processing based smart aid system for fire and danger management. In: 2017 7th IEEE International Workshop on Advances in Sensors and Interfaces (IWASI). IEEE (2017)
13. Snorlaxprime. Work From Home Status Indicator. Instructables. <https://www.instructables.com/Work-From-Home-Status-Indicator/>. Accessed 30 June 2023
14. Purmaissur, J., Seeam, A., Guness, S., Bellekens, X.: Augmented reality intelligent lighting smart spaces. In: 2019 Conference on Next Generation Computing Applications (NextComp), pp. 1–5. IEEE (2019). *IEEE Internet of Things J.* **1**(2), 112–121 (2014)
15. Okoshi, T., Ramos, J., Nozaki, H., Nakazawa, J., Dey, A.K., Tokuda, H.: Attelia: Reducing user’s cognitive load due to interruptive notifications on smart phones. In: 2015 IEEE International Conference on Pervasive Computing and Communications (PerCom), 23–27 March 2015, pp. 96–104 (2015). <https://doi.org/10.1109/PERCOM.2015.7146515>
16. Pejovic, V., Musolesi, M.: InterruptMe: designing intelligent prompting mechanisms for pervasive applications. In ACM UbiComp, Seattle, WA, USA (2014). <https://doi.org/10.1145/2632048.2632062>
17. Hyungik, O., Jalali, L., Jain, R.: An intelligent notification system using context from real-time personal activity monitoring. In: 2015 IEEE International Conference on Multimedia and Expo (ICME), 29 June–3 July 2015, pp. 1–6 (2015). <https://doi.org/10.1109/ICME.2015.7177508>

18. Corno, F., Russis, L.D., Montanaro, T.: A context and user aware smart notification system. In: 2015 IEEE 2nd World Forum on Internet of Things (WF-IoT), 14–16 December 2015, pp. 645–651 (2015). <https://doi.org/10.1109/WF-IoT.2015.7389130>
19. Roecker, C., Bayon, V., Memisoglu, M., Streitz, N.: Context-dependent email notification using ambient displays and mobile devices. In: Proceedings of the 2005 International Conference on Active Media Technology (AMT 2005), 19–21 May 2005, pp. 137–138 (2005). <https://doi.org/10.1109/AMT.2005.1505288>
20. Leonidis, A., et al.: AlertMe: a semantics-based context-aware notification system. In: 2009 33rd Annual IEEE International Computer Software and Applications Conference, 20–24 July 2009, vol. 2, pp. 200–205 (2009). <https://doi.org/10.1109/COMPSAC.2009.134>