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Development of Telegram-Based Home Automation and Data Acquisition System

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***Abstract*—The home automation and data acquisition system using the Telegram application enables users to automate tasks related to controlling and monitoring electronic devices through a system installed in homes or buildings. This study proposes a model, algorithm, and architecture for a Telegram-based home automation and data acquisition system that utilizes various sensors to monitor environmental conditions. The sensors used include humidity, temperature, carbon dioxide (CO2), and volatile organic compounds (VOC) sensors, which serve as indicators of indoor air quality. The proposed architecture allows users to monitor environmental conditions in real time and control devices such as relays through the Telegram application on their smartphones. Users receive instant notifications about air quality and other environmental parameters, enabling them to make informed decisions regarding device settings, such as ventilation or heating, to maintain a comfortable and healthy home environment. Experiments conducted demonstrate that the system can accurately measure environmental conditions and control relays with fast and efficient response times. Moreover, the system provides air quality information that is easily accessible via smartphones, enhancing convenience and ease in monitoring and managing home conditions. The results of this study show significant potential for application in IoT-based smart home automation systems, offering improved user experience and energy management in home environments.**

Keywords*— *home automation, telegram, air quality sensor, temperature, humidity.

I. Introduction

We are live in Artificial Intelligence era, automation and Internet of Things (IoT) plays an important role in all places, from industries to living homes. When you are not at home you are always worried about the protection of your family and residents. But with automation & alarm systems, you can be at your office as well as a residence. The techniques for getting information from sensor are implemented using microcontrollers. Telegram is known as emerging mobile instant messaging that very popular and has recently gained good response from many countries such as Brazil, Indonesia, Brazil, Russia and Uzbekistan. Telegram is a messaging application that is like other messenger, but can be connected to control the embedded systems. It was created by businessman Pavel Durov and is renowned for emphasizing speed and superior security [1]. Telegram has gained popularity and become a valuable resource for researchers to investigate and examine automation and user behavior. Furthermore, the ease of data collection through its API and access to historical data makes it an interesting platform for research with topic of social computing and mobile application. This research paper explores the features of Telegram for sending data to a controller and relays and presents a methodology to collect data for displaying to smartphone.

Much engineer and researcher that implementing Telegram for controlling and data acquisition, such as Raghu et al propose a model for door security system based on telegram. The family or residents at home will always keep the door closed/locked security reasons. However, there are times when the home's resident rushes out the door and fails to lock it, or they may question if they have whether to lock the door. The program is based on Telegram in Android which tracks the condition of the door using IoT technology, and able for managing the door whether it is opened or closed [2].

Numerous features of Telegram, include the ability to share files, videos, messages, and images to other users as well as the ability to support group chats with up to 200,000 participants. Telegram have two kinds of APIs for developers. It's what we called a Bot API, and it makes it simple to write programs that use Telegram messages as their interface. You can create your own personalized Telegram clients with ease using the Telegram API and TDLib.

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Our objective in this research paper is to make a model, an algorithm and application that can send information and controlling devices from smartphone. We propose a model of Telegram-based data acquisition system using telegram apps and Arduino controller, section I is an introduction, section II is discussed about Telegram technology and sensor, and in section III, we suggested a technique. Section IV is experimtanl result. Figure 1 shows our prototype that can control device using Telegram apps.

Figure 1. User interface for displaying devices using Telegram apps

II. Literature Review

A. Telegram Apps

Telegram basically is a freeware, cloud-based and cross platform instant messaging and application service. The service also provides end-to-end encrypted video calling, VoIP, file sharing and several other features. It was initially launched for iOS on 14 August 2013 and Android in October 2013. There are several uses for the Telegram Bot API, such as telegraph for Node.js, and it support from image manipulation and videos to the systems in charge of handling alerts and quick responses. Personalized news updates and the creation of interactive games are two possible applications for the Telegram Bot API. In order to access the Telegram Bot API, we must first create a token from our BotFather account. This token will be used in the Python client's subsequent calls to the API endpoint. To login to an account protected by a 2FA password or to perform some other actions, you will need to verify the user's knowledge of the current 2FA account password

Many previous studies about Telegram innovation propose monitored, controlled, or monitored and controlled household electricity consumption using sensors and the Telegram application. The study aims to monitor voltages, current, frequency and protection of household electrical equipment simultaneously using the PZEM004T sensor, the Telegram application, and relays [3]. Figure 2 shows the BotFather that should be created for our application:

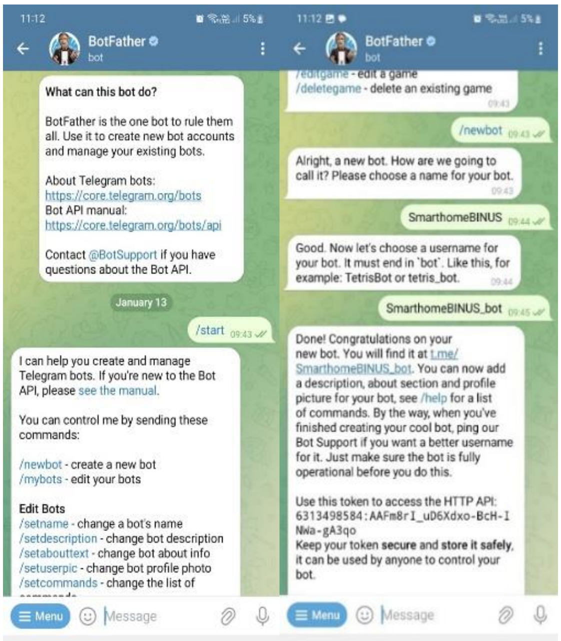

Figure 2. BotFather account from Telegram for creating a new bot and token.

B. Wemos D1 R2 Controller

The WeMos D1 WiFi UNO R3 development board is a development board based on the ESP8266 WiFi module. It is designed to be compatible with the Arduino Uno R3 form factor, making it easy to use with Arduino shields and libraries while providing WiFi connectivity through the ESP8266 module. The main part of the board is the ESP8266 module, which provides WiFi connectivity. The ESP8266 is a versatile and widely used module for IoT (Internet of Things) projects due to its low cost and built-in WiFi capabilities. Figure 3 shows the pins for Wemos D1 R2 development board:

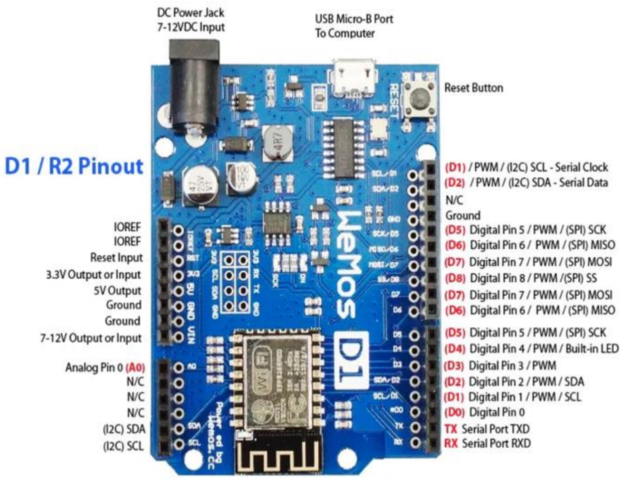

Figure 3. WeMos D1 R2 WiFi Arduino UNO based Controller [4]

Technical details of the controller:

- High speed ESP8266 microcontroller
- 11 Digital I/O Pins
- Operating Voltage 3.3 VDC
- 1 Analog I/O Pin.
- 4 MB Flash Memory

- Temperature Range -20 to 80 °C
- Detection angle less than 140°.
- Delay Time: 5 to 200s (Can be Adjusted, Default 5s +/- 3%).

C. *Data Acquisition system*

Data acquisition System (DAS) is a part of electrical engineering method the process of sampling signals for measuring real-world physical conditions, after that converting the resulting samples into digital numeric values that can be manipulated by a computer. DAS is useful in fields like industrial automation, environmental monitoring, scientific research, and medical diagnostics. It ensures data accuracy, precision, and reliability, allowing organizations to make informed decisions, control processes, and monitor critical parameters. The components of data acquisition systems include sensors, signal conditioning circuitry and ADC.

D. *SGP30 Air Quality Sensor*

The high rise in population has increased energy consumption and resource use. It leads to higher pollutant levels and greater health risks, especially respiratory illnesses. The sensor for air quality measurement in this research is SGP30 that provides information on the quality of the indoor air quality (IAQ) of your room or home by keeping an eye on the volatile organic compounds in the vicinity of the sensor and providing accurate measurements in less than 15 seconds after activation. Some VOCs are less dangerous than others, but VOCs are highly hazardous. In general, some symptoms to look out for are Eye, nose, and throat irritation, loss of coordination and Headaches and nausea.

Because of its high resistance to gas contamination, the SGP30 ensures little drift and long-term stability for incredibly dependable results. From the SGP30 gas sensor output data, we determined the total volatile organic compounds (VOCs) in parts per billion (ppb) and the carbon dioxide (CO2) equivalent in parts per million (ppm). The SGP30 generates two complementary air quality signals using on-chip calibration parameters and a dynamic baseline correction method. A total VOC signal (TVOC) and a CO2 equivalent signal (CO2eq) are computed based on the sensor signals [5]. The simplified block diagram of the sensor, which includes the Baseline Compensation, MEMS, Hotplate T-Sensor, Signal Processing, and Heater Controller circuits, is displayed in Figure 4. I2C (Inter-Integrated Circuit) technology, which includes SDA and SCL, is used by the SGP30.

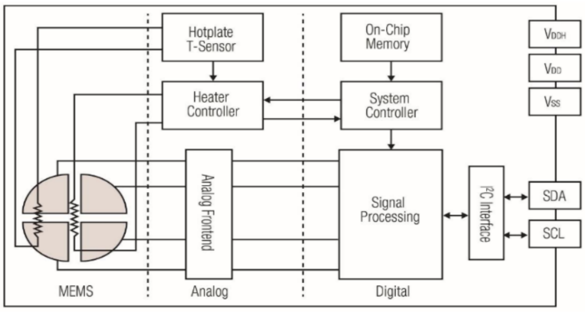

Figure 4. Block diagram showing the main part of the SGP30 with on-chip memory and system controller[5].

The I2C master should be configured to periodically request measurements, receive data, and then send measurement instructions. Next, I2C master polls data until the read header is accepted by the sensor, and finally, it reads out the measurement result. This can be done by waiting for the maximum execution time or by waiting for the anticipated duration. The ethanol and H_2 measurement module of the air quality sensor is seen in Figure 5.

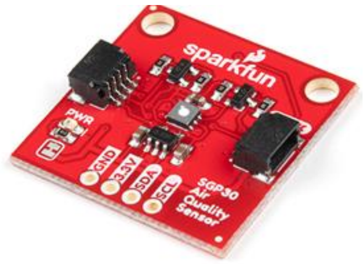

Figure 5. Module of Air quality sensor SGP30, with type of Qwiic [6].

TVOC and CO_2eq are calculated from Ethanol and H_2 measurements using internal conversion and baseline compensation algorithms as shown in Figure 6:

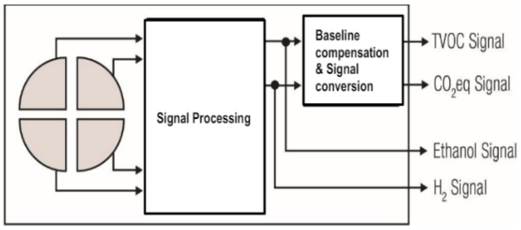

Figure 6. Functional block diagram showing the signal paths of the SGP30 with output sch as TVOC signal, Ethanol signal and H_2 signal [5].

Using good sensors is very important for IoT systems especially for measuring gas. Measurements such as total volatile organic compounds (TVOC) in parts per billion (ppb), carbon dioxide equivalent in parts per million (ppm), and raw gas readings of hydrogen (H2) and ethanol are produced by the SGP30 gas sensor. Particularly for the ethanol and H2 measurements, the calibration of this sensor and its precise location are critical to the investigation. The characteristics and basic parameters of SGP30 sensor is shown in Table 1:

TABLE I. CHARACTERISTICS OF SGP30 SENSOR

Sensing Parameter	Value
TVOC Output Signal Range	0 to 60,000 ppb
CO_2 eq Output Signal Range	400 to 60,000 ppm
Ethanol Signal Measurement Range	0 to 1,000 ppm
H_2 Signal Measurement Range	0 to 1,000 ppm

Table 2 is an information about TVOC safety levels chart from Kaiterra:

TABLE II. TVOC SAFETY LEVELS CHART BASED ON DATASET [7]

Index Category	Index Value	TVOC (ppb)
Good	0-50	0-220
Moderate	51-100	221-660

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High	101-150	661-1430
Very High	151-200	1431-2200
Very High	201-300	2201-3300
Very High	351-500	3301-5500

In standard conditions, TVOC will be expressed as parts per million (ppm), parts per billion (ppb), milligrams per cubic meter of air (mg/m3), or micrograms per cubic meter (ug/m3) [7]. For temperature and humidity sensor, we use DHT-22 [8].

III. Proposed Methods

A. System architecture

Researches for building Telegram application has been developed for automation and IoT such as [9]. Cheerla et al propose an embedded system board with Telegram Bot for detecting and express moistness in specific area, including controlling household appliances and voice commands while indoors, and controlling MQTT usage when outdoors [10]. Figure 7 shows the architecture of our system that is very compact and accessed using Smartphone.

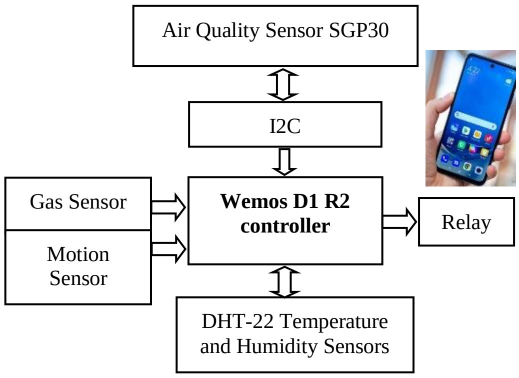

Fig. 7. The architecture of telegram-based Home Automation and Data Acquisition systems using DHT-22, gas sensor and motion sensor.

B. Algorithm

We begin with the first software, which creates a serial connection between the smartphone and the Wemos D1 controller. The algorithm for Telegram-based Home Automation System shown in algorithm 1:

Algorithm 1. Telegram-based Home Automation and Data Acquisition System using IoT Sensors.

```
declaring variables
import libraries
setting token and WiFi Connection
setup the WemosD1 R2()
begin
  Serial.begin(152100)// default baudrate
   I2C settings and connection
  Displaying initial message to user
end
begin
  reading temperature,  humidity and air quality sensor.
  reading input from telegram.
  end
 //controlling relay
Display sensor's value to Smartphone
 if (input !==null)
   begin
     on/off specific relay.
   end
if (input==/status)
begin
    display status.
end
if (input==/information)
begin
    display sensors value.
end
end
```

IV. Experimental Result

A. Experimental setup

A program developed in our lab for controlling the sensors using Wemos D1. At the stage of making Telegram Bot, we use Instant application Telegram messaging because it is open source and provides API features, the first thing to do is search BotFather telegram for Bot creation request. The term API refers to the Application Programming Interface, which enables programmers to concurrently combine two or more application components. We utilize an Android smartphone, Samsung A72. But, first we have to install the Telegram application.

B. Results

Our experiment indicates that the program has excellent control and data-gathering capabilities from sensors. Table III shows experimental results:

TABLE III. Experimental Results with 10 Times Simulation

No	Results from 10 times simulation		
	Action	***Success***	***Not success***
1	Controlling relay	10	0
2	Display status	10	0
3	Displaying information	10	0
	Accuracy	100%	

Figure 8 shows the result of temperature sampling using DHT-22.

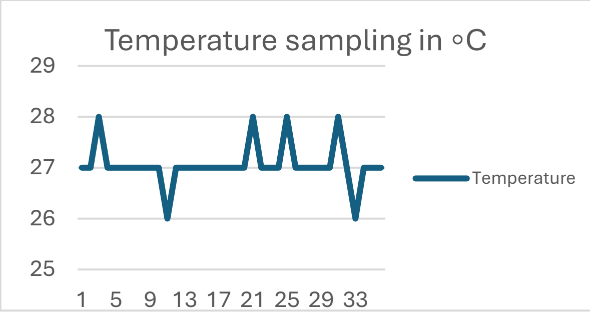

Figure 8. Result of temperature sampling using DHT-22

Figure 9 shows the application in Telegram for controlling devices and get data from sensors, we can se that each device can be controlled easily and we got information for each sensor from the Telegram with simple command such as /Device1on or /Information. By using the Python Telegram Bot Library, which offers an asynchronous, pure Python interface for the Telegram Bot API, we may increase the complexity and features of our program. It works with Python versions 3.8 and higher. We also able to add intelligence by implementing deep learning for prediction [12].

Fig. 9. Using Telegram, we can control devices and get information from the sensors.

Based on the experiment, our system can run smoothly using Wi-Fi Technology and easy to be assemble.

V. Conclusion

Society 5.0 was initiated by the Japanese government to prepare society so as not to be left behind by the current technological advances such as implementation of IoT and AI. Based on the literature study and experiments, we propose a simple model of Telegram-based home automation and data acquisition system. We propose an algorithm and architecture that can be implemented using low-cost controller. With the help of Telegram Bot, users may operate household appliances from any internet-connected device, including low-const controllers. For future work, we will add more sensors for data acquisition, machine learning and LoRa technology that can be used in our lab at Campus. This research also shows the importance of IoT and air quality measurement for today.

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