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IMPLEMENTATION OF NGINX SERVER WITH RTMP MODULE FOR TEA LEAF MATURITY MONITORING

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Abstract

This research focuses on the application of Nginx Server to monitor the ripeness level of tea leaves in real-time using RTMP module and IP camera. In the tea industry, monitoring the ripeness of tea leaves is essential to ensure the quality of the final product. To achieve this goal, a system was built using Nginx as the main server that manages the real-time video transmission of IP cameras installed in tea plantations. The RTMP module is used to transmit streaming video efficiently and reliably. The implementation of this system involves several stages, including the installation and configuration of the Nginx server, the integration of the RTMP module, and the installation of the IP cameras in strategic locations. The video data collected was analyzed to determine the maturity level of tea leaves based on certain visual indicators. The results of this study show that the use of Nginx server with RTMP module can provide an effective and efficient solution for real-time monitoring of tea leaf ripeness, which can help farmers and tea producers in improving their quality and productivity. These findings make important contributions in the field of smart agriculture and IoT-based monitoring technologies, and open up opportunities for the development of similar systems in other agricultural contexts.

Keywords: Tea Leaf, Nginx Server, RTMP, Ip Camera, Real-Time

Introduction

Indonesia has a variety of plants, one of which is tea (Camelia Sinensis) which can grow to a height of 6-9 meters. In addition, Indonesia is also known as the seventh largest tea producer in the world (Syahbudin, Widyastuti, Masruri, & Meinata, 2019). Currently, monitoring the ripeness of tea leaves is still done manually by farmers, so it takes a long time (Latha et al., 2021). When planting, the farmer will calculate the harvest time, and when the tea leaves are ripe, the specified blocks will be harvested. When the dry season arrives, the growth of tea leaf shoots becomes slower, and the harvest can become backward from the predetermined schedule. This causes inaccuracies in harvesting tea leaves (Rokhmah, Astutik, & Supriadi, 2022).

One of the technologies that is currently popular is video live streaming technology (SHI & Chung, 2021). The era of globalization has triggered an increase in communication between countries that is more active. Today's technology allows for real-time communication Munirathinam, (2020), which facilitates relations between countries more effectively. In addition, globalization also encourages cooperation between universities or educational institutions from various countries (Tight, 2021). To build such cooperation, communication is the main key, and one of the best communication media that can be used is teleconference (Yi, 2022). Meanwhile, live

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streaming often only allows one-way communication, meaning that only one party is involved in the broadcast process (Xu, Cui, & Lyu, 2022).

The main concept of streaming video is to divide the main video into small segments that are sent in succession. This allows the receiver to decode and play the video based on those segments without having to wait for the entire video to finish being delivered (Fan, Lo, Pai, & Hsu, 2019). With the adoption of streaming technology, there are various benefits that can be obtained. One of them is the economic aspect, as it only requires one server that can serve many users at the same time. This streaming system allows multiple users to connect in a single network, with files referred to as streams, which consist of a series of packages equipped with time-stamps (Kariyamin, Riadi, & Herman, 2023).

The use of video streaming can be applied in the ever-growing tea industry, which requires innovation in the monitoring and management of tea plants. In this case, information and communication technology is very important to improve the efficiency and accuracy of monitoring. This study introduces a study that uses Nginx server and RTMP (Real-Time Messaging Protocol) protocol to monitor the ripeness of tea leaves in real-time. This system can help farmers by utilizing these technologies.

In the realm of applied information technology, research related to the use of Nginx servers, namely to monitor the maturity level of tea leaves through RTMP data streams, has become the focus of in-depth exploration. The implementation of Nginx infrastructure marks a step forward in utilizing technology to monitor the growth process of tea plants in real-time, making a significant contribution to the field of agriculture and technology.

Many studies have been conducted in the field of technology to detect the maturity level of tea leaves. One of them, Pavel, Kamruzzaman, Hasan, & Sabuj, (2019) proposed a multi-class classification model to recognize diseases in leaves through features such as shape and texture. In this study, using the Convolutional Neural Network (CNN) model visually aims to recognize, identify, and classify various diseases in tea leaves based on images accurately (Jing Chen, Liu, & Gao, 2019).

The development of information technology has made it possible to implement the concept of smart agriculture in the agricultural sector (Yu Zhang, 2023). Currently, IoT is widely used for research such as IoT-Based Garden Monitoring System Sambath, Prasant, Raghava, & Jagadeesh, (2019) and Iot-based Plant Health monitoring system (Pavel et al., 2019). By utilizing IoT sensors and devices, farmers can monitor the condition of their gardens in real time, allowing for more precise and efficient decision-making (Liang & Shah, 2023; Sambath et al., 2019). In addition, this system can also potentially increase work productivity while reducing operational costs (Sambath et al., 2019). Traditional farming methods are now considered inefficient and unable to meet the increasing demand for food production. The agricultural sector needs technology to overcome these challenges. Smart farming systems powered by IoT have the potential to revolutionize the agricultural sector by providing real-time data on crops and the environment (Dhanaraju, Chenniappan, Ramalingam, Pazhanivelan, & Kaliaperumal, 2022; Saiz-Rubio & Rovira-Más, 2020). This system can help farmers make informed decisions about irrigation, fertilization, and other important aspects of agriculture (Mini et al., 2023).

The next research shows that the system of farmers and farm workers in the US uses Nginx servers that utilize IoT technology to overcome problems such as natural disasters, diseases in livestock and poultry, and pest attacks. The application of this system has proven to be effective in reducing losses experienced by farmers Liu, Guo, Webb, Ya, & Chang, (2019), and displaying plant health data in real-time (Suanpang & Jamjuntr, 2019).

The research uses Nginx and RTMP, such as cloud research based on game resource optimization (Pawaskar, Mankoo, Mishra, & Sawant, 2020), the development of an interactive teaching platform for calligraphy majors in universities based on streaming media Ping Chen, (2023), and the development of a remote guidance service platform for higher education based on streaming media technology (Yu Zhang, 2023).

Nginx serves as a streaming media server that supports the RTMP protocol (She et al., 2020). Nginx is used to forward streaming media data, while the RTMP protocol is used to transmit data between the client and the server during the streaming process (Shi, 2022). The incorporation of Nginx and RTMP makes it possible to stream video in real-time (Wang, 2022). The use of RTMP in video streaming Kirve, Waghela, More, Prasade, & Patil, (2024) can help monitor plant conditions. This technology allows farmers to see crop conditions in real-time Song, Burns, Pandey, & Roth, (2019) and make decisions based on the visual data received. Load testing using Locust for Nginx RTMP servers aims to measure server performance when handling a large number of requests simultaneously (Van Rossem, Tavernier, Colle, Pickavet, & Demeester, 2020).

To install the Nginx server with the RTMP module, use a virtual machine. A Virtual Machine (VM) is software that mimics computer hardware. Virtual machines can make it easier for multiple operating systems to run simultaneously on a single physical machine (Almutairy, Al-Shqeerat, & Al Hamad, 2019). The use of virtual machines has benefits in software development and testing, as well as in the deployment of secure and isolated servers (Watada, Roy, Kadikar, Pham, & Xu, 2019; Xiantao Zhang et al., 2019).

The virtual machine will run the ubuntu server operating system. Ubuntu Server is one of the popular Linux distributions used to create as well as manage servers (Erawan & Salman, 2023). Ubuntu Server is renowned for its stability, security, and ease of management. The long-term support (LTS) offered by Ubuntu guarantees that the system receives security and maintenance updates for five years, making it a reliable choice for server implementations (Zeynalli, 2023).

The test required the VLC media player application, which is a cross-platform media player software that supports a variety of audio and video formats (Laitinen & Valo, 2018). In addition to being a media player, VLC also has the ability to capture and play media streams from networks, including RTMP. In this study, VLC was used as a tool to monitor video streams transmitted by Nginx servers with RTMP modules. VLC's reliability and extensive support for various streaming protocols make it an ideal tool for verifying that video streams from surveillance cameras (which monitor the maturity level of tea leaves) can be received and played properly. Previous research has used VLC to validate video streaming in a variety of applications, including surveillance systems and live broadcasting (Assunção & Gotchev, 2019).

Wireshark is a program for the most widely used network protocol analyzer Jaya, Dewi, & Mahendra, (2022), and can encode all packets that pass through and display detailed data. Wireshark functions to track the network management of a company or institution so that it can check whether the network is functioning properly and track what is happening to the network (Jain, 2021). The advantages of using wireshark are that it supports many protocols, ease of use, free, program support, and supports operating systems such as windows, Mac OS X, linux-based platforms (Dodiya & Singh, 2022).

In this study, the focus is on the application of nginx servers and RTMP modules as a medium for live streaming, which will be applied to technology-based agriculture. Based on previous research, we mapped RTMP modules, nginx servers, and the application of technology in modern agriculture. The map is shown in figure 1.

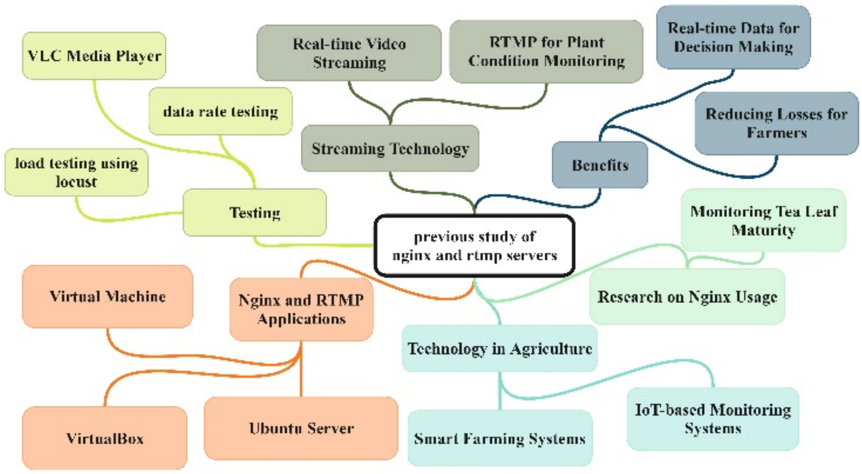

Figure 1. Related work mapping of Server nginx and RTMP

Research Method

This research was compiled using a method known as RTMP or Real-Time Messaging Protocol. The initial stage of this research involves architectural systems as shown in Fig. 2.

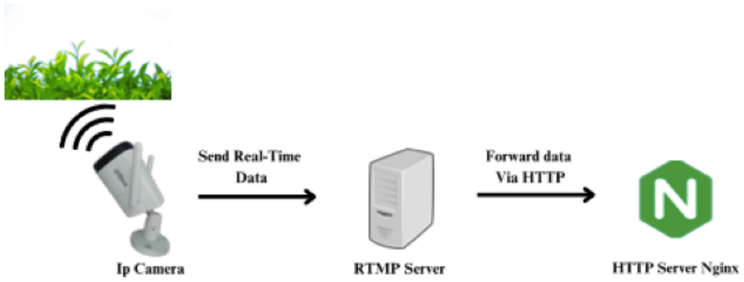

Figure 2. The system architecture

Based on architecture, it describes how IP cameras work in capturing video in real-time from an area or object being monitored. The video data produced by this camera is in the form of a digital signal which is then transmitted wirelessly. The IP camera then sends data using the RTMP protocol to the RTMP server. Then the RTMP server receives the streaming data from the IP camera, processes it, and forwards it to the HTTP server. The task of this RTMP server is to buffer and manage the stream before sending it to the HTTP server. The Nginx server serves as handling HTTP requests from end users and serving the processed video data. HTTP is used to transmit data from an RTMP server to the end user.

The flowchart on the video streaming-based monitoring system using the nginx server can be seen in figure 3

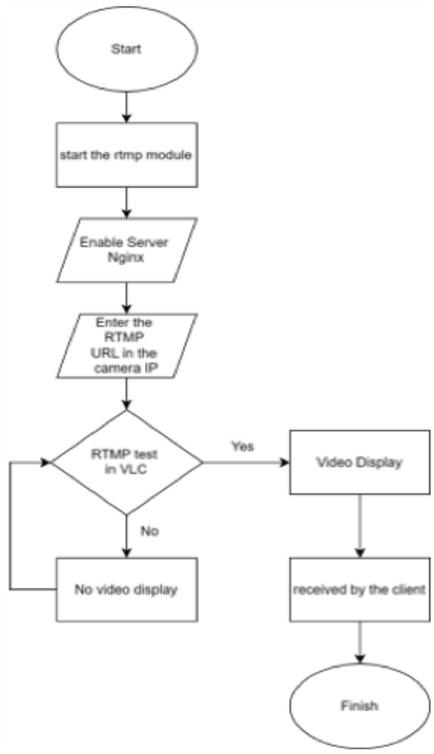

Figure 3. The Flowchart of Monitoring System Based on Video Streaming Implementation

The process begins by starting the RTMP module. This module is required to set the flow of the video stream to be delivered. Next, the Nginx server must be activated. Nginx serves as a streaming server that receives and processes video streams from the source. Once the server is live, the RTMP URL generated by the Nginx server is entered into the camera's IP settings. This URL directs the camera to send the video stream to the Nginx server. The stream sent by the camera is then tested using the VLC media player. VLC serves as a client to ensure that video streams are well received and displayed. This test consists of two possible outcomes, namely if the test is successful then the video stream is displayed on the VLC media player, this process is considered successful. Furthermore, if the test fails, then there is no video display on the VLC media player and the process goes back to the step of entering the RTMP URL on the camera Ip for retesting until the stream is successful.

The protocols used in this study are RTMP and HTTP. RTMP is a protocol developed by Adobe Systems for real-time streaming of audio, video, and data over the internet (Goyal & Balamurugan, 2020). RTMP was originally used by Adobe Flash Player to deliver content to user software, but it is now also used by various applications and streaming services (Putra & Agustia, 2020). RTMP operates by using a TCP connection to transmit data. This protocol allows for continuous data transmission. RTMP divides the data into small pieces that are delivered in a specific order to ensure smooth streaming. The default port used for RTMP is port 1935. There are several variants of RTMP, including RTMPT (RTMP over HTTP) and RTMPS (RTMP over SSL/TLS), which offer additional flexibility in various network conditions (Shaheed & Al-radwan, 2022). Furthermore, HTTP is a protocol used to send and receive data over the World Wide Web (Jara Ochoa, Peña, Ledo Mezquita, Gonzalez, & Camacho-Leon, 2023). HTTP is the basis of data communication for the web and is used to transfer HTML documents, as well as other files (Hamid & Alisa, 2021). HTTP can be used in conjunction with SSL/TLS to become HTTPS, which provides data encryption for added security (Calzavara, Focardi, Nemec, Rabitti, & Squarcina, 2019; Wijitrisnanto & Yustianto, 2020).

Result and Discussion

The following is the process of installing an Nginx server with an RTMP module using a Virtual Machine. The Virtual Machine application used is VirtualBox. The block diagram of this installation process can be seen in figure 4.

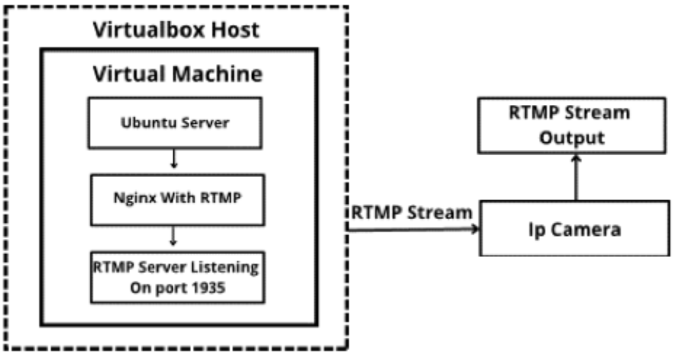

Figure 4. The block diagram of the nginx server installation process for RTMP

The block diagram illustrates how an RTMP server is set up to receive and manage video streams from a camera's IP. The initial stages of a block diagram begin with running the VirtualBox software. With VirtualBox, the operating system can run simultaneously on Virtual Machines (DUMITRACHE, STĂNESCU, & PARASCHIV, 2023). Furthermore, in the VirtualBox host there is a virtual machine that runs the Ubuntu server operating system (Pratama & Raharja, 2023). On ubuntu server, the nginx server is installed and configured. Nginx servers have high performance and their ability to handle multiple connections simultaneously. By adding an RTMP module, Nginx can receive, manage, and forward RTMP streams. This RTMP module is capable of streaming video streams found on port 1935. Furthermore, the camera used is Ip Camera, this Ip camera supports RTMP streaming. That way this Ip camera is a device that is able to capture video and transmit it over the network. The Video Stream from the Ip Camera is sent using RTMP to the Ip address of the virtual machine running the RTMP server. After receiving the RTMP Stream from the IP Camera, the RTMP Server can process and output the stream. This output can be sent to other clients or services that need access to the video stream.

The following will be done Load testing is done using locust tools to evaluate the performance of the system under different loads. The graph below can be seen in Fig. 5. shows the results of the test with three main metrics, namely Total Requests per Second (RPS), Response Time (ms), and Number of Users.

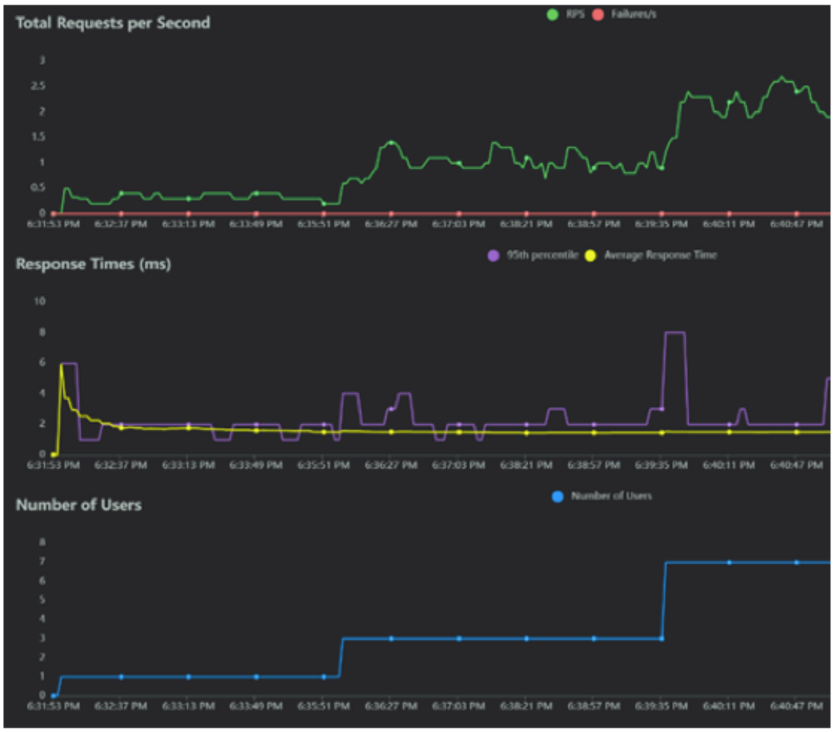

Figure 5. The graph of load testing locust

In the first graph, it shows the number of requests processed per second (RPS) and the number of failures per second. In the early stages of testing, the RPS was stable at around 0.5 to 1 RPS. In the later stages the RPS gradually increases until it reaches more than 2 RPS at the end of the test, no failures are displayed during this test. This failure can be seen in the red line which remains at 0. Then, the second graph displays the average response time (ms). The yellow line shows a stable average response time of around 1-2 ms during the test, and the purple line shows a response time metric below 95%, which means it has a better response time. However, there are some requests that take longer. The number of active users during the test can be seen in the third graph. The number of users increased from 0 to about 6 users at the end of the test, i.e. by adding users every few minutes.

The test results show that the system has stable performance. RPS continued to run well during testing and no failures occurred. The average response time is at a low level and the same time across the test, although in the 95th percentile we can read a few spikes. If the number of users increases but does not have an impact on response time, this means that the system has passed the test.

Data rate analysis on Wi-Fi networks is essential for identifying network performance, detecting problems, and optimizing performance. In this study, we analyzed the I/O graphs generated by Wireshark to monitor data traffic within a Wi-Fi network over a period of time. The I/O graph can be seen below in figure 6

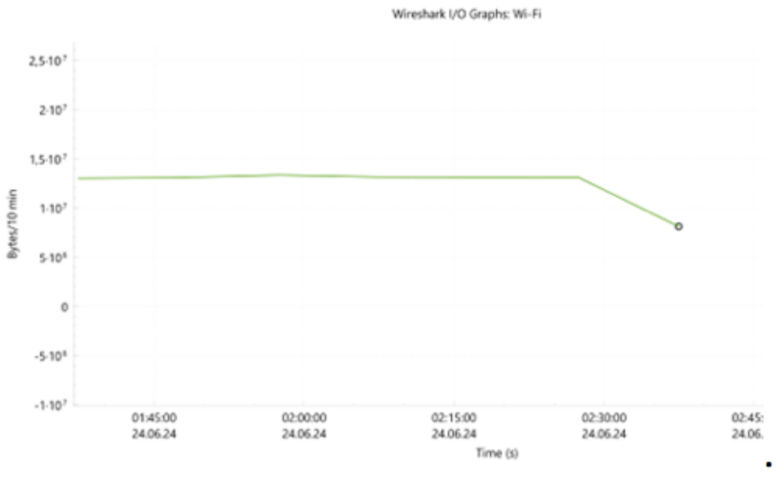

Figure 6. I/O chart of data rate analysis

The I/O graph generated by Wireshark displays the volume of data transferred over a given period of time. This graph depicts data traffic activity measured in bytes every 10 minutes during the measurement period from 01:45:00 to 02:45:00 on June 24, 2024. The volume of data transferred showed relative stability at the beginning of the measurement period, with values ranging from 4 x 10^6 to 2 x 10^7 bytes per 10 minutes. It shows consistent network activity, most likely reflecting constant video streaming or data transmission. However, at around 02:30:00, there was a sharp decrease in the amount of data transferred. The volume of data decreased from about 2 x 10^7 bytes per 10 minutes to almost zero. This drop is likely due to several factors, such as users stopping or reducing activity, or RTMP sessions have been stopped.

It is important to measure the data throughput of RTMP traffic sent and received by servers running on Ubuntu virtual machines, using Wireshark as a network analysis tool. Based on data obtained from Wireshark, throughput calculations are carried out to provide insight into network performance in transferring streaming data. The following shows a summary of the RTMP traffic data Captured in figure 7.

Table 1. Summary of Captured RTMP Traffic Data

Metric	Value
Total Bytes Sent	9 MB
Total Bytes Received	85 MB
Duration (Second)	4240,4486 Second
Total Bytes Transferred	98,590,208 Bytes
Total Bits Transferred	788,721,664 Bits
Throughput	0.186 Mbps

Formula to calculate Throughput (Mbps):

$$Throughput\ (Mbps) = \frac{Total\ Bits}{Durasi\ (detik)\ x10^6}$$

The first step is to convert Bytes to Bits:

1. Total bytes sent : 9 Mb (9,437,184 bytes)
2. Total Bytes Received : 85 Mb (89,153,024 bytes)
3. Duration : 4240.4486

Throughput Calculation Steps (Mbps) :

1. Calculating Total Bytes Transferred :
   $= 9{,}437{,}184 + 89{,}153{,}024 = 98{,}590.208$ bytes

2. Convert Bytes to Bits :
   $= 98{,}590.208$ bytes x 8 $= 788{,}721{,}664$ Bits

3. Menghitung Throughput dalam Mbps :
   $$Throughput\ (Mbps) = \frac{788{,}721{,}664}{4240.4486\ x10^{6}} = 0.186\ Mbps$$

The results of the throughput calculation show that the network is capable of transferring data at an average speed of about 0.186 Mbps. While this value is sufficient for some streaming applications, improvements in network conditions and optimization of RTMP server settings can further improve performance. Further analysis and testing under more controlled conditions is recommended to obtain more comprehensive and reliable results.

Conclussion

This study shows that using Nginx server and RTMP module effectively and efficiently monitors tea leaves' ripeness in real-time. The accuracy of the data produced in this study reaches a high enough level for the need for real-time monitoring in the tea industry. The throughput data shows an average speed of 0.186 Mbps, which allows the transmission of streaming video with sufficient stability. The combination of RTMP and Nginx was chosen because of its data transmission efficiency, high performance, stability, reliability, and good compatibility with various devices. This technology provides a practical solution for farmers to improve the quality and productivity of crops, and has great potential to be applied in other modern agricultural sectors.

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