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Design of a Microcontroller-Based Automatic Cat Feeding and Monitoring Device

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ABSTRACT

This final project discusses the design and development of an automatic cat feeding and monitoring device.The system uses a control mechanism to set the schedule for when the cat food will be dispensed through the Blynk application, synchronized with the current time using an RTC DS3231. When the scheduled time is reached, the servo motor will rotate 120 degrees to dispense the cat food. Once the load cell sensor reads that the weight of the food has reached 30 grams, the servo motor will return to 0 degrees. This load cell sensor get average error of 2.422% This control system uses the NODEMCU ESP32 module as the controller, as well as the data transmitter and receiver for Blynk IoT. The device also includes a monitoring system using an ESP32 CAM and its downloader, where the camera can be moved up and down using a servo motor and accessed in real-time. Communication between the ESP32 CAM and Blynk IoT uses the HTTP (Hypertext Transfer Protocol), and the ngrok application is used to create a tunnel from the local device to the internet.

INTRODUCTION

Cats are one of the most widely kept animals by humans. humans. Just like with other pets, in keeping cats there are several things that need to be considered. One of the main focuses is taking care of it by fulfilling all its needs, especially eating. In today's era, the era of automation is a big step inhuman civilization. The use of automation technology integrated with Internet connection, or better known as the Internet of Things (IoT), has helped many daily lives. An example is feeding when the owner is busy working or working for more than 2 days. However, the presence of an automatic cat feeder can be a solution to this problem. this problem. (Muhammad Angga Ramadhan, Bambang Setia Nugroho, Arif Indra Irawan,2023,)

However, the difficulty that often occurs is when traveling for a long time and there is no free time, and not being at home so that owners rarely feed their favorite pet cats. Therefore there is a way to feed pet cats regularly without interrupting daily activities or disturbing others. (Sofitri Rahayu, Jaka Abdul Khoir,2022,)

By using sensors and microcontrollers and applying IoT to the tool, it can have monitoring and automatic feeding functions that can be displayed in real-time. automatic feeding that can be displayed in real-time. Previously, an IoT system has been made on an automatic cat feed tool with the title "Cat Feed Monitoring System Based on IoT". Website" However, the final project does not yet have a camera for monitoring cats and does not have a schedule system. monitoring cats and does not have a schedule system. from the background above, the author decided to make a Final Project entitled "Design of a microcontroller-based automatic cat feeding and monitoring based on microcontroller"

LITERATURE REVIEW

1.1 Internet of Things

The Internet of Things (IoT) is a concept that extends the benefits of always-on Internet connectivity. Basically, the Internet of Things refers to objects that can be uniquely identified as virtual representations in Internet-based structures (H. D. Septama, et al., 2018).

The Internet of Things is useful to help optimize various processes and activities, so as to increase time efficiency and save energy and costs. The main purpose of the Internet of Things is to facilitate control and supervision by users in making a tool, due to the design of this tool by implementing the Internet of Things in order to increase efficiency and accuracy in measuring sensor data to users, and collecting data by connecting each device via the internet and sharing information using the IoT platform. (C. Skad and R. Nandika, 2020).

1.2 Mikrokontroller

A microcontroller is a functional computer system on a chip. In It contains a processor core, memory (a small amount of RAM, program memory, or both), and input-output equipment. program, or both), and input-output

equipment. Microcontrollers areone of the basic parts of a computer system, examples such as ESP32 Arduino, ATmega169, etc. (Djuandi F., 2011)

Although it has a much smaller form than a personal computer and a mainframe computer, a microcontroller and mainframe computers, microcontrollers are built from the same basic elements. elements. In simple terms, a computer will produce specific outputs based on the input received and the program executed (Djuandi F., 2011).

1.3 Real Time Clock

Real Time Clock is a chip (IC) that has a function as a timer including seconds, minutes, hours, dates, months, days of the week, and years. Data accessing is done with a serial system so that it only requires two lines to communicate, namely the clock line which is used to carry clock data information. and data lines that carry data that can be called I2C (T. H. Kusmanto and A. Susano, 2019). Real Time Clock or often referred to as RTC is one of the active electronic components that can store date and time data in it (T. H. Kusmanto and A. Susano, 2019).

RTC is I2C which stands for Inter Integrated Circuit. This type of communication only uses 2 communication lines, namely SCL and SDA. All microcontrollers are equipped with this 2-line communication feature, including the Arduino Microcontroller. Can be combined with Seven segment displays, LCD type displays or led matrix types to display data from the RTC IC. With the help of the Arduino microcontroller all these options will become easier. The DS3231 RTC component has accuracy with an error of 1 minute per year (E. Wilyanto et al., 2019).

1.4 Sensor Load Cell

Load cell is a mechanically active force sensor, where this force sensor uses the principle of pressure by using a strain gauge as a sensor. A strain gauge is a passive transducer that converts mechanical displacement into resistance changes (K. L. Yana, K. R. Dantes, and N. A. Wigraha, 2017). This change is then measured by the Wheatsone bridge where the output voltage is used as a reference for the load received by the load cell. With the ability to measure weight accurately, the load cell sensor is the right choice as a sensor used to measure the weight of food. cat (V. M. M. Lusi, A. C. Louk, and A. Warsito, 2018).

1.5 Modul HX711

The HX711 module is a module that allows us to read force sensors in weight measurement easily. This module is used to amplify the output signal from the sensor and convert analog data into digital data. By connecting the microcontroller, we can read the resistance change of the force sensor. (L. Fikriyah and A. Rohmanu, 2018)

1.6 Blynk

Blynk is an Internet of Things (IoT) platform that allows developers to build interfaces for their IoT projects using mobile or web applications. Blynk supports a wide range of microcontrollers such as Arduino, Raspberry Pi, and ESP8266, and provides connectivity to devices via WiFi, Bluetooth, or cellular connection (International Journal of Engineering Research & Technology, 2022)

1.7 ESP 32

The ESP32 NodeMCU is a series of low-power System- on-a-Chip (SoC) with dual-mode Wi-Fi and Bluetooth capabilities. ESP32 12 utilizes a dual-core or single-core Tensilica Xtensa LX6 processor with a clock frequency up to 240 MHz. The ESP32 is integrated with an antenna switch switch, RF balun, power amplifier, low-noise receiver amplifier, filter, and power management module (K. L. Yana, K. R. Dantes, and N. A. Wigraha, 2017)

The ESP32 is the successor to the very popular ESP8266 for IoT applications. IoT applications. The ESP32 has faster Wi-Fi and Central Processing Unit (CPU) cores, more General PurposeInput/Output (GPIO) core, more General Purpose Input/Output (GPIO), and Bluetooth Low Energy support. Bluetooth Low Energy. In the IoT system, the NodeMCU is a platform that can be versatile in IoT application development, as well as more reliable and efficient for implementing IoT solutions. for implementing IoT solutions to be able to perform high performance with the features it has (K. L. Yana, K. R. Dantes, and N. A. Wigraha, 2017)

1.8 ESP32 CAM

WiFi and Bluetooth development board with Esp32 microcontroller and camera. This module provides features that anyone can use, or can be said to be open source. can be said to be open source, one of the features is that it is used to take pictures, face recognition and face detection. images, face recognition and face detection. The peripheral module can be used using the Arduino IDE editor to utilize libraries or features that have been provided (joy-it, 2018).

Esp32-Cam is a module that can be used in many projects. projects is also a complete module with an integrated microcontroller, which can make it work independently. can make it work independently. In addition to WiFi and Bluetooth connectivity, it also has an integrated video camera, and a microSD slot for storage. (joy-it, 2018)

1.9 Ngrok

Ngrok is a program created by Alan Shreve that can create a tunneling from a public network to a local computer port using the url given by ngrok with the url format: http://subdomain.ngrok.com..(A. Shreve,2019)

Ngrok will create/open a network through NAT or firewall to connect localhost to the internet with a secure tunnel. (Soeleman, 2018)

METHOD

3.1 Diagram Block

In making a tool, block diagrams are important in designing a tool so that it makes it easier to make the tool. The work of the system is to be able to feed cats automatically and as cat monitoring. The microcontroller used is NodeMCU ESP32 which functions to regulate the movement of servo motor one to feed the cat, then servo motor two and servo motor three function as moving the ESP32 cam in the direction we want, NodeMCU ESP32 also functions as the main control of the sensor read, reading NodeMCU ESP32 sends load cell and RTC data with serial communication, NodeMCU ESP32 sends weight and clock reading data to blynk data stream using HTTP protocol that uses TCP/IP network then blynk mobile dashboard reads the data and displayed on the smart phone screen. The block diagram of the tool to be made can be seen in Fig 1.

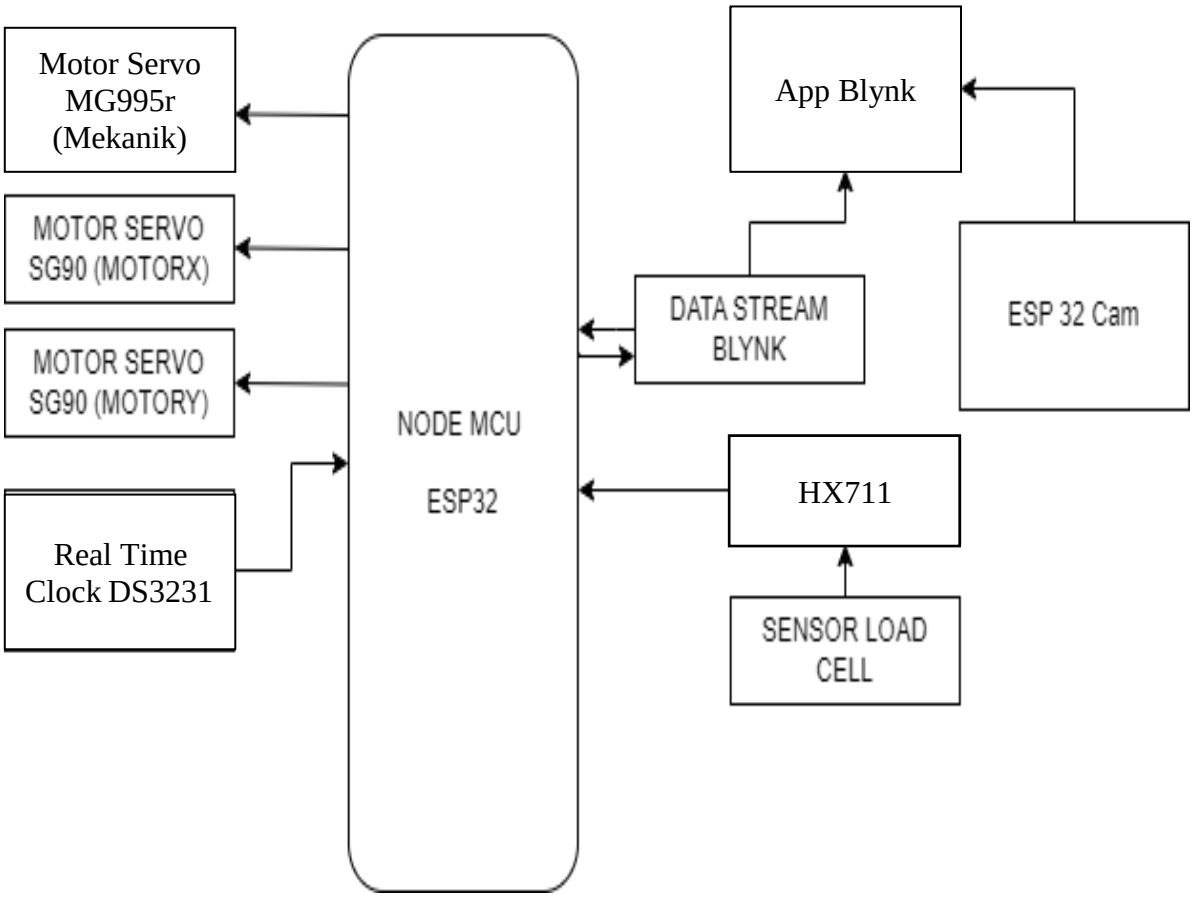


Fig 1 Block Diagram

3.2 Flowchart Automatic Cat Feeder

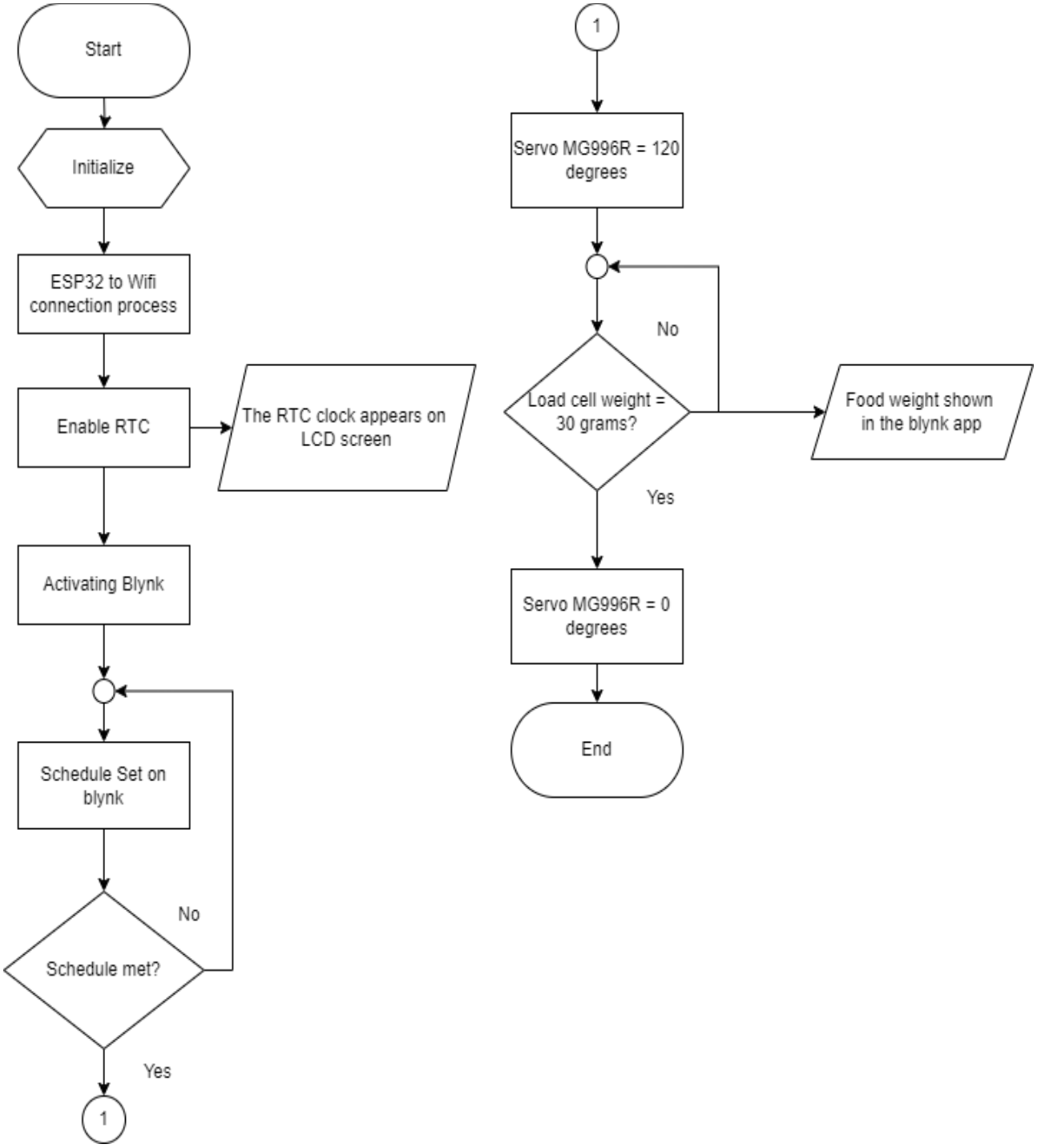


Fig 2 Flowchart

Figure 2 is a flowchart of the tool which first initiates all library components and sensors that will be used, then the connection process to WiFi occurs. After that the RTC will be active and the LCD will display the clock, then blynk will be active, after that blynk will set the schedule according to the hours we want, and if the schedule is met then the servo motor will move 120 degrees, otherwise it will repeat to set the schedule.

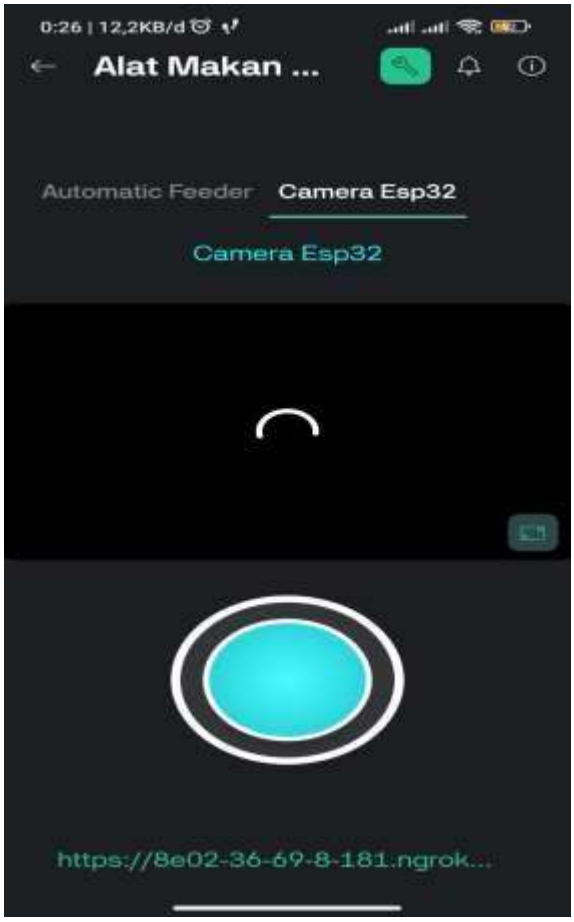
After that if the weight reaches 30 grams then the servo will return to 0 degrees and if not then the servo motor will remain at 120 degrees, and the data from the load cell sensor will be displayed in the blynk application.

RESULT

4.1 Mobile Dashboard

The mobile dashboard displays the automatic feeding system and monitoring using the esp32 cam. There is a schedule system where we can set the feeding schedule automatically, and we can also provide food manually by pressing the on off button on the mobile dashboard. Furthermore, there is a monitoring system where we can see the camera in real time and we can move the camera using a joystick. The mobile dashboard display can be seen in the following figures 3 (a) and (b)

Fig 3 (a) Mobile Dashboard Schedule



(b) Mobile Dashboard Camera

4.2 RTC Testing

This test was carried out on the RTC, which was carried out with 5 tests with different schedules. For the mechanism, if the schedule is correct, the servo motor will move 120 degrees automatically. Schedule testing on RTC can be seen in table 1 below

Table 1 Testing on RTC

Schedule RTC	Motor Servo	Results
10.20	Move 120 degrees	Suitable
16.20	Move 120 degrees	Suitable
19.12	Move 120 degrees	Suitable
09.10	Move 120 degrees	Suitable
13.14	Move 120 degrees	Suitable

4.3 Load Cell Testing

Load cell sensor testing is done in order to ensure the accuracy of measuring the weight of cat food when the weight has reached 30 grams, the servo motor will move to 0 degrees. For this reason, by conducting experiments using a 1 kg load cell sensor and manual scales on cat food. Cat food weight measurements can be seen in table 2

Table 2 Testing on Load Cell
Data *Load Cell*

No	Food Weight (grams)	Load cell sesnsor reading (gram)	Difference between the reading of the scale and the load cell sensor (gram)	ERROR
1	46	45	1 gram	2.22 %
2	48	46	2 gram	4.34 %
3	51	50	1 gram	2.22 %
4	52	51	1 gram	2.22 %
5	55	54	1 gram	2.22 %
6	56	55	1 gram	2.22 %
7	58	56	2 gram	4.34 %
8	60	60	0 gram	0 %
9	63	62	1 gram	2.22 %
10	62	61	1 gram	2.22 %
		Error Average		2.422 %

Equation for calculating the measurement error:

$Error = \frac{46-45}{45}$ x 100

Error = 2.22 %

From the test results in table 2 conducted on 10 trials of different weight sizes. The results of the comparison between the load cell sensor readings and the readings using digital scales, the weight reading value of cat food gets results that are not much different, with an average measurement difference of 2.422%.

4.4 Camera Testing

The following is a test of the ESP32 CAM camera using HTTP and tunneled using ngrok

Figure 4 Testing the ESP32 cam camera

DISCUSSION

In testing this microcontroller-based automatic cat feeder and monitoring tool, several analyzes can be obtained on devices and sensors. In the first test, testing is carried out on the Wifi connection, if Wifi is not connected to the device then the program will repeat until Wifi is connected. Ensure that the internet connection is connected in order to create effective communication with the blynk application that the author has used.

Next, make a blynk mobile dashboard display, where some of the widgets used include buttons as on off buttons, labels as weight displays, LCD as a clock viewer, joystick as a camera drive, and video streaming as an ESP 32 CAM viewer. This mobile dashboard is used to make it easier for users to manage pet food schedules remotely, as well as monitor the state of pets from application users. Furthermore, testing on the RTC, where the RTC here functions as a timer for feeding based on the schedule set in the blynk application, besides that the use of this RTC is to provide time based on the user zone displayed on the 16x2 LCD, so that the RTC allows synchronization of the feeding schedule with the blynk application and the application can send commands to users based on the time set on the RTC according to table 1 where based on the results of the table it can be analyzed that when the cat feeding schedule is in accordance with what is inputted on the RTC, namely at 10.20 then the servo motor will move by 120 degrees resulting in cat food will come out, as well as at 16.20 and ends at the last schedule which is 13.14.

Furthermore, in testing the load cell sensor, where in the manufacture of this cat feeder, the load cell acts as a measure of the weight of the food in the feeder container. Data from the load cell will be used to determine how much food is available and how much needs to be removed and control the servo motor to return to its original position when the weight is 30 grams. The system also requires calibration to ensure that the required data is appropriate. In addition, after testing 10 trials of different weight sizes, the results of the comparison between the load cell sensor readings and readings using digital scales, the weight reading value of cat food gets results that are not much different, with an average difference in measurements of 2.422%.

Camera testing is carried out in order to monitor pets using the http protocol and tunneled using the ngrok application so that it can be accessed by public ip.

CONCLUSION

Microcontroller-based automatic cat feeding and monitoring allows pet owners to schedule feeding times through the Blynk application, where a servo motor dispenses 30 grams of food with a 2.422% average error, while an ESP32 CAM system provides visual monitoring via HTTP protocol, tunneled through ngrok for remote access.

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