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ITERA Astronomical Observatory Information System

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Abstract

In the current information age, data is a valuable asset for companies. Technological advances encourage the digitization of information in almost all fields of science, including astronomy. Technological developments make it easy to access open data in the public domain. The availability of open data will encourage the acceleration of research. ITERA Astronomical Observatory is an observatory located in Lampung. This observatory is planned to be the largest in Southeast Asia [9]. To face the challenges in the digitization of information, ITERA Astronomical Observatory plans to build an information system specifically for storing and handling astronomical data. This paper describes the basic idea and design of this information system which is aimed at researchers, students as well as public.

Keywords: *Information System, Astronomical Data, ITERA Astronomical Observatory.*

1. Introduction

In the current information age, data is a valuable asset for companies [1]. Data represent an event in the business world and tangible objects such as places, objects, and people [2]. Processing a set of data will produce information that is more useful for the recipient. There are two activities in data processing, namely data storage and data handling [2]. The data storage process includes collecting, searching, and maintaining data. Meanwhile, the data handling process includes checking, comparing, selecting, summarizing, and using data. Advances in technology and the development of the internet today encourage digitizing information in almost all disciplines, including astronomy. Technological developments make it easy to access open data in the public domain. The availability of open data will help researchers and practitioners to utilize the data further. The challenge of digitizing information makes companies/organizations have to adapt.

In addition to being faced with the challenges of digitizing information, companies/organizations that do not yet have an information system have problems with their data. The manual data storage process can cause issues with data quality, such as duplicate data, lost data, or corrupted data. The absence of a single source of truth has resulted in multiple data where there are many versions of one data. The manual recording process also results in lost data during archiving or problems with damaged data due to human error or natural disasters.

ITERA Astronomical Observatory is an observatory located on the Institut Teknologi Sumatera campus, Lampung Province. This observatory is aimed to be the largest in Southeast Asia [9]. Currently, in the ITERA Astronomical Observatory, astronomical data is still stored manually and does not yet have an information system that can perform centralized data storage and processing. To face the challenges of digital information and in order to maintain the quality of astronomical data, ITERA Astronomical Observatory

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plans to build an information system that directly processes data taken at ITERA Astronomical Observatory.

ITERA Astronomical Observatory Information System is an information system supported by a centralized database that functions to store and to handle astronomical data used for research by the academic community of the Institut Teknologi Sumatera. The ITERA Astronomical Observatory (OAIL) Information System also provides various data such as stars, solar system objects, deep sky objects, and the crescent moon images, weather conditions acquired by the observatory's detector and sensor system.

The difference between the ITERA Astronomical Observatory Information System and the information system in the literature review is that the ITERA Astronomical Observatory Information System performs storing and handling astronomical data. Database design for astronomical data, astronomical data processing, keeping the quality of data astronomical, and ease of data access, are the focus of this paper.

2. Research Methodology

2.1. Literature review

The literature review in this study aims to form theoretical and conceptual frameworks, and the stages of research adopted in this research. Some of the studies discussed include astronomical data, astronomical data processing, and information systems

a) Astronomical Data

Data represents an event in the business world and real objects such as places, objects, and people [2]. According to Anwer et.al. (2017) [2], classification of data based on type, nature, and source. In the classification of data by type, there are measurement data that shows the value of a data and arithmetic data that shows the value of a certain amount of data. Then on the classification based on its nature, quantitative data is related to the summation of data, and qualitative data is related to data quality. The classification data, based on data sources, there are 2 data. First is internal data, which is original data, and second is external data resulting from observations of others.

Astronomical data generally includes 1-D spectra, time-series and photometric data and 2-D spectrum and image data [6]. Astronomical data in this study were originated from observations of celestial objects conducted at the ITERA Astronomical Observatory. Most astronomical images obtained from the ITERA Astronomical Observatory are represented in the FITS (Flexible Image Transport System) format. The FITS format meets the needs of the standard format of astronomical data. The FITS format already has embedded human-readable metadata, has some software package capable of reading it; published specifications; and a well-defined set of models, metadata, and keywords [6].

b) Astronomical Data Processing

In [2], there are two activities in data processing, namely data storage and data handling. The data storage process includes collecting, searching, and maintaining data. Meanwhile, the data handling process includes checking, comparing, selecting, summarizing, and using data.

In this research, astronomical images, which is the entity of research in developing information system, are subject of data processing, including data storage and data handling processes. The ITERA Astronomical Observatory Information System implements several processes such as collecting (adding data), searching (based on parameters), maintenance (data management), checking (data validation), selection (data filtering), summarizing (archiving), and data usage (displaying data).

c) Information Systems

The information system is a system that supports the goals of the organization through operational activities, managerial activities, and strategic activities and provides output in

the form of reports [5]. The information system developed in this research will focus on managing specific data types, maintaining data quality, and making it easier for users to access data

2.2. Theoretical framework

Based on the literature study and the team's condition, the system development method with an agile model using extreme programming techniques was chosen. Development using extreme programming techniques allows developers to build applications quickly, be flexible to changes, and be suitable for conditions that are not yet clear in defining the system. The extreme programming method has several iterations of development that allow clients to try prototypes of the application [3], thereby minimizing the risk of developing system features errors [7]. The flow of this research, starting from identifying the problem, then conducts a literature study regarding selecting the right system development technique according to the conditions of the case study. After choosing a system development method, then carry out the information system development process.

Figure 1. Research flow

2.3. System Development Life Cycle

The system development cycle in this research uses an agile model approach using extreme programming techniques. The development phase goes through the exploration, planning, iteration, production, maintenance, and death phases of system development [4]. Figure 1 is a system development cycle using an agile approach with extreme programming techniques.

Figure 2. System development cycle using extreme programming

a. Exploration phase

In the exploration phase, it produces system development documents in the form of user stories. Break down user stories into small tasks, where each task created has attributes of name, type (analysis, design, coding, testing), description, dependencies, priority, difficulty level, and work time. In this phase, the research uses focus group discussions to collect information. In the exploration stage, it produces system development documents in the form of user stories.

b. Planning phase

In the planning phase, the development process is carried out by selecting tasks in the next iteration. Task selection considers a priority, dependencies, estimated difficulty level, and estimated duration of work. For stories that are not selected will be worked on in the next iteration. This process occurs at the beginning of the iteration and repeats until all tasks are completed.

c. Iteration's phase

There are four development processes, including analysis, design, coding, testing in the iterations phase. Process analysis explores the current task to ensure that it can be worked on in the development process. After that, then do the mockup design, database design and discuss it with the team. Next is the process of coding. The coding process is done by creating features of the program. After this process ends, the program test for unit tests using a white box testing approach where the amount of code coverage for each file is calculated, and if the code coverage is below 70%, then the test is considered failed. [10]

d. Production (production phase)

At the production stage, the team will get system updates. If the features released are according to the team's wishes, then continue to the next iteration, but if not, return to the system development iteration phase with application improvement stories.

e. Maintenance (maintenance phase)

After going through the feature testing stage by the client, the system is released to production and can be seen by end-users. The iteration process continues until the system successfully releases all features to the end-user. This stage marks the end of the system development process.

3. Results and Discussions

The result of this research is the development of the ITERA Astronomical Observatory information system.

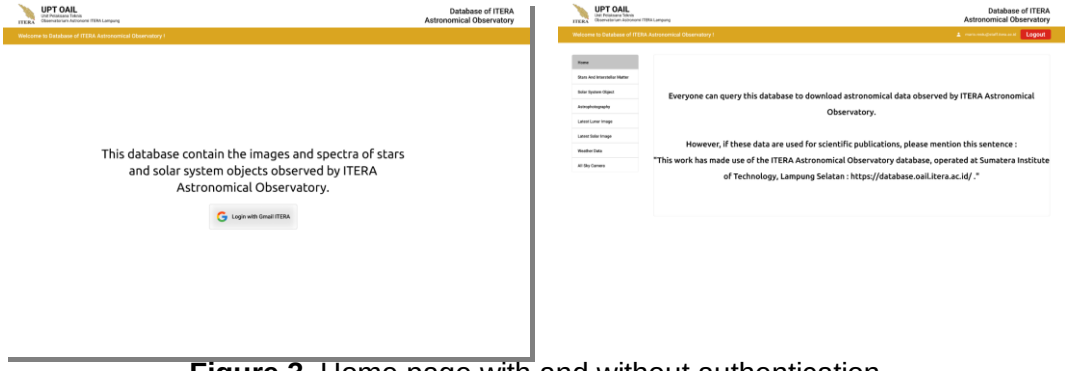

Figure 3. Home page with and without authentication

Figure 3 shows the home page as the implementation of the ITERA Astronomical Observatory Information System. It also shows when the user first visits the website, and when the user authenticates into the system.

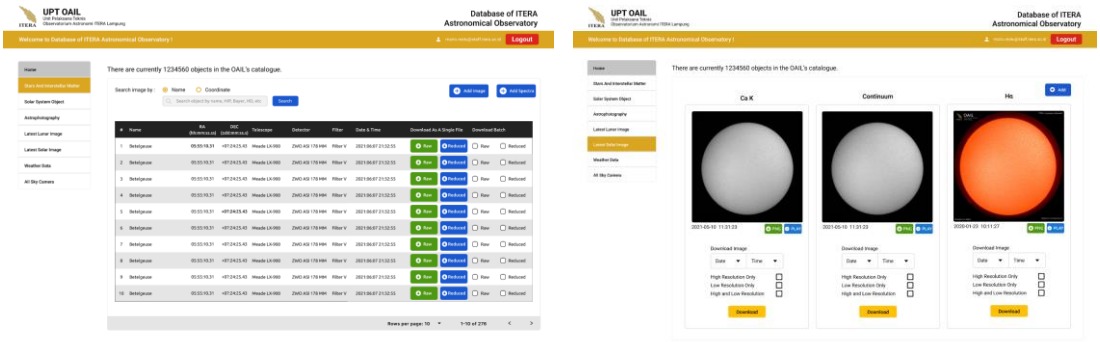

Figure 4. Stars and Latest Solar Image page

Figure 4 displays stars and solar image data. One can use a filter and search function on stellar data. In addition, as a user one can download data.

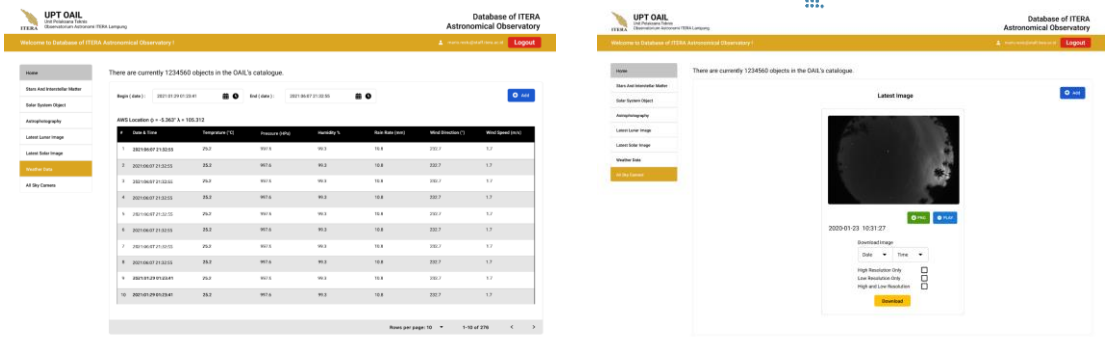

Figure 6. Weather and All-sky camera pages

In Figure 6, an all-sky camera page shows the last image that was input into the system, and this process enters the sky-camera data manually into the system. For ITERA Astronomical Observatory Information System, we propose four user's roles given in Table 1 .

Table 1. User's roles and user's accesses

Role	Access Control List
Administrator	search, filter, insert, view, add, delete, download, and edit data on stars, solar system objects, deep sky objects, and the crescent moon images, weather conditions, all-sky camera data and inactivate user
Contributor	search, filter, insert, view, add, download, and edit data on stars, solar system objects, deep sky objects, and the crescent moon images, weather conditions, all-sky camera
Staff, Student dan Lecturer	search, filter, view, and download (data on stars, solar system objects, deep sky objects, and the crescent moon images, weather conditions, all-sky camera)

ITERA Astronomical Observatory Information System has been built using the python programming language with the pyramid framework for the server-side and using modern JavaScript framework react js for the client side. Several features have been successfully implemented, including multiple uploads, filter, search, authentication, manage data, manage user and log activity. Detail descriptions are given in Table 2.

Table 2. Features in the information system

Features	Description	Role
Multiple uploads	Upload astronomical data	Administrator and Contributor
Filter	Filtering astronomical data	All roles
Search	Searching astronomical data	All roles
Authentication	login using OAuth 2 (ITERA email)	All roles
Manage data	Manage astronomical data by user role	All roles Contributors: +edit data Admin: +edit and delete data
Manage user	Manage user data, and only admin can use inactive users	Administator
Log Activity	display a table of user activity in accessing each feature	Administrator

4. Conclusions

Based on this research, it can be concluded that there are five user roles proposed in the system to support data processing management. These include Administrator, Contributors, Staff, Students, and Lecturers. In the ITERA Astronomical Observatory Information System, there are 7 features the system (See Table 2), including upload, search, filter, login, manage data, manage users, and log activity. ITERA Astronomical Observatory Information System will provide various data such as stars, solar system objects, the crescent moon images, solar images, weather data, and image data acquired by the observatory's instruments. The data will be used for academic and research purposes by the Civitas Academica of the Institut Teknologi Sumatera.

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