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## IoT-Enabled Smart Lock System



**Abstract:** - Access is a system for improving accessibility and security approaches that is centrally regulated and adaptable. Security is a major worry, and with the advent of technology, everyone wants things to be simple and quick. Many Internet of Things (IoT) developers are working today leaning toward home automation. Lock and key systems automation in houses and businesses has piqued people's interest recently. This article includes systems for viewing visits to homes, machines, or any other appliances that can be remotely administered through a mobile application. Visitors can be monitored by the owners and decide to who they wish to give entry and that is accomplished by granting temporary access rights to the guests for a period of time determined by the owner. They can also do so at the same time and keep an eye on the visitors' activities.

**Keywords:** Smart lock, Internet of things, Security, locking system

### I. INTRODUCTION

Every human being wishes for safety, whether it be in terms of his possessions or his personal life. To combat this, we've taken a variety of initiatives. You must achieve it in order to enjoy a worry-free existence. We're working on a project called proposing a smart locking system, which is meant to prevent trespassing and unwanted access using the Internet of Things (IoT). Banks, financial institutions, government offices, and retailers, as well as organizations, are frequently used targets for illegal access. These types of actions are carried out with the intention of stealing money or engaging in any other unlawful [1] activity in order to acquire vital documents for personal benefit. The Internet of Things is an essential subject in the realms of technology, engineering, and politics, as it has garnered considerable attention in both the trade and public press. The implementation of this technology is evident in various networked devices, systems, and sensors that leverage advancements in computing power, downsizing of electronics, and network connectivity to deliver previously unattainable functionalities. Its impact is significant, and it continues to shape the landscape of various industries. The authors discussed some smart locks which work on the concept of the biometric lock using the fingerprint sensor. In these locks, Arduino IDE is needed to be uploaded into the microcontroller which is Arduino Nano in this lock. This creates a connection between the Nano board and a smartphone through the utilization of Bluetooth

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technology. The establishment of such a link will prove beneficial in the long run as it will facilitate the control of the micro-controller through a smartphone. By enabling control of the microcontroller through a mobile device, this technology will revolutionize the industry. Here a program will be developed which will contain a unique IDE that will be sent to mobile so as to make a secure connection. Using the program an app will be developed which will be installed in smartphones [2].

The "Internet of Things revolution" has been a topic of discussion in numerous conferences, articles, and news stories, with a focus on its potential consequences. These consequences range from opening up new market opportunities and business models to tackling security, privacy, and technical interoperability challenges. The IoT sector is expected to become the most significant industry in the future. IoT enables convenient and effective services in any location at any time, regardless of technological or economic constraints, as well as temporal and spatial constraints, by delivering services in a variety of disciplines. In connection with the expansion of information and communication technology, it also facilitates the dissemination of intelligent terminals, such as smartphones [3]. This paper's major purpose is to devise a viable and effective answer to a spate of similar difficulties. This can help to avoid money theft and provide better protection than before. The benefits of the Internet of Things are starting to revolutionize everything from corporations to governments to homes and hospitals all across the world. Smart home appliances, in particular, have grown in popularity in the IoT sector as an important feature of IoT devices and their functionality. As a result, they've gotten more specialized and powerful. As an example, we can control a voice-activated speaker or a home coffee machine by speaking into the air. Every smart lock has a unique owner, who can provide control the number of people for any length of time and remove their access from the smart lock at any instant. They can also be notified whenever their locks are opened by someone else. It's also made sure that only the owners can access their locks remotely, and those guests can only do so while they're close to them. In the event that there is no internet connection, the technology allows users to manually open the locks using offline means [4].

The article discusses the problem of traditional door lock systems control and seeks to replace it with a method that allows for remote system control and access. The researcher of the [5] author sectors with various solutions for the problem. The research methodology used in these papers uncovered flaws in these solutions. The main purpose of these articles is to create a completely effective smart security control system that can also help overcome all of the shortcomings that previous comparable works have. In this covid time, everyone had to take lots of care on maintaining their hygiene. Touch is the most common way of spreading viruses so the smart lock is the best way to tackle this problem [6-12]. We only need to open one application and tap on it to open the door and it can reduce the risk of spreading this virus in this pandemic. The project's goals were to create a modern, user-friendly smart door lock that allows for easy unlocking and offers convenience, utility, and security to your house. It allows customers to remotely open their doors using the Smart Lock mobile app [13-20].

The pathogen SARS-CoV-2 is responsible for triggering the onset of the severe respiratory illness known as COVID-19. While the majority of individuals infected with COVID-19 will display mild to moderate symptoms and eventually recover without the need for therapeutic intervention, a significant subset may present with severe manifestations that require urgent medical attention [20-21]. It is noteworthy that the clinical course of COVID-19 can vary considerably from person to person, highlighting the complexity of this disease and the importance of careful monitoring and management of affected individuals. As such, healthcare professionals must remain vigilant and attuned to the evolving nature of this pandemic [8-10]. The progression of symptoms and treatments for chronic illnesses differ widely. Some can cause a patient's death if not detected and treated early [1]. Traditional testing at specialist health facilities were the normal way for assessing heart rate, body temperature, and oxygen saturation for many years. With the rise of technology, there is now a wide range of sensors that can learn crucial signals like as blood pressure, heart rate, and blood oxygen saturation, allowing patients to take basics on a daily basis in this pandemic. Doctors will receive daily readings and will prescribe medicine and exercise routines to help patients enhance their standard of living and stay safe from this hazardous condition. [2]. The networking of resources used in patient safety is becoming more widespread in the promotion of oncology, which improves wellbeing of individuals and keeps them secure while also building social distances.

The internet of everything (IoE) is described as the unification including all networked devices which can be operated over the website and offer real-time data, facilitating interactions with individuals [1-3].

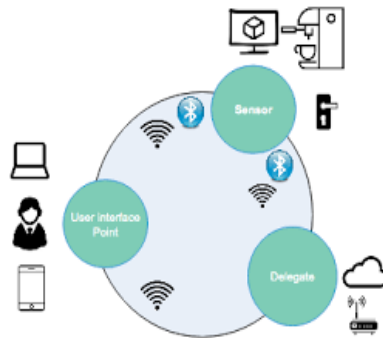


Fig 1. Infrastructure of IoT ecosystem [1]

## II. SCOPE

The many of scope is to design and develop a smart lock control system. The control systems should be more secure and more user-friendly. The main motive of the project has been listed below

- To construct a more efficient smart lock
- To make it more secure and easy to use
- To use technologies like IoT (Internet of Things), Bluetooth, Wi-Fi other, etc.
- Make use of more applications of the smart lock control system
- For getting a security policy for personal life and things and to authenticate the all who are users trying to access the smart door lock
- For creating an android app for the controlling the smart lock for the user end.

## III. 3. HARDWARE AND SOFTWARE

### A. Working Components

**Smart door lock:** It's an electromechanical lock that uses a wireless protocol and a cryptographic key to execute locking and unlocking activities on a door when prompted to do so by an authorized device. It also tracks access and sends notifications for the several events it tracks, as well as a few additional important events related to the device's status. A smart lock is one of the components of a smart house [8-10].

**Raspberry pi 3:** The development board under consideration is a PI series product that boasts impressive features. It is a single-board computer that is powered by the LINUX operating system [7]. The board has a wide range of functionalities that would be of great interest to users. Moreover, the processing speed of this board is exceptional, making it the perfect choice for demanding applications that require high levels of complexity.

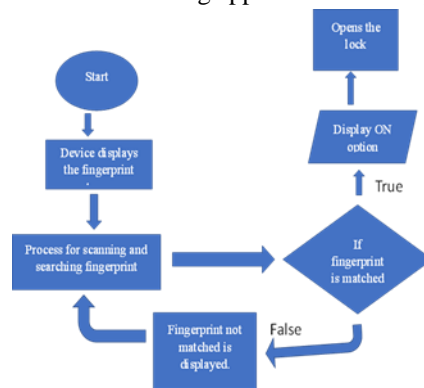


Fig 2 Flow chart diagram

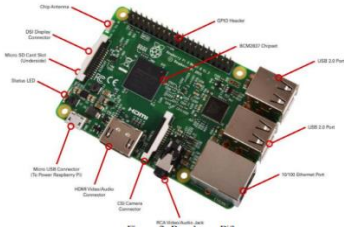


Fig 3. Raspberry [7]



Fig 4. ESP-32 [5]



Fig 5. Bluetooth module [9]

**ESP 32:** The ESP32 series is a cost-effective and energy-efficient microcontroller series that features Wi-Fi and dual-mode Bluetooth capabilities. Apart from the Tensilica Xtensa LX6 dual-core or single-core RISC-V microprocessor, this series has antenna switches, RF baluns, power amplifiers, low-noise receive amplifiers, filters, and power management modules. Expressive Systems, a Chinese company based in Shanghai, was responsible for designing and developing the ESP32, which was made possible by TSMC's 40 nm technology. This microcontroller series provides a high level of functionality and performance, making it an excellent choice for numerous applications.

**Printed Circuit Board (PCB):** It is a type of electrical circuit that is employed in devices to offer mechanical support as well as a conduit to the device's electronic components. It is created by fusing together various sheets of non-conductive material, such as fibreglass or plastic that can readily retain a copper circuit.

**Security alarm:** It's a system that detects unauthorised entry into a structure or other facility, such as a home or school. Burglary (stealing), property damage, and personal safety are all protected by security alarms in homes, businesses, industries, and the military. Lower robberies have been connected to neighbourhood security warnings. Car alarms also help to keep automobiles and their contents safe. In prisons, security measures are also utilised to keep inmates under control.

**Display screen:** The display screen refers to the display portion of a monitor. Most display displays operate on the same concept as televisions, employing a cathode ray tube (CRT). As a result, the word CRT is frequently used instead of display screen.

**Bluetooth module:** Bluetooth module is a chip's basic circuit set with an inbuilt Bluetooth capability that is used for short-range 2.4G wireless communication. The Bluetooth module is a semi-finished product for the end customer. There are various types of Bluetooth modules like HC-02, HC -06, HC-05, HM- BT4502.

**DC Power supply:** A dc voltage (DC) power supply is a power source that provides direct current (DC) voltage to a device. Because they are generally used on an engineer's or technician's bench for a variety of energy testing, DC power supplies are sometimes referred to as "bench power supplies." The circuit is frequently constructed with 12 volts and 5 amps.

**MIT app inventor:** MIT app inventor is a straightforward graphical development tool that allows anyone, including children, to create perfectly functioning apps for smartphones and tablets. In just 30 minutes, newcomers to MIT App Inventor can create a basic first app. Furthermore, unlike conventional programming surroundings, our blocks-based technology allows for the rapid development of complex, high-impact projects. The MIT App Inventor project aims to make software development easier for anyone, especially young people, by allowing them to go from technology usage to production. It's also a website-based tool developed by the Massachusetts Institute of Technology for quickly creating Android apps [7-10].

**Ubidots:** It's an IoT device interface that enables entrepreneurs and businesses to prototype and scale up IoT projects. Use the Ubidots platform to send data to the cloud from any Internet-connected device. Then, using visual tools, you can design actions and alerts based on your real-time data, allowing you to maximize the benefits of your information. Ubidots provides a REST API that allows you to read and write data to data sources, variables, values, events, and insights. The API requires an API Key and supports both HTTP protocol and HTTPS protocol. Two additional replications, protected storage, and optional Transport layer security data support will keep your personal information safe [11].

**RFID (Radio Frequency Identification):** It is a technology that detects marked items using radio waves. From tracking products through a supply chain to keeping track of materials checked out of a library, it's used in a variety of commercial and industrial applications.

**Fingerprint scanner:** A fingerprint scanner works by detecting and authenticating a person's fingerprints in order to grant or deny access to the computer or a physical location. It's a biometric security system that uses a wide range of devices to identify an individual's fingerprint scans.

**Arduino IDE:** The software, which is available at no cost, offers developers the opportunity to create code for Arduino boards and upload it to them. The IDE program supports Windows, Mac OS X, and Linux operating systems. The programming languages C and C++ are both supported by this program. The term IDE, in this context, refers to Integrated Development Environment. When a program or code is written in the Arduino IDE, it is referred to as sketching. To upload the illustration that has been written in the Arduino IDE software, it is necessary to connect the Genuino and Arduino boards to the IDE. The saved drawing is given the '.ino' extension.

### B. User Privileges

Other than basic lock functions, the mobile application is used for a variety of functions. The system may have three sorts of users:

**Primary user** – These users have full lock rights. They can lock and unlock their locks while they are close to them or even remotely themes it. They also have the ability to create new locks, as well as alter or delete present users

**Secondary user** – They also have the same permissions as the primary user, but they can make a change to a smart lock system like alter or delete the present users.

**Visitors**– They can also access the lock as the other two users but they will be monitored and will be recording the entries by the primary user.

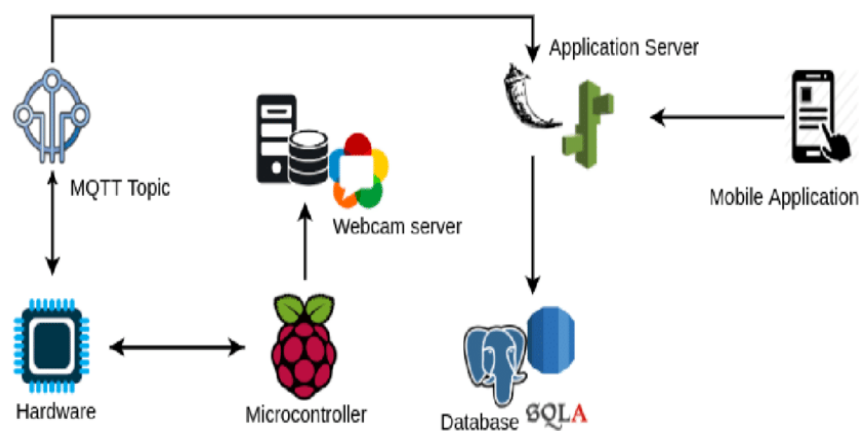


Figure 6 working pathway [5]

### C. Authentication and Security

A cloud authentication service is used to authenticate the users. Each user can only see their own information through the program, and so their information is not visible to any other user. Only systems on the same network can access the database. The database can only be accessible to authenticated primary users who have provided the necessary user id and passwords. All of these safeguards were taken to preserve data and prevent unauthorized access or hacker assaults. [8] IoT consists of large amounts of data. And maintaining system security is critical in any IoT project. Unauthorized use is a prevalent type of security attack, and the suggested approach prevents it.

## IV. 4. RESULTS AND DISCUSSION

In this flow chart, it is given that the main sensor that is HC 05 will be the main component of our project which is at the centre in our flow chart. It contains the Arduino IDE which will be installed in HC 05 using computers. This IDE will also contain the key to link it with the application which is installed on one's device. Then here HC 05 is connected to the servomotor and the servomotor is connected to the smart lock So, when the application whose screenshot is shown here will give instruction to the HC 05 to command the motor to work then the lock will be opened and the application can only open using one's fingerprint and it will deny access to any other user whose fingerprint is not saved. One can also access the lock by entering the and unique password of that lock. This particular undertaking is geared towards facilitating the establishment of a thriving economy by constructing a low-cost biometric lock with the aid of MIT app inventor. The first phase of this venture entails the creation of a program through the utilization of Arduino IDE and uploading it to a microcontroller. This particular program is responsible for establishing a communication channel between the Arduino board and a smartphone, utilizing HC 05. This communication link enables the microcontroller to execute the commands that have been transmitted via the app.

In order to develop the program, the initial step involves generating a string variable that retains the singular device ID for the lock. Additionally, the servo library is integrated in the process. The fundamental principle that underlies the functioning of the door lock is the ID that is transmitted by the Android phone by means of the app that has been developed. In order to receive the data that has been transmitted by phone, we employ HC 05 [10-12]. This device is connected to the Arduino UNO board, which functions as the microcontroller. In this work an app on MIT app inventor app (Massachusetts Institute of Technology) website in which the turning on and off feature will be there. Figures 8 and 9 show the MIT app interface and MIT code. This will open only with the help of the fingerprint sensor the user. So, when the command will be sent to HC 05, it will start the servomotor which will open the lock by giving it instructions [13-15]. If the fingerprint of the user is not matched then the screen will not open and the user will not be able to give any instructions [16-21].



Figure 7 MIT app interface

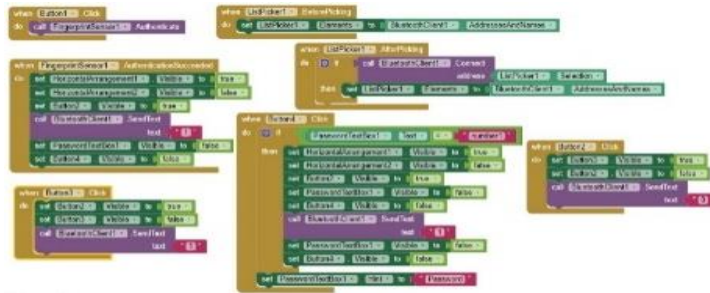


Figure 8 MIT app code

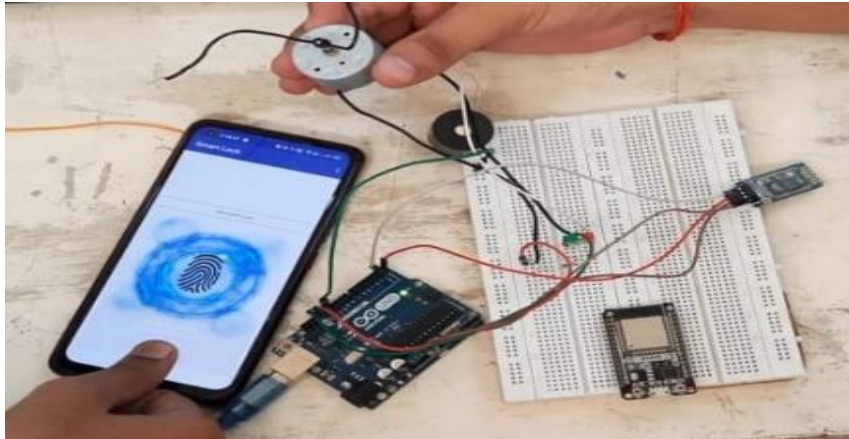


Figure 9. A Prototype of a smart lock system

## V. CONCLUSION

The application of this concept is versatile and can be utilized in a multitude of settings such as residential homes, educational institutions, corporate offices, and other locations to enhance convenience and security for people. This mechanism can be employed in any area that requires restricted access. The Internet of Things (IoT) technology is commonly used for weather monitoring and smart home systems, as evidenced by existing works. Given that doors are frequently used on a daily basis and to avoid the inconvenience of not being present at home when visitors arrive, the recommended approach is commonly implemented in households. This technology can also regulate the functioning of various equipment, storage compartments, rooms, and appliances. In the context of computer systems and equipment, it functions as a power supply, whereas in the case of doors, it operates as a lock. By enabling remote access and control, this mechanism enhances the security and convenience of various settings. Therefore, this technology is not only practical but also has the potential to revolutionize the way we secure our surroundings. The enhancement of the monitoring system in terms of access and exits from the domicile is critical to ensure the safety of senior citizens. The proposed system, as indicated by research, endeavours to overcome the inadequacies of the current system while simultaneously incorporating innovative concepts from comparable studies. The system's efficacy is expected to be enhanced significantly as a result of this integrated approach.

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## VI. REFERENCES

- [1] A Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, IEEE Communications Surveys and Tutorials 17, 2347,2015.

- [2] Aljaidi, M., Aslam, N., Kaiwartya, O., Chen, X., Sadiq, A. S., Kumar, S., & Alsarhan, A. (2024). QoE-based assignment of EVs to charging stations in metropolitan environments. *IEEE Transactions on Intelligent Vehicles*.
- [3] Kumar, R., Aljaidi, M., Singla, M. K., Gupta, A., Alhomoud, A. M., Alsuwaylimi, A. A., & Alenezi, S. M. (2024). Development of a Prototype Global Positioning System Based Stick for Blind Patients. *International Journal of Online & Biomedical Engineering*, 20(8). Kumar, R., Kumar, S., & Sengupta, A. (2016). A review: Electrical impedance tomography system and its application. *J. Control Instrum.*, 7(2), 14-22.
- [4] M. P. Shinde, S. Mehta, I. Shanbhag, V. Lele and A. Bhise, "Android based smart door locking system," *International Journal of Engineering Research & Technology (IJERT)*, vol. 9, no. 1, pp. 329-331, 2020.
- [5] Sharma, Manvinder, Harjinder Singh, Anuj Kumar Gupta, and Dishant Khosla. "Target identification and control model of autopilot for passive homing missiles." *Multimedia Tools and Applications* (2023): 1-30.
- [6] D. Vimala and K. Manikandan, *International Journal of Pure and Applied Mathematics* 118, 231, 2018.
- [7] R. Satti, S. Ejaz, and M. Arshad, A Smart Visitors Notification System with Automatic Secure Door Lock using Mobile Communication Technology *International Journal of Computer and Communication System Engineering*, 2:39-44, 2015
- [8] A. Wheeler, Commercial Applications of Wireless Sensor Network Using ZigBee, *IEEE Communications Magazine*, V. 45, N. 4, pp.:70-77, April 2007
- [9] H. Hassan, R. Bakar, and A. Mokhtar, Face Recognition Based on Auto-Switching Magnetic Door Lock System Using, in *Proceedings of International Conference on System Engineering and Technology*, 1-6, 2012
- [10] Ramesh Kumar, Ratneshwar Kumar Ratnesh, Jay Singh, Ashok Kumar and Ramesh Chandra, IoT-Driven Experimental Framework for Advancing Electrical Impedance Tomography, *ECS Journal of Solid State Science and Technology*, Volume 13, Number 2, 13 027002, 7 February 2024.
- [11] Tiwari, S., Kumar, S., & Guleria, K. (2020). Outbreak trends of coronavirus disease–2019 in India: a prediction. *Disaster medicine and public health preparedness*, 14(5), e33-e38.
- [12] Kumar, A., Sharma, S., Goyal, N., Singh, A., Cheng, X., & Singh, P. (2021). Secure and energy-efficient smart building architecture with emerging technology IoT. *Computer Communications*, 176, 207-217.
- [13] Abdullah Bin Queyam, Ramesh Kumar, Ratneshwar Kumar Ratnesh, and Rajeev Kumar Chauhan, LabVIEW-Enabled Synthetic Signal for Empowering Fetal-Maternal Healthcare, *ECS Journal of Solid State Science and Technology*, Volume 13, Number 5, Published 29 May 2024
- [14] Aljawawdeh, H., Aljaidi, M., & Maghrabi, L. (2024). Towards Serverless & Microservices Architecture: Strategies, Challenges, and Insights into Technology. In *Artificial Intelligence and Economic Sustainability in the Era of Industrial Revolution 5.0* (pp. 447-458). Cham: Springer Nature Switzerland.
- [15] Idhaim, H., Aljaidi, M., Samara, G., Qasem, M. H., Alsarhan, A., & Khalid, M. (2023, December). Internal Hidden Processing Model-Based for SELECT Command in Structured Query Language. In *2023 24th International Arab Conference on Information Technology (ACIT)* (pp. 1-6). IEEE.
- [16] Nijhawan, P., Singh, P., Goyal, V., & Singla, M. K. (2020). Covid-19 Infected Case Estimation in India Using 5-PI Model. *European Journal of Molecular & Clinical Medicine*, 7.
- [17] Kumar, Ramesh; Aljaidi, Mohammad; Singla, Manish Kumar; Gupta, Anupma; Alhomoud, Ahmed Mershed; Alsuwaylimi, Amjad A.; Alenezi, Sami M., Development of a Prototype Global Positioning System Based Stick for Blind Patients, *International Journal of Online & Biomedical Engineering*, 2024, Vol 20, Issue 8, p21
- [18] Mahato, D. P., Sandhu, J. K., Singh, N. P., & Kaushal, V. On scheduling transaction in grid computing using cuckoo search-ant colony optimization considering load. *Cluster Computing*, 2020, 23, 1483-1504.
- [19] Hamdare, S., Brown, D. J., Cao, Y., Aljaidi, M., Kaiwartya, O., Yadav, R., ... & Jugran, M. (2024). EV Charging Management and Security for Multi-Charging Stations Environment. *IEEE Open Journal of Vehicular Technology*.
- [20] Kumar, R., Pahuja, S. K., & Sengupta, A. (2015). Phantom based analysis and validation using electrical impedance tomography. *J Instrum Technol Innov*, 5(3), 17-23p.
- [21] Kumar, M., Kumar, R., Mahdi, A. A., & Dhole, T. N. (2017). Study of viral load and CD4 count in diagnosis of HIV-1 positive patients. *Journal Family Medicine*, 4(4), 1117-1119.