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MTProto Algorithm in Smart Home Remote Control Using Robot Telegram

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Abstract

In a smart home automation system, all electrical systems, including electronic household appliances, are connected to each other in a smart network. In this research, using a Telegram robot, the relative reduction of communication delays in the remote control of home appliances is discussed.The proposed method based on the MTProto algorithm works in the form of AES encryption, 256-bit symmetric, RSA encryption, 2048 and Diffie key exchange protocol. This protocol is designed for mobile applications that connect to the server through an application interface. All messages shared in Telegram are encrypted "end-to-end" by this protocol. Sensors connected to home appliances are controlled by a Raspberry Pi board, and using the Internet connection, it is possible to remotely control the home intelligently from any location. Reducing communication delay is critical in timely control of appliances. In this research, the reduction of communication delay in sending messages between the user and objects is 30% less than the previous basic methods.

Key words

smart home; remote control; telegram robot; MTProto algorithm; communication delay

1.Introduction

The Internet of Things (IoT) is a network of physical devices, vehicles, home appliances, and other items with electronics, software, sensors, actuators, and communications that enable these objects to connect and exchange data. Internet of Things includes objects and devices around us that are connected to the Internet and can be controlled and managed by applications on smartphones and tablets [7]. The Internet of Things allows objects to be remotely controlled across existing network infrastructures, and also provides the opportunity to integrate directly from the physical world into computer-based systems, while improving efficiency, accuracy, and economic benefits in addition to reducing Human intervention has led [1]. One of the most important applications of the Internet of Things in home automation is the smart home. An intelligent building is a building that contains a dynamic and cost-effective environment by integrating the four main elements, systems, structure, services, management and the relationship between them, which interact with each other. IoT devices can be used for monitoring and control and mechanical, electrical and electronic systems used in various types of buildings (eg public, private, industrial, institutional and residential) in home and building automation systems [11]. Some of the services of a smart home include lighting, cooling and heating, security, TV, music player, garden irrigation and door control. Smart homes can use wireless or hardware systems. Wireless systems are cheaper and easier to install, while hardware systems, despite being expensive, are more reliable and usually harder to hack. To make the house smart, it is necessary to install a number of sensors such as temperature control, night detection, intrusion detection, etc. These sensors are wired to a Raspberry Pi board that controls the smart home and exchanges

commands. Also, after configuring the board, there is a need for an Internet platform for telecommunications [6]. An intelligent remote control is a device or interface that allows communication (control) with any smart device in the home ecosystem. Remote control devices are devices that can be used to control any electrical device from anywhere in the world, regardless of distance, via SMS and voice calls. The most important issue in the IoT debate is the connection between objects. The speed of communication between the user and the home is very important for the exchange of messages [4]. In cases such as fire or theft, a delay of several minutes in sending the message can be irreparable. In this article, we examine the communication delay in sending a message between the user and the smart home. This delay can last from one second to several seconds and sometimes several minutes. The continuation of the article is as follows. In the second part, the relevant works are reviewed and in the third part, the Internet of Things is described. The fourth section describes the smart home and the fifth section describes the remote control of the house. The seventh section is dedicated to the proposed method and the eighth section is dedicated to the implementation of the method. In the ninth section, the time delay is measured and in the last section, a conclusion of the work is presented.

2.Related Work

In the OpenFlow protocol distribute the traffic among several paths depending on the balance between bandwidth and delay link. when route delay increases significantly, the bulk of traffic is transmitted through the route , which in turn reduces delay for these applications[1]. Using ESP8266 WiFi module as a wireless communication module to realize data communication between hardware and software and an APP based on Android platform to realize smart home management by user terminal[3].This article [5] formulates joint and scheduling problems into combinatorial integer linear programming (CILP). article propose a joint task offloading and scheduling (JTOS) framework based on the problem. JTOS consists of task offloading, sequencing, scheduling, searching, and failure components. The study's goal is to minimize the hybrid delay of all applications. The performance evaluation shows that JTOS reduces the processing delay and the communication delay for IoT applications compared to existing schemes. [6] Smart home may use more than one platform to support its devices and automation. IoT devices of a home may transmit messages over different paths. By selectively delaying IoT messages, two issues, inconsistency and disorder, can be exacerbated by attackers significantly. For this reason, time delay is very important in smart home security issues. article then explore how these issues can be exploited and present seven types of exploitation, collectively referred to as Delay-based Automation Interference (DAI) attacks. In this paper [7], a two-step queue model is developed to estimate the average end-to-end latency and predict latency changes in closed forms. It also provides a feedback mechanism for examining other key performance metrics, such as operation, and the optimal number of computational units required in a cluster. This model applies to two categories of networks, edge sensor networks (ESNs) and data center networks (DCNs). In this article, the communication delay in the Internet of Things is about 1 second. In [8], joint optimization of energy consumption and time delay in fog cloud computing environments in IoT has been performed using non-dominant NSGA-II genetic algorithm and bees algorithm. Also, to improve the quality of the solutions, each of these methods is combined with a type of differential evolution approach called Minimax Differential Evolution (MMDE). The time delay in this article is about 2 seconds. In [9], matrix filling theory based on data collection scheme, latency and energy efficiency for IoT are calculated by dynamic traffic. The DEEDC scheme uses a clustering approach. Data is collected randomly in the network. The time delay in this method is about 2 seconds. In this paper [10], end-to-end packet latency analysis is performed for the Internet of Things in wireless communications. On the one hand, the aim is to propose a new real-time evaluation criterion that deals with the effects of the variable load size of the PP packet, which shows a delay of about two seconds. In [11], IoT service latency reduction through fog loading proposes a policy of cooperating and unloading latency loading for fog-enabled devices. The time delay in this case is different and sometimes 2 to 4 seconds is obtained. In the next article [8], it provides computing, storage and network resources for the Internet of Things and users. in [9] IOTtalk-RC sensor mechanism of an IRR-D infrared receiver; And IrT-D infrared transmitter; Connects to IoTtalk server. The server can be installed in a cloud or Wi-Fi AP. After learning the RC key, IoTtalk can connect various Ctls sensors to IrT-D to control appliances. The server automatically defines and executes interactions between IoT devices. The time delay in this method is about 1 second. [10] Bluetooth remote control uses Arduino board, Bluetooth module, smartphone, Ultrasonic sensor (to detect water level) and humidity sensor. The Hc-06 Bluetooth module is faster than GPS and wireless, and data transmission is serial up to 3 Mbps in the physical range of 10 to 100 meters. The smartphone app in this way has the ability to connect to 18 home devices and sensors. Works in the range of up to 20 meters with 100% accuracy. The time delay in this method is about 1.5 to 2 seconds, depending on the distance. In [11]

Raspberry pi microcontroller, the card is able to receive commands sent by the user remotely with Android mobile and Internet. The Android app is deployed through the Microsoft AZURE cloud service. AZURE retrieves and processes user commands using different queues. The time delay in this method is about 1 second. [12] is the use of the cloud interaction with the central element (smart home gateway), which ensures the connection of various sensors and actuators in a smart home. This method communicates with the gateway by a pi3 controller computer and sensors and receivers using BLE technology. The sensors are managed by the Alljoyn application. The connection is made via wireless Wi-Fi and Bluetooth. in [13] Lab VIEV software is based on graphical programming and also supports text programming. This method is mostly used for light sensor, temperature sensor and security sensor. In the [14] lighting control method with BLE, the DALI lighting control protocol has a semi-two-way communication and is very simple. Each node is connected to a controller supported by Arduino with a DALI control interface. This method is managed with Arduino uno and the communication platform is Bluetooth HC-06. Data integration with multiple sensors is used to control movement, locate people, prevent fire and alarm. With a wearable portable sensor and a microcontroller and an internal sensor module, it detects the acceleration and angle signals of speed generated by hand movements and sends them to the management algorithm via a radio transmission (RF) module. For example, it is used in TV control, touch screen and ventilation system. The time delay in this method is about 1 second. The method of text and human speech consists of three stages: speech discovery, speech comprehension and command execution. Several microphones are installed in the home environment. The recorded voice is transmitted along with the microphone index number to identify the user's location. Images are taken at home with smart cameras to detect faces. Static face recognition involves extracting facial features from each individual and then recognizing the face. But in the dynamic method, face recognition is directly based on dynamic video. For example, the geometric method and the eigenface method can be mentioned. NFC, fingerprint and PIR sensor are used in home security discussion. If an unauthorized person enters, the infrared motion sensor (PIR) will sound the alarm. A text message is then sent to the homeowner informing her of the unauthorized entry. The ZigBee method includes external network (Internet) and internal network (ZigBee). Inside the house includes a radio frequency receiver module, an operation and control unit, and a measurement and performance module. The wireless transmitter module is called CC2530. A coordinator is responsible for creating and maintaining the network and must allow new nodes to join. If the address is confirmed, the network and its information will be distributed. If there is a problem at home, an email will be sent to the homeowner. For example, in case of unauthorized entry, a photo of the person entered will be emailed to the homeowner with an unauthorized entry alert.

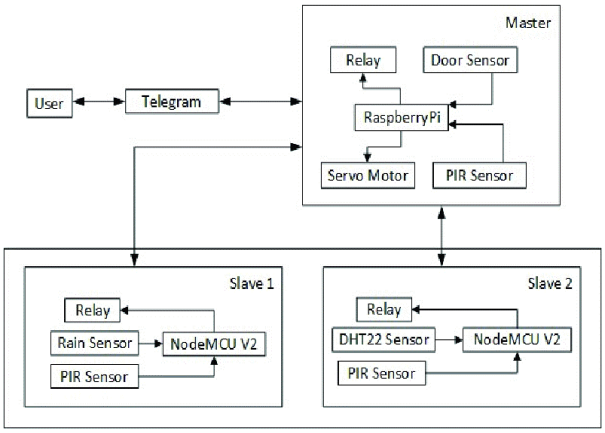

Figure 1) Complete block diagram of smart home system

3.Internet of Things

Sensors and devices are connected to a network through which they can interact with each other and with their users. Refers to an object in the physical world (physical objects) or information world (virtual objects) that has the ability to be identified and integrated with communication networks. The Internet of Things allows objects to be remotely controlled across existing network infrastructures, and also provides the opportunity to integrate directly from the physical world into computer-based systems. In addition to reducing human intervention, IoT has led to improved productivity, accuracy and economic benefits.

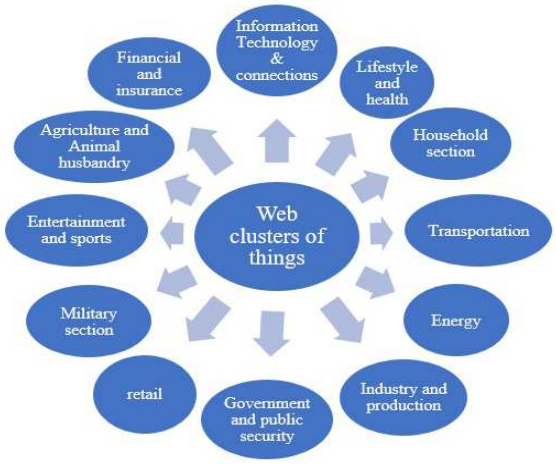

Figure 2) Internet applications of things

3.1 Internet of the Things Features:

- **Intelligence:** Intelligence: The control of confidential information is not independent of the basic concept of the Internet of Things. Environmental information and independent control do not necessarily require Internet structures. In the future, the IoT may be an uncertain, open network in which organizations are organized automatically or intelligently (web services, SOA components). They are compatible with virtual objects (avatars) and are able to do independent work (pursuing common goals or concepts themselves) depending on the context, circumstances or environment.
- **Structure:** Structure: This system is probably an example of an event-based architecture built from top to bottom (based on the context of processes and operations, in real time) and takes into account each dependent level. In the IoT, the meaning of an event will be based on the context of the event. As a result, there is not necessarily a need for common standards that can meet any context or use.
- **Network architecture:** The Internet of Things (IoT) requires large scalability of network space to handle increasing devices. IETF 6LoWPAN is used to connect devices to IP networks. IPv6 is used to manage the scalability of the network layer.
- **Complexity:** Semi-open or closed loops (such as value chains) are often considered as a complex system because there are so many different links, interactions between independent actors, and the capacity to integrate new actors.
- **Size:** The Internet of Things decrypts 50 to 100 trillion objects and can track the movements of those objects.
- **Distance:** In the Internet of Things, location and exact geographical dimensions will be a vital object. So facts about an object, such as its location in time and space, are important for further tracking. The person who processes the information can decide how important that information is to get the job done.

3.2 IOT Standards:

This is a list of technical standards for IoT, most of which are open standards and are set by standard organizations:

- **MTConnect Institute** (MTConnect is an industrial manufacturing standard for data exchange related to industrial machinery and equipment. Important for a subset of the IoT)
- **Auto-ID Labs** (RFID Network (Radio Frequency Identification) and Emerging Sensing Technologies)
- **OMA** (OMA DM and OMA LWM2M for IoT device management, as well as GotAPI, which provides a secure framework for IoT applications)
- **XSF** (Standard for simple devices using CoAP (Limited Request Protocol))
- **GS1** (Standard UIDs (unique identifiers) and RFID fast consumer goods (consumer packaged goods), sanitary ware and other items)
- **IETF** ((TCP / IP standards (Internet Protocol suite))
- **FDA** (UDI (Unique Device Identifier) for unique identifiers for medical devices)
- **IEEE** ((Sub-standards of communication technology such as IEEE 802.15.4))

4. Smart Home

An intelligent building is a building that contains a dynamic and cost-effective environment by integrating the four main elements: systems, structure, services, management and the relationship between them. All the internal components of the house interact with the environment by being integrated and creating a compatible logic. In the smart home, instead of all the devices working separately, it has a central controller that manages everything. Receives information from devices in the house, issues commands and controls everything in the house. Almost any appliance in the house that works with electricity can be controlled. Features and capabilities of a complete smart home system include lighting, cooling and heating, security, TV, music control and playback, garden irrigation and more.

Figure 3) smart Home

Dedicated home automation systems such as Z-Wave, Zigbee, KNX and Control4 can be used over the Internet. Also, many of them have Bluetooth connectivity, so they do not need the Internet. All of these systems have advantages and disadvantages that need to be considered. Some of the features of a smart home include saving energy with a smart thermostat, controlling access to doors, monitoring the home via video, adjusting the lamp mode, controlling the home by sound, home security, and more.

5. Smart Home Remote Control

A smart remote control is a device or interface that allows the user to communicate (control) with any smart device in the home ecosystem. Remote control devices are devices that can be used without considering the distance and via SMS and audio call to any electric device from the world. Using the mobile network, you can monitor and control at any distance that covers the mobile network, by connecting different sensors to the device.

5.1 From Remote Control System Applications:

- Ability to control blue and gas coolers before entering work or home
- Turn and off automatic heat and refrigerating systems to prevent energy dissipation
- Ability to convert to alarm system and alert in case of unauthorized traffic
- Control lighting and lamps
- Announce fire alerts, smoke and ... by sending SMS and playing siren
- Temperature control by temperature sensors

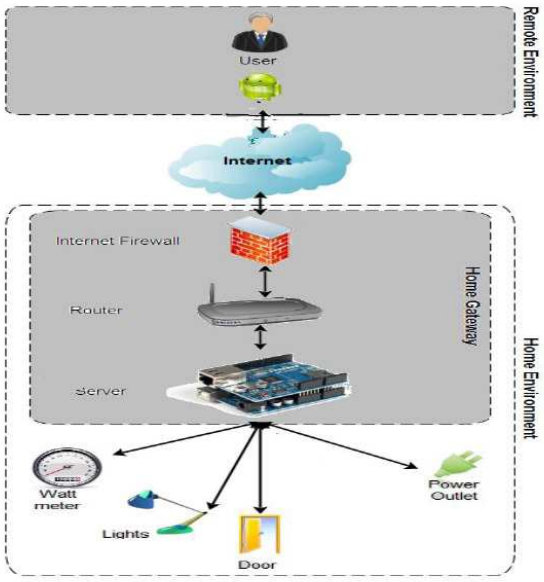

Figure 4) Flowchart Smart Home Remote Control System

Some of the home remote control devices include logitech, ONQ / Legrand, Veraedge, Samsung Hub SmartThings, Nubryte and more.

5.2 Problems of the methods available in the remote control of the smart home:

Each of the existing methods used for private tasks and have their own benefits. These methods have made access for the user very easy. But however, these devices also have disadvantages. Some methods are limited and not used in any part. The preparation of control devices for each family members is sometimes not possible, and only one person can to have the control. The other is a high cost of preparing this control device that will cost it if lost or damaged. The other issue of security is our relationship between the controller and the house because these devices do not have a specific security structure.

6. Communication Delay in Smart Home

IOT is based on the IOT network. In short, the Internet of Things is defined as a proposed development of the Internet in which objects are connected to the network on a daily basis, allowing them to send and receive data. The most important thing here is the connection between objects.

6.1 IoT Communication Protocols:

- Infrastructure (6LowPAN, IPv4 / IPv6, RPL)
- Identification (eg: EPC, uCode, IPv6, URIs)
- Coms / Transport (Example: WiFi, Bluetooth, 6LPWAN)
- Discovery (Physical Web, mDNS, DNS-SD)
- Data protocols (MQTT, CoAP, AMQP, Websocket, Node)
- Device Manager (TR-069, OMA-DM)
- Semantic (e.g. JSON-LD, web subject model)
- Multilayer framework (e.g. Alljoyn, IoTivity, Weave, Homekit)

6.2 Investigation of Communication Delays in Existing Methods:

Examining the existing methods and their infrastructures, results were obtained about their communication speed. These methods have some communication delay due to the use of software on a mobile phone or sometimes on a peripheral device. This delay varies from case to case and depends on the speed of the Internet, but varies from 1 second to several seconds (sometimes one minute). The user must first instruct the software on the remote control that these softwares are not supported online and have a delay in connecting to the central controller of the house. Communication delay, for example, is not very important when we instruct the device to turn on the lamp or play music, and delaying for a few seconds does not make much difference. But when the house is stolen or a fire occurs, a delay of a few seconds or minutes can have serious and irreparable consequences.

7. Suggested Method: Using the Telegram Robot

Due to the problems of previous methods (communication speed, security, etc.), the use of Telegram robot for remote control of smart home is recommended. Telegram is a multi-level open source messaging service based on cloud computing. The MTProto protocol was developed by Nikolai Dorf based on AES encryption, 256-bit symmetric, RSA encryption, 2048, and Diffie Hellmann key exchange protocol. This protocol is designed for mobile applications that connect to the server via an API. All messages in Telegram are encrypted by the MTProto protocol as "end to end". This protocol is divided into three independent factors:

- The Top-level Component (API Query Language): defines the way in which queries and API queries are converted to binary messages.
- Encryption Layer (Authorization): Defines the way in which messages are encrypted before sending the transport protocol.
- Transport Component: Defines a way for the client and server to send messages over some existing network protocols (HTTP, HTTPS, TCP, UDP).

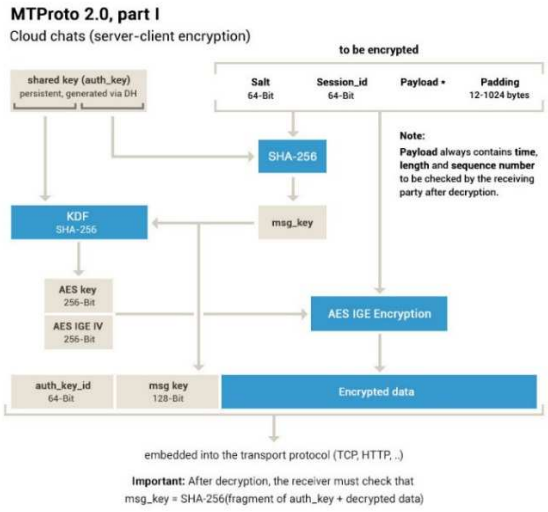

Figure 5) MTProto Protocol flowchart

7.1 Some of The Basic TL Code in The MTProto Protocol:

boolFalse = Bool;

boolTrue= Bool;

true = True;

vector {t:Type} # [t] = Vector t;

error code:int text:string = Error;

null = Null;

inputPeerEmpty = InputPeer;

inputPeerSelf = InputPeer;

inputPeerContact user_id:int = InputPeer;

inputPeerForeign user_id:int access_hash:long = InputPeer;

inputPeerChat chat_id:int = InputPeer;

inputUserEmpty = InputUser;

inputUserSelf = InputUser;

inputUserContact user_id:int = InputUser;

8. Implementation of the Proposed Method

To implement we idea, we started making a model of a smart building, and the features used in a real smart home are included in this model. For this purpose, night detection, presence and temperature sensors were used. A number of lamps, fan motors, alarms and LEDs were also used. We will also use a solar cell and a power bank. During the day, the solar cell uses sunlight to absorb energy and store it in the power bank. Therefore, in the event of a power outage, the electricity in the power bank can be used, which can be charged by both sunlight and the power cable.

Figure 6) Sensors used

A board is needed to control and manage the sensors and communicate with the user, but here we use the Raspberry Pi board due to the need for high speed. The Raspberry Pi board a single-board computer (Single-board computer), the size of a credit card, and is usually be launched by the Linux operating system. This board is a very small and cheap computer with all the capabilities of a real computer that can be used in robotic systems, automation and IoT. Also, because the voltage used by parts of the circuit are different from each other and a driver board has been designed to prevent damage caused by the return current of the motor (FAN).

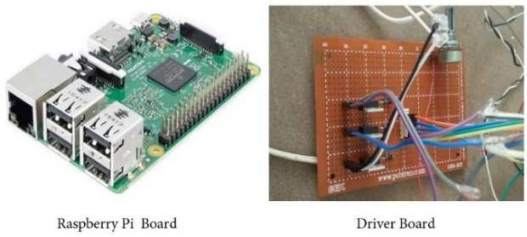

Figure 7) Raspberry pi board and Driver board

Necessary wiring was done for each sensor as well as their connection to Raspberry board and driver board.

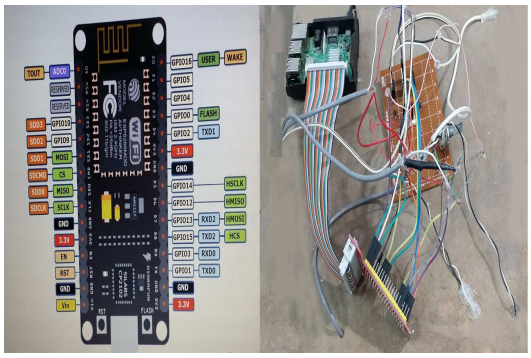

Figure 8) Relevant connections

A modem is also needed at home to connect the Raspberry Pi board to the Internet. After installing all the sensors and parts on the smart home and performing the relevant connections and wiring, the view of the smart home is as

follows. Raspberry Pi is also coded and configured with the Python programming language, which is a general-purpose, high-level, object-oriented, scripted, and open source programming language. To set up the software and hardware system of the project, first the Raspberry Pi board was connected to the monitor, and the initial configurations, including the installation of real VNC software and screen configuration, were performed. Then we connected to the Raspberry Pi board network using Wi-Fi , and at the same time we connected to the Wi-Fi network from the laptop. Using the software, we access the Raspberry operating system, and the necessary coding was done. In the coding section, we defined the functions that perform the relevant tasks. For each piece on the board, we assigned a hardware base and included the same base in the coding for that part in order to intelligently control the output values according to the input commands and inform the homeowner.

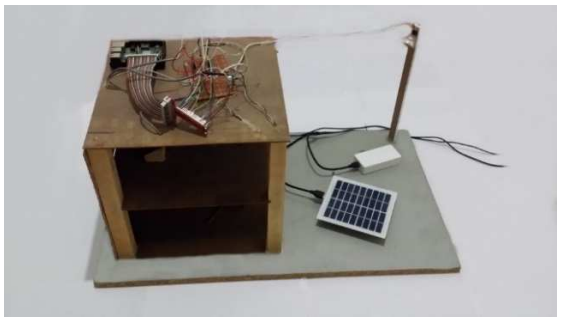

Figure 9) Smart home replica overview

To do this, we must first create a robot in Telegram and include its token in the programmer (if the user sends a message, the message will be directed to the Raspberry Pi board and send the response according to the message). The token is a unique code that Telegram assigns to each robot that is created. How to receive the token is that first, using the Telegram software, go to the @BOTFather robot, and after some steps, the robot is created and the token is assigned to it. This robot has a number of commands for measuring the temperature of the house, turning on and off the lamps, electric and LED light poles and alarms. Flowcharts of all the work done step by step are shown in the figure below, showing how to do it.

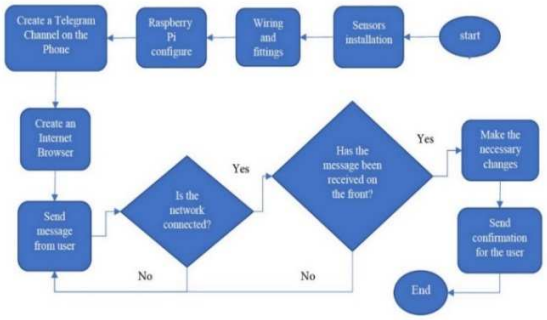

Figure 10) Flowchart of The Proposed Method

9.Time Delay Measurement

In this step, we must measure the speed of sending and receiving messages between the Raspberry Pi board and the Telegram robot. To do this, Python language coding had to be done on the Raspberry Pi board, but due to Telegram filtering in Iran, this feature cannot be used. Therefore, C # programming was used in the Visual Studio environment. The general procedure of the program is as follows: we first send a message to the robot. The time of sending this message is recorded in the program and in the Telegram server. Now, after sending a test message by the robot, the system time is sent to the user again. The time interval is equal to half the difference between the time of sending and receiving the message.

```
public static void
ManageMessage(TelegramBotSharp.Types.Message Mess)

    {

        string tt = "";

        string pp = "";

        //int count=0;

        if (Mess.Text == null) return;

        MessageTarget target = (MessageTarget)Mess.Chat
?? Mess.From;

        if (Mess.Text.Contains("/start"))

        {

            bot.SendMessage(target, "test");
```

```
    tt = Mess.Date.TimeOfDay.ToString();
    bot.SendMessage(target, tt + "\n/stop");
}
if (Mess.Text.Contains("/stop"))
{
    pp = Mess.Date.TimeOfDay.ToString();
    bot.SendMessage(target, "LastPost --> " + pp);
}
```

In this way, the time of sending the message from the Raspberry Pi board to the Telegram server is measured. This time is equal to the time of sending to the destination and returning the message to the source. We calculate half of this time. We designed a robot that can work on the system using a filter breaker. We Defined the robot token in C # and create a form and define the start key.

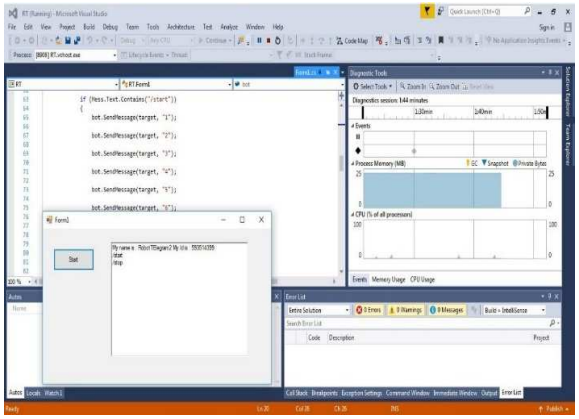

Figure 11) C# programing

The program will send a number of messages to the robot. 50 messages were sent to increase the accuracy of the number of messages. Finally, the time of messages reaching the robot can be seen inside the robot.

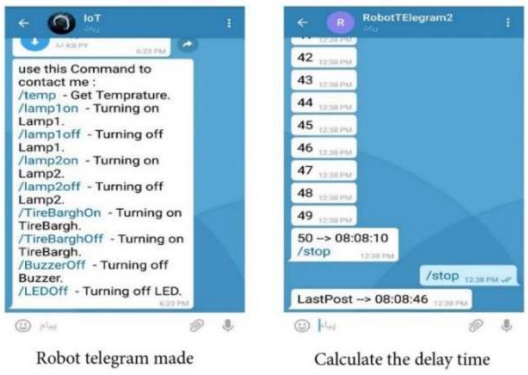

Figure 12) Calculating the time delay in the robot

The robot is set to show the time of sending the first message and the last message that 50 messages were sent in 36 seconds. (figure 13). Therefore, the communication delay is about 0.7, which is less than the delay obtained in the Other methods. Average communication delay in other methods is 1 second at best. Therefore, the time delay has been reduced by about 30%. Of course, the obtained number is obtained by using the filter breaker (due to the limitation of Telegram in Iran) and if it is used where Telegram is not filtered, the numerical time delay is predicted to be between 0.4 and 0.6 seconds.

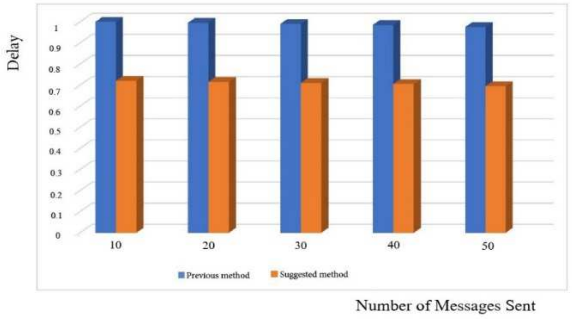

Figure 13) Graph comparing the delay in the new method with the previous method

10.Conclusion

The main purpose of this research is to obtain a new communication method with the least time delay between the user and the smart home. The Internet of Things is a system of computers, computing machines, digital and mechanical devices, humans and animals, each with its own code and as a distinct device. A significant share of information exchange and behavior and the relationship

between them is done without direct human intervention and supervision. Home automation system is the building automation used inside a house, which is called smart home. An intelligent remote control is a device or interface that allows communication and complete control of the home ecosystem with any smart device. In the Internet of Things, devices connect to the grid on a daily basis, allowing them to send and receive data, and reducing energy consumption at home. The most important thing here is the connection between objects. The previous methods have some communication delay due to the use of a software for example on a mobile phone or on a peripheral device. This delay depends on the speed of the Internet but varies from 1 second to several seconds (sometimes one minute). In software control method, software development can be very time consuming and costly. Another problem is that the user must always have the relevant software (or remote control device) with them everywhere to communicate. The proposed method is based on remote control of the house with a telegram robot. Telegram has the highest speed among all messengers and is the best communication option. To increase the communication speed, the best choice is to use Raspberry Pi board. By programming and connecting it to the Telegram robot, the house can be controlled remotely. The robot was contacted to measure the delay through C # programming in the Visual Studio environment. The time delay associated with sending 50 messages was measured and was about 0.7 seconds, which is very optimal compared to the basic method with a delay of about 1 second. Problems such as power outages or slow internet speeds can affect communication. For a power outage, it is recommended to use a solar cell and a battery (or power bank). It is also recommended to use Raspberry Pi board at home, which has a faster processing speed than other boards such as Arduino. Equipping all homes with IoT technology can make life very comfortable and safe for us.

11. References

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