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# Real-Time Monitoring of Tango Based GMRT Hardware System

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## ABSTRACT

**Gaint Meterwave Radio Telescope (GMRT), located near Pune at Khodad in India, is an organization to study radio astronomy. GMRT is an array of 30 parabolic dishes of 45m diameter each, spread over a distance of 25km. GMRT has been upgraded to use next-generation control & monitor system called TANGO Based GMRT Control & Monitor System (TGC). The TGC comprises RFI shielded antenna-based computers working as local monitor and control with different hardware. The status of this local computer is crucial for the observatory which is looked at by a team of engineers. Also, the hardware details of each antenna base need to be taken care of. Thus, the paper describes the design and implementation of a web-based application for monitoring the hardware system in real-time. The application is developed in Flask. The real-time monitoring is accomplished by the use of psutil and maintaining the other hardware details using MongoDB as a database, which can perform all the CRUD (Create, Read, Update, Delete) operations.**

**Keywords: CRUD Operations, MongoDB, psutil, Flask**

## I INTRODUCTION

Gaint Meterwave Radio Telescope(GMRT) is a unique facility for astronomical study and research, which uses the Meter wavelength of radio waves, set up by the Tata Institute of Fundamental Research(TIFR) under the leadership of the National Centre for Radio Astrophysics(NCRA). Recently, this system has been **upgraded and called the TANGO-based GMRT Control and Monitor System (TGC).** The TGC of the radio telescope is required to provide the necessary coordination between the various building blocks of the receiver system. The TGC comprises of RFI shielded antenna-base computer working as local monitor & control along with upgraded embedded board and network switch as well as powerful server as central node and database server. The status of this local computer such as the CPU utilization, memory space, disk usage, and the running process is required to be known by the engineers' team to ensure the smooth working of radio telescopes.

## II SYSTEM ANALYSIS

### II.A Software Requirments

1. The web-based application is developed in Flask. Flask is a microframework written in Python, which is mostly used to make web applications through Python.
2. The backend for the application is MongoDB. The MongoDB driver PyMongo helps connect the backend to the frontend.
3. The application has a user login system with password encryption which allows only authorized users to access the application.

### II.B Python Libraries

1. pymongo - pymongo is the official MongoDB Python Driver for MongoDB.
2. psutil - Process and System utilities (psutil) is a library that helps retrieve information on running processes and utilization. This helps in monitoring the CPU, memory, disk, and network.
3. plotly - The graphical representation of the real-time monitoring is accomplished by the plotly library of python.

*II.C Architecture*

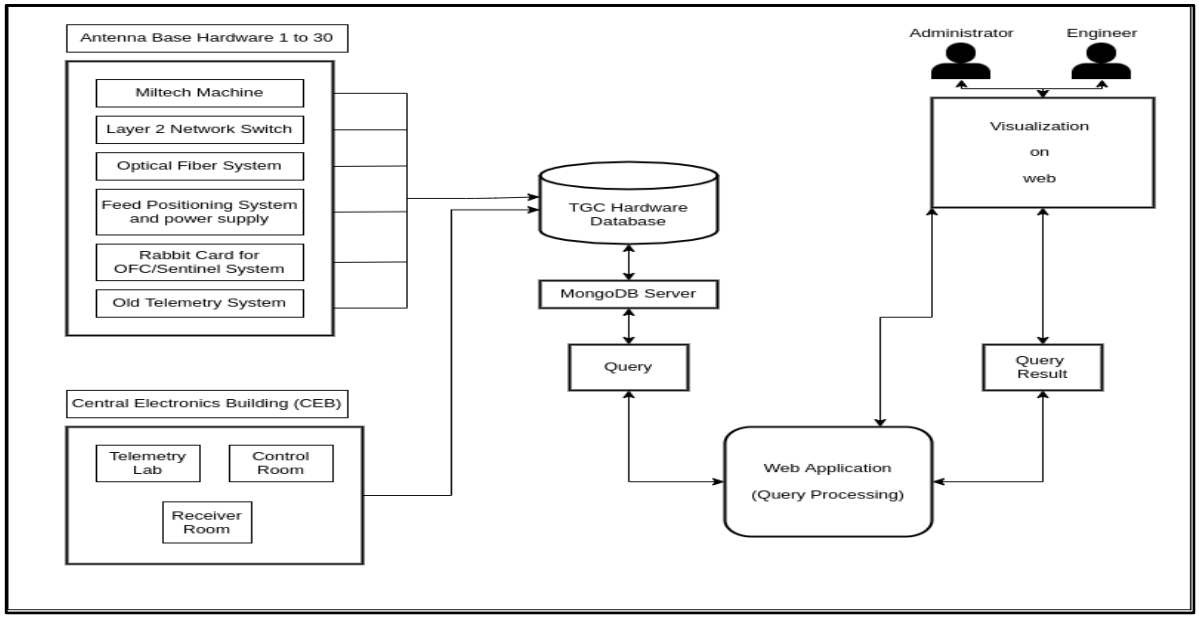


**Fig. I: Architecture of the complete application**

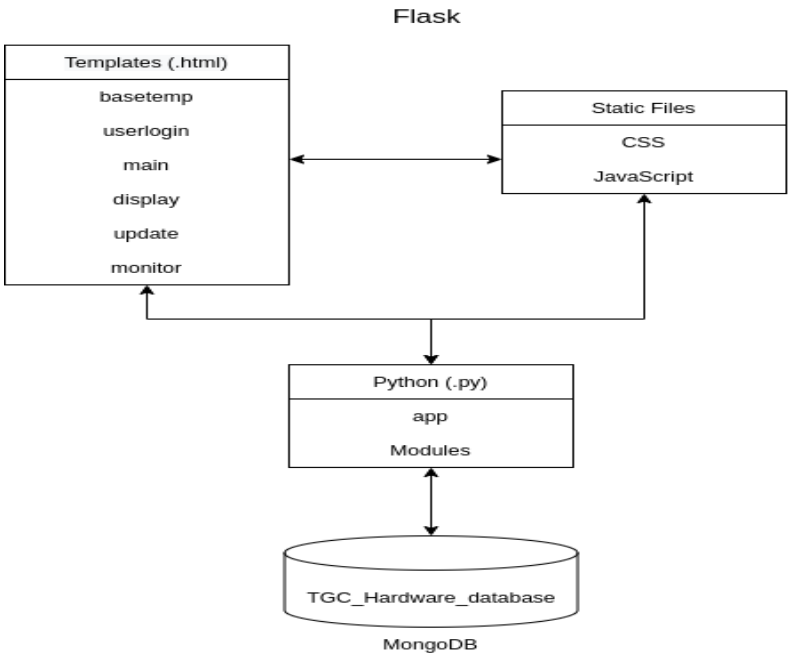


**Fig. II: Architecture of Flask**

**II.D** *Objectives of the proposed web-based application for real-time monitoring*

Knowing the current status of the antenna base is a key factor for the observatory. Therefore, the following are the objectives of the application:

1 Monitoring the local machine remotely, i.e, from their respective labs, will help the engineers' team to troubleshoot a problem if occurred. It will also ensure the smooth working of the hardware system.

2 The collection of other hardware present at the antenna base is helpful for the administrator to keep the track of changing hardware.

## III MATHEMATICAL FORMULATION

- The algorithm used for password encryption is of hash bcrypt. the algorithm is as follows:

Function bcrypt

Input:

cost: Number (4..31) $\log_2$(Iterations)
salt: array of Bytes (16 bytes) random salt
password: array of Bytes (1..72 bytes)

Output:

hash: array of Bytes (24 bytes)

```
//Initialize Blowfish state with expensive key setup algorithm
P, S <-- EksBlowfishSetup(cost, salt, password)
//P: array of 18 subkeys (UInt32[18])
//S: 4 substitution boxes (S-boxes), S0...S3. Each S-box is 1,024 bytes

ctext <-- "OrpheanBeholderScryDoubt"
repeat (64)          //Repeatedly encrypt the text 64 times
ctext <-- EncryptECB(P, S, ctext)

return Concatenate(cost, salt, ctext)          // 24-byte ctext is resulting password hash
```

- The cross-platform library is psutil is used to retrieve the system status for monitoring. This data is been graphically represented on the web with plotly.

- The CRUD operations.

Create, Read, Update, Delete operations are performed on the database.
Create Operation: db.collection.insertOne()
Read Operation: db.collection.find({"query name"})
Update Operation: db.collection.updateOne()
Delete Operation: db.collection.deleteOne()

## IV HELPFUL POINTS

### IV.A Literature Survey

The Giant Metrewave Radio Telescope (GMRT), is being upgraded with a modern Monitor & Control (M&C) system. The central supervisory M&C system remotely controls and coordinates the activity of all 30 antennas, distributed over a radial distance of ~ 15 km. The Next Generation M&C System being developed as part of the upgrade aims to provide an end-to-end radio telescope software solution, ranging from auto-execution of scheduled observing proposal to meta-data generation for supporting science data analysis.[1]

In this paper, the model for real-time monitoring of selected premises is presented and implemented as a web-based interactive interface while utilizing open-source hardware. The rudimentary idea is based on the capabilities offered by contemporary web technology which enables the development of complex and interactive solutions – essential for our purpose is HTML5 and JavaScript technology. Approach we take incorporates three major parts – model design, interface design, and monitoring tool development.[2]

Today, with the high-speed Web application development, the requirements of Web application to real-time data for communication are more urgent. This paper analyzed the traditional model of Web applications and the work mode of WebSocket push technology based on HTML5. This paper designed a real-time monitoring system in B/S mode based on WebSocket technology. System improves the stability and reliability of real-time monitoring system, and it helps improve the safety and effectiveness of power plants in real-time monitoring.[3]

This paper will explained the purposed system by integrating face recognition system and dashboard website. Face recognition system implementation is using Dlib, a general-purpose open-source library written in C++, and Tiny Face Detector. Whilst, the dashboard website is developed using Dash by Plotly, an open-source Python framework for building web-based analytic applications.[4]

In this paper, the design of the monitoring system is based on the LabVIEW platform. This paper does a CO2 concentration measurement as an example, the system can realize real-time data measurement, display, storage, limit alarm, etc. The monitoring system software part is mainly composed of device initialization, data acquisition, processing, storage, display, and alarm VI.[5]

NoSQL database is the broad definition of non-relational data storage. As a result of the new storage model, the traditional normal-form theory is difficult to adapt to new applications. In this paper, the characteristics of the data logic model of NoSQL database MongoDB and the mode design principles were analyzed, then a method based on anti-normal form model was proposed.[6]

Traditional relational databases are usually vertically scalable and offer strong data consistency because ACID (Atomicity, Consistency, Isolation, and Durability) properties are fulfilled. The consistency was considered for almost every system. As is indicated, the scalability is an issue because one powerful machine serves all requests. On the other hand, NoSQL databases are designed with respect to scaling in mind, which leads to a weak consistency. This approach is known as BASE (Basically Available, Soft-state, and Eventually consistent).[7]

Docker is an open platform for developers and system administrators to build, ship, and run distributed applications using Docker Engine, a portable, lightweight run-time and packaging tool, and Docker Hub, a cloud service for sharing applications and automating workflows. Docker containers are evaluated based on their system performance. That is based on system resource utilization. Different benchmarking tools are used for this. Performance-based on file system is evaluated using Bonnie++. Other system resources such as CPU utilization, memory utilization, etc. are evaluated based on the benchmarking code (using psutil) developed using python.[8]

### IV.B Abbreviations and Acronyms

TIFR - Tata Institute of Fundamental Research
NCRA - National Center for Radio Astrophysics
GMRT - Gaint Meterwave Radio Telescope
TGC - TANGO Based GMRT Control & Monitor System
CRUD Operations - Create Read Update Delete Operations

## CONCLUSION

The development of a web-based real-time monitoring application for TGC will simplify the work of the engineers' team. The use of flask and other python libraries produces a light weighted web application. Being the application lightweight will not interrupt the other applications and processes already running on the GMRT servers. Other than this, the application can be further extended to solve the problems from the website itself.

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