Design and Development of Face Mask Reminder Box Technology using Arduino Uno

Chee Ken Nee[1]*, Rafiza Abdul Razak[2], Muhamad Hariz Bin Muhamad Adnan[3]
Wan Fatin Liyana Mutalib[4], Nur Fatirah Roslee[5], Noor Mursheeda Mahyuddin[6]
Department of Computing, Faculty of Arts, Computing and Creative Industry
Sultan Idris Education University, 35900 Tanjung Malim, Perak, Malaysia[1, 3]
Curriculum & Instructional Technology Department
Faculty of Education, University of Malaya, 50603 Kuala Lumpur, Malaysia[2, 4, 5, 6]

Abstract—**The World Health Organization (WHO) declared the COVID-19 pandemic on 12 Mar, 2020, due to the growth in the number of cases worldwide. WHO advises wearing a face mask and practicing social distancing, which has played a crucial role in prevention and control measures that can prevent the spread of COVID-19. Thus, this paper presents the process through which face mask box is equipped with a voice reminder and sensor. It is made with the help of an Arduino Uno board to give awareness or reminder whenever a person is alerted with a voice reminder to wear a face mask before going outside. It can be helpful, especially in the pandemic era, as a new norm of practice in wearing a mask.**

Keywords—*Face mask box; COVID-19; Voice reminder; Arduino; New norm*

I. INTRODUCTION

The World Health Organization (WHO) declared COVID-19 as a pandemic on 12 Mar, 2020 due to the growth in the number of cases worldwide [1]. The Covid-19 pandemic has had a negative impact on health, education, economy, finance, and others, resulting in the introduction of the Movement Control Order for many countries. People were advised to stay at home, work from home, limit their movement outside the house, wear a mask to cover their nose and mouth, regularly wash their hands, establish social imprisonment, and so on as precautions to stop this pandemic [2]. So, all people need to carry and adapt to daily life with the new norm; as a prevention and control measure to limit the spread of COVID-19, WHO advises wearing a face mask and practicing social distancing [3]. Mask has played a crucial role in prevention and control measures to prevent the spreading of some respiratory diseases and COVID-19. The use of masks and frequent hand hygiene, social distancing, and other Infection Prevention and Control (IPC) measures should be followed to prevent the spread of COVID-19 [4].

One significant benefit of wearing face masks is to protect the people around us, especially if we have been exposed to someone carrying the virus or work in a crowded place. Therefore, wearing masks is a critical habit everyone should be applying since this simple step could significantly reduce the risk of transmission [5]. Hence, it is a pressing need to design and develop a face mask reminder with a low-cost material that

can be easily made since there is also none of this product available in the market to date.

II. BACKGROUND AND PREVIOUS RELATED WORK

A. Motivation and Problem Statement

Coronavirus Disease 2019 or known as COVID-19, has become the latest threat to global health [6]. It is an infectious disease [7] that causes severe acute respiratory syndrome (SARS) [6]. The symptoms of the infection consist of fever, cough, nasal congestion, fatigue, and other signs of upper respiratory tract infections [8]. The condition can cause severe disease or death; as a prevention and control measure to limit the spread of COVID-19, the WHO advises wearing a face mask and practicing social distancing [3].

Recently, it seems like some people are starting to disregard the WHO order to practice social distancing and wear a face mask whenever they leave the house or are in a crowded place. Thus, to address these problems, every country affected by COVID-19 has made it mandatory for people to wear face masks in public, especially in crowded places. The new normal must be continued depending on our awareness level, attitudes, and habits. For this project, the problem focuses on the attitude and practices of wearing face masks. Thus, to solve the issues stated, this project developed a face mask reminder to give awareness of the importance of face masks. A person will be alerted with a voice reminder to wear a face mask before going outside through the project.

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B. Previous Related Work

Based on the literature review of the previous works, the ideas of face mask boxes and voice reminders are considered to develop an awareness system toward the importance of face masks. The difference from previous related work is through the project, a person will be alerted with a voice reminder to wear a face mask before going outside.

*Corresponding Author
Research Management and Innovation Center (RMIC), Universiti Pendidikan Sultan Idris.

1) Build your own COVID-19 face mask reminder using Arduino: The project designed and made by The Assembly Production addressed how people always forgot to wear a face mask when going outside [9]. The emergence of COVID-19 has made the entire world obey the rules on social distancing and wear face masks to prevent the spread of COVID-19.

Thus, the Assembly Production designed a face mask reminder using Arduino Uno, PIR sensor, buzzer, LCD, and keypad. The PIR sensor detects the motion of a person going through the device, and the buzzer will make a noise to alert the person to wear a face mask before going outside [9]. The device also has an LCD to display the number of face masks and a keypad to enter the number of face masks in the box. Fig. 1 shows the device produced by the Assembly where the user can store the face mask in the designated container. The face mask's material was a paper box, which was low in cost.

Fig. 1.   Face Mask Reminder Device.

2) Contact-free hand wash dispenser with voice assistance: The Assembly Production The project designed and made by Neutrino addressed how to use a hand wash without making any contact while taking the hand soap, as illustrated in Fig. 2 [10]. It is designed using Arduino Pro Mini, DF Player, PIR sensor, DS1307 Tiny RTC, SD Card module, and speaker. The intelligent hand wash dispenser reminds a user with a message after every 2 hours to wash hands. The PIR sensor detects the motion of a person by putting their hands next to the hand soap. Then, the signal is sent to the DF player, and voice assistance will help them wash their hands.

Fig. 2.   Contact - Free Hand Wash Dispenser.

III. DEVELOPMENT OF FACE MASK REMINDER PROTOTYPE

A. Methods

The face mask reminder is designed to alert the person to wear a face mask before going out. Fig. 3 shows the flowchart for project planning.

To assure the project runs smoothly, systematic action was taken to analyze the face mask reminder's performance. The project flow is divided into four phases: Research, Design and Modelling, Prototype, and Result and Analysis.

For Phase 1: Research, the project begins with a detailed study on a literature review about voice reminders and motion detection. Based on the previous related works, [9] designed a face mask reminder box to noise to alert the person to wear a face mask before going outside. While [10] developed a contact-free hand wash dispenser with a voice reminder feature. The project will also focus on the simulation and coding to implement motion detection and voice reminder.

For Phase 2: Design and Modelling, the project followed by designing the device for a better experience. In this phase, some research was done on hardware and software compatibility and suitability for the proposed system. Every system is a combination of hardware and software, mainly hardware or software [11].

For Phase 3: Prototype, the prototype's functionality is tested after the simulation and design is done. The design was done using Fritzing to determine the hardware connection of each component. At the same time, the simulation of hardware connection was done by using Proteus software.

For Phase 4: Result and Analysis, the result obtained from testing the prototype was analyzed to monitor the system's performance. The analysis was done on the device's performance and improvement on other parts.
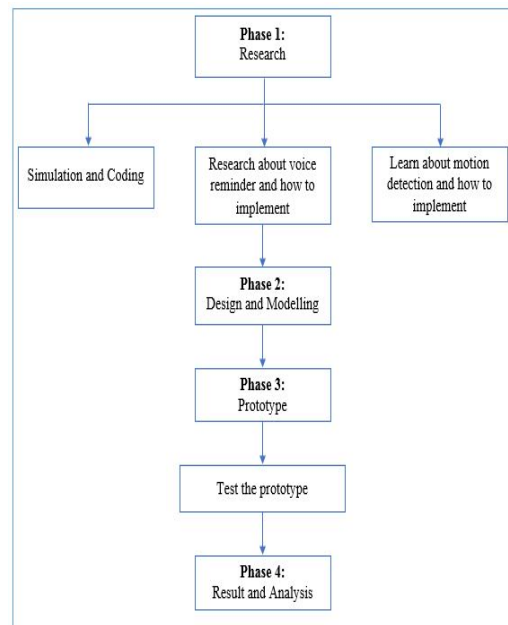

Fig. 3.   Flowchart of the Project Planning.

B. Face Mask Reminder Box Design

To assure the project runs smoothly, systematic action was taken to analyze the face mask reminder's performance. The project flow is divided into four phases: Research; the Face Mask Reminder is designed on Sketch Up software based on the requirements.

The prototype design includes space for hardware and a face mask box. Fig. 4 shows the face mask reminder box's design using SketchUp software. SketchUp has a lot of possibilities and needs a low amount of pre-knowledge to get started. This software shows some knowledge about models, building and using models can be getting through its help. There might be a few doubts for the new users, but this can be solved easily with help and demonstrated videos. There are tools for selection, drawing, component, view, and sharing the drawing designs [12]. The sketching shows the sides to be used to place all the hardware with each part labeling. The 4x4 keypad membrane, PIR sensor, and 16x2 LCD display are placed side by side for the front side. For the right side, the speaker and IR sensor are also placed side to side.

Hardware space is for placing the Arduino UNO and power supply; the suggested power supply to be used is a power bank. Arduino is used as an open-source computing platform that is used for constructing and programming electronic devices. It can also act as a mini-computer, like other microcontrollers, by taking inputs and controlling the outputs for various electronic devices [13]. At the same time, the face mask box is for the user to put the face mask in the box up to 100 pieces of face mask. The IR sensor function will detect a person's hand that takes out the face mask, and the number displayed on the LCD will be reduced. Then, the PIR sensor will detect a person's movement through the box and play a voice reminder: "Please wear a face mask before going out" using a speaker. So people will become more alert during going out.
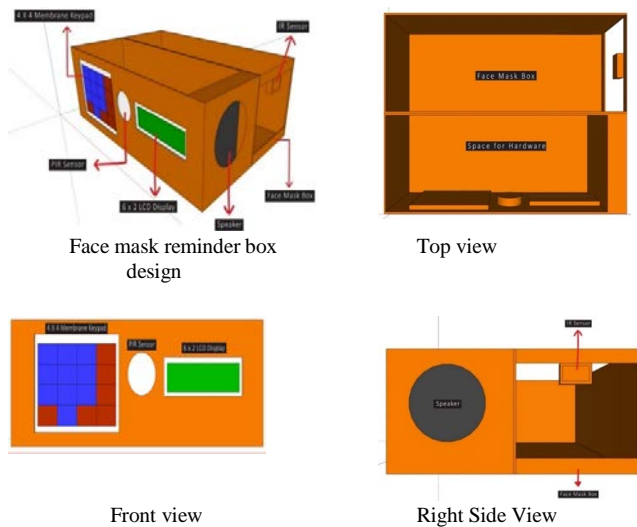
C. Mask Reminder Box Fabrication

The face mask reminder is designed to alert the person to wear a face mask before going out. As shown in Fig. 4, the face mask reminder box design is divided into two parts. The first part is for hardware connection space, where all the hardware will be placed in this space. This box comes with a small hole for power supply purposes. The second part is for a face mask box where a user can store up to 100 face masks in this space.

The material used for the box is Acrylic or Perspex. Acrylic is a transparent plastic material with outstanding strength, stiffness, and optical clarity. Acrylic is also a material with properties such as transparency and durability. It is now being used in a wide range of applications such as lenses of glasses, tail lights, and various other instruments in a vehicle to reduce cost and productivity [14]. It is highly resistant to variations in temperature and humidity. Thus, it is helpful in outdoor applications as well. Fig. 5 shows the top view of the box. The box has a lid that can be opened to check the hardware connection and fill in the face mask. The cover can be opened and closed quickly.

Fig. 6 shows the front view of the face reminder box. The 4x4 membrane keypad and 16x2 LCD keypad with I2C are placed side to side on the front side. The keypad is used to key in the number of face masks in the box. The LCD display presents the actual number of face masks in the box. On display, it will show the exact number of masks and the maximum number that can be entered. The maximum number of face masks that can be placed in the box is 100 pieces. The device can be used easily if the hardware is connected.

Fig. 7 shows the left side view of the face reminder box. The speakers, PIR, and IR sensor are placed side to side on the left side. In addition, on the right is a face mask box where the user can place a face mask. The speaker is used to alert "Please wear a face mask before going out" to anyone passing through the box. PIR sensor is used to detect a person's motion. When it detects a motion, the speaker will sound an alert. At the same time, an IR sensor is used to detect a hand motion of a person. If a person removes a face mask from the box, the number displayed on the LCD will be reduced.

Face mask reminder box design

Top view

Front view

Right Side View

Fig. 4. Design of Face Mask Reminder Prototype using SketchUp Software.

Fig. 5. Top View of Face Mask Reminder Box.

Fig. 6. Front View of Face Mask Reminder Box.

Fig. 7.   Left Side View of Face Mask Reminder Box.

Fig. 8.   Right Side View of Face Mask Reminder Box.

Fig. 8 shows the right-side view of the face reminder box. There is only a tiny cutout of acrylic sheet for connecting the hardware to the power supply on the right side. But, since the power supply is a small 20000mAH power bank, it is just placed inside the box. Fig. 9 shows the backside view of the face mask reminder box.

Fig. 9.   Backside View of Face Mask Reminder Box.

IV.   DEVELOPMENT OF FACE MASK REMINDER SYSTEM

A. Circuit Design of Face Mask Reminder

The hardware component for the prototype is Arduino UNO with PIR and IR sensor, LCD with I2C, Keypad, SD card module, and Speaker. Fig. 10 shows the circuit connection using Fritzing application.
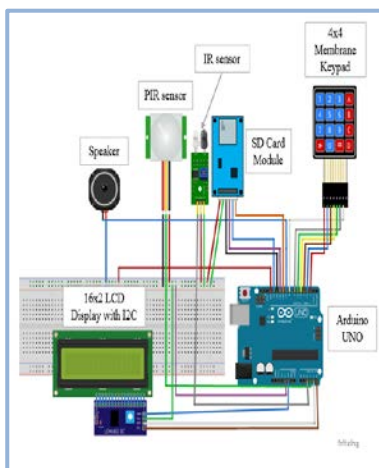

Fig. 10. Hardware Connection of Face Mask Reminder using Fritzing.
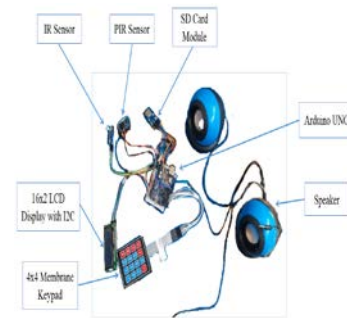

Fig. 11. Hardware Connection of Face Mask Reminder.

The prototype consists of only hardware parts tested to assure the device's functionality. Fig. 11 shows the hardware connection of the face mask reminder. Arduino UNO acts as a microcontroller and holds all of the other components. The power supply is a 20000mAH power bank to keep the hardware active.

V.   IMPLEMENTATION OF FACE MASK REMINDER

A. Testing the Face Mask Reminder Box

The face mask reminder box was tested to get its functionality in this part. The test was done in a living room near a door. A hardware component is connected to the 20000mAH power bank that acts as a power supply to keep the box active through the testing. The audio of different voice alerts is stored on an SD card in waveform audio file (WAV) format [15].

A person passed through the box, and the speaker sent an alert with a voice reminder, "Please wear a face mask before going out." Next, the box reminds the person to wear a face mask before going outside to prevent exposure to the virus COVID-19. Then, the person takes out a face mask from the box and decreases the number of face masks shown on the LCD display.

On the other hand, the person refills the face mask in the box. After that, he keys in the actual amount of face mask added using the keypad. Thus, the exact number of face masks in a box appeared on the LCD.

The result obtained in this project is analyzed according to the related part. It has been proved that the face mask reminder box works systematically according to the working principle and based on the testing phase. As a result, the face mask reminder is successfully implemented.

B. Manual to Key in Quantity of Face Mask

Fig. 12 shows that the keypad matrix with 16 push buttons [16] is used to key in the number of face masks in a box. This type of keypad has four rows and four columns where the overlapping rows and columns are the keys [17]. To key in the number of face masks, the user can follow the instruction below.

1) Press any number from 1 to 100.
2) Press "#" to enter.
3) The number will be shown on the LCD.
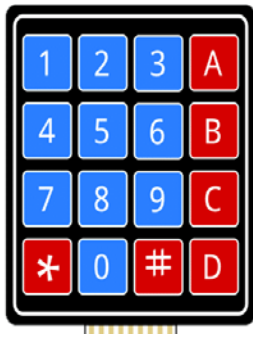*4)* To backspace, press "A."

Fig. 12. 4x4 Keypad Membrane.

Users can only enter numbers 1 to 100 because the system only allowed face masks up to 100 pieces. If a user enters more than 100, the LCD will show "Invalid number," and it must key in the number again. If the user enters a wrong number, press keypad "A" during the process to backspace.

VI. OVERALL SYSTEM ARCHITECTURE

The overall system architecture of the developed Face Mask Reminder system is illustrated in Fig. 11 and Fig. 13. The system design consists of one central part: hardware. The hardware components are Arduino UNO, PIR and IR sensor, 16x2 LCD with I2C, 4x4 membrane keypad, SD card module, and speaker.

Firstly, Arduino UNO acts as a microcontroller that integrates with the PIR sensor to detect any motion within the range [11]. When the sensor detects a person's movement, a speaker will alert with a voice reminder from the SD card module. It will be a warning for a person to wear a face mask before going outside. Secondly, Arduino UNO is a microcontroller that integrates with an IR sensor to detect the hand motion of someone taking a face mask from the box [18]. When the sensor detects a hand motion, the number displayed on the LCD will be decreased. Lastly, the keypad is used to enter the number of face masks in the box.

The flowchart of the system operation mechanism is shown in Fig. 14. The application starts with the face mask reminder box attached next to the door or somewhere close to the door. Then, a user can fill in the face mask in the box and key in the quantity of the face mask using the keypad membrane. The actual number of face masks in a box is shown on the LCD.
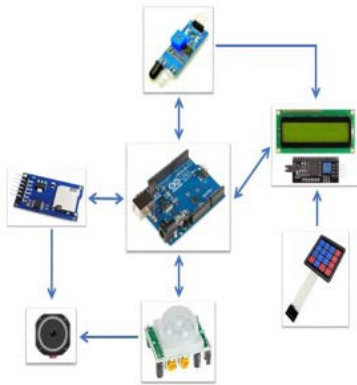

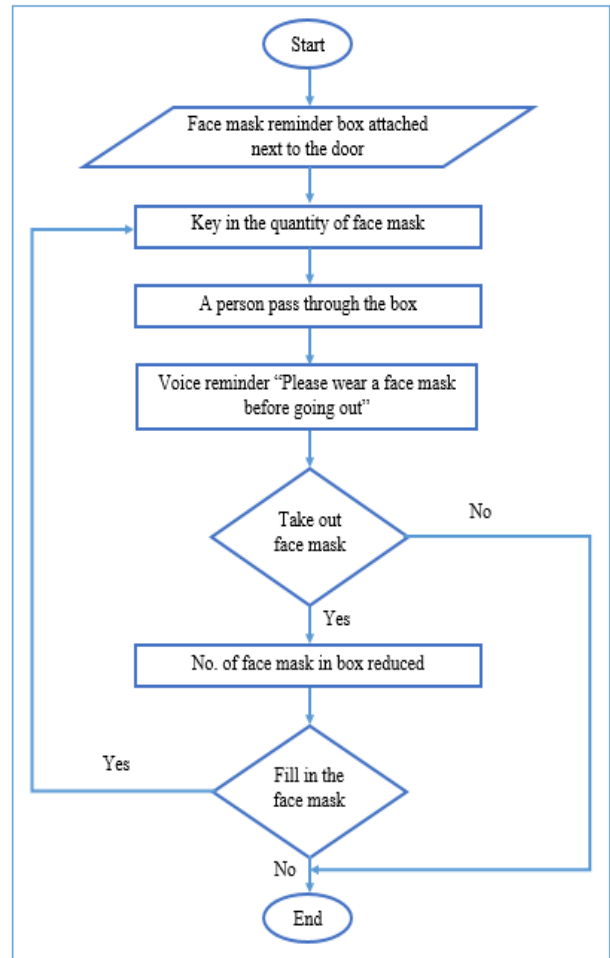Fig. 13. Face Mask Reminder System Architecture.

Fig. 14. Flowchart of Face Mask Reminder Application.

When a person passes through the box, the PIR sensor detects a motion and sends a signal to the speaker [19]. A voice reminder alerts the person with a warning, "Please wear a face mask before going out." If a person takes a face mask from the box, the IR sensor senses a hand motion into the face mask box [20]. Then, the number of face masks in the box was reduced. Thus, if a user fills in the face mask in the box, they must key in quantity, and the actual number appears on the LCD [21]. If a person does not make a face mask or fill in the face mask, they can continue their way out. The complete supplementary files for the Facemask Reminder coding algorithm can be found in the link here: https://tinyurl.com/facemaskbox reminder

VII. CONCLUSION AND RECOMMENDATION

The design of the proposed system only consists of hardware parts. The hardware implementation used Arduino UNO, PIR and IR sensor, LCD Display, Keypad, Speaker, and SD Card Module. It is used to develop the Face Mask Reminder, which provides a face mask box with a voice reminder. The Face Mask Reminder box capabilities provide a voice reminder as an alert or warning to a person to wear a face mask before going outside. To reduce the problem of people who recently forgot to wear a face mask, the box comes with a space to place a face mask up to 100pcs. The sensors increased

accuracy in detecting a person's motion when it passed through the box and taking a face mask out of the box. The performance of the box is tested in the living room, and it shows an excellent result that can be used for a face mask reminder. The Face Mask Reminder box is built successfully. However, this system could be upgraded better by using more accurate sensors. PIR sensors depend on motion detection, with the motion sensitivity declining as the user's distance from the sensor increases [22]. While IR sensor is highly accurate, they are highly fragile in nature [23].

REFERENCES

[1] Ministry of Health. (2020). COVID-19: Social Distancing Guidelines for Workplace, Homes and Individuals. Guidelines COVID-19 Management. Annex 26. No. 5/2020. Retrieved from http://covid-19.moh.gov.my/garis-panduan/garis-panduan-kkm.

[2] World Health Organization (2020). Coronavirus disease (COVID-19) advice for public: When and how to use masks. Retrieved from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public/when-and-how-to-usemasks?adgroupsurvey={adgroup survey}&gclid=Cj0KCQjwpdqDBhCSARIsAEUJ0hNx_wVZvjBA43M9PfAqjWaH51d_IVzI7XOcmAUD7VKhseupyH6_p8waAr65EALw_wcB.

[3] World Health Organization. (2020). Mask use in the context of COVID-19: interim guidance. COVID-19: Infection prevention and control. Emergencies Preparedness, WHO Headquarter (HQ). WHO/2019-nCoV/IPC_Masks/2020.5 Retrieved from https://www.who.int/publications/i/item/advice-on-the-use-of-masks-in-the-community-during-home-care-and-in-healthcare-settings-in-the-context-of-the-novel-coronavirus-(2019-ncov)-outbreak.

[4] Ministry of Health. (2020). Annex 8a: Guidance on the Use of Masks with Regards to Covid-19 Pandemic. Guidelines COVID-19 Management. Annex 8. No. 5/2020. Retrieved from http://covid-19.moh.gov.my/garis-panduan/garis-panduan-kkm.

[5] World Medical Card (2020). The Importance of Wearing Masks. Retrieved from https://www.wmc-card.com/uk/the-importance-of-wearing-masks/.

[6] Fauci, A. S., Lane, H. C., & Redfield, R. R. (2020). Covid-19 — Navigating the Uncharted. New England Journal of Medicine, 382(13), 1268–1269. https://doi.org/10.1056/nejme2002387.

[7] Post-COVID-19 global health strategies: the need for an interdisciplinary approach. (2020). Aging Clinical and Experimental Research, 32(8), 1613–1620. https://doi.org/10.1007/s40520-020-01616-x.

[8] Velavan, T. P., & Meyer, C. G. (2020). The COVID-19 Epidemic. Tropical Medicine & International Health, 25(3), 278–280. https://doi.org/10.1111/tmi.13383.

[9] The Assembly Production. (2020). Build Your Own COVID-19 Face Mask Reminder Using Arduino. The Assembly Production Team. Retrieved from https://youtu.be/yu8g9jn41zU.

[10] Neutrino. (2020). Contact-Free Hand Wash Dispenser with Voice Assistance. Neutrino Team. Retrieved from https://youtu.be/N_-7oMFJ18k.

[11] Budijono, S., Andrianto, J., & Axis Novradin Noor, M. (2014). Design and implementation of modular home security system with short messaging system. EPJ Web of Conferences, 68, 00025. https://doi.org/10.1051/epjconf/20146800025.

[12] Dr.Pradip Ashok Symote (2016). Google Sketch up: A Powerful Tool for 3D Mapping and Modeling. International Journal of Computer Application and Engineering Technology. Volume 5-Issue. Pp. 377 - 382.

[13] Leo Louis (2016). Working Principle of Arduino and using it as a Tool for Study and Research. Department of Electronics and Communication Engineering, Gujarat Technological University, Ahmedabad, India. International Journal of Control, Automation, Communication and Systems (IJCACS), Vol.1, No.2.

[14] Eshwar Pawar (2016). A Review Article on Acrylic PMMA, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 13, Issue 2 Ver. I.

[15] Sharmad, P. (2016). Thingspeak Based Sensing and Monitoring System for IoT with Matlab Analysis. International Journal of New Technology and Research, 2(6), 19-23. https://www.ijntr.org.

[16] Arduino Website. Accessed: Nov. 5, 2020. [Online]. Available: https://www.arduino.cc/en/software.

[17] Khan, S., Rahman, O., & Ehsan, M. (2017). Design and Fabrication of a Password Protected Vehicle Security and Performance Monitoring System. 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), 568–571. https://doi.org/10.1109/r10-htc.2017.8289022.

[18] Rindhe, C. (2020). Smart Car Parking System using IR Sensor. International Journal for Research in Applied Science and Engineering Technology, 8(5), 2460–2462. https://doi.org/10.22214/ijraset.2020.5405.

[19] Woodstock, T. K., & Karlicek, R. F. (2020). RGB Color Sensors for Occupant Detection: An Alternative to PIR Sensors. IEEE Sensors Journal, 20(20), 12364–12373. https://doi.org/10.1109/jsen.2020.3000170.

[20] Kumar, P. L. (2020). Vehicle Speed Detection System using IR Sensor. International Journal for Research in Applied Science and Engineering Technology, 8(5), 1563–1567. https://doi.org/10.22214/ijraset.2020.5253.

[21] Rajkumar, M., Anamika, & Sushmita, K. (2018). Biometric Based Electronic Voting Machine. International Journal of Engineering Development and Research, 6(2), 273-277.

[22] Lopez-Belmonte, J., Marin-Marin, J. A., Soler-Costa, R., & Moreno-Guerrero, A. J. (2020). Arduino Advances in Web of Science. A Scientific Mapping of Literary Production. IEEE Access, 8, 128674–128682. https://doi.org/10.1109/access.2020.3008572.

[23] Kumar, P. L. (2020). Vehicle Speed Detection System using IR Sensor. International Journal for Research in Applied Science and Engineering Technology, 8(5), 1563–1567. https://doi.org/10.22214/ijraset.2020.5253.