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ARCHITECTURE DESIGN OF HEALTH ASSET DETECTION SYSTEM IN HOSPITAL

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Abstract

Efficient management of hospital assets is essential to ensure that operations can run optimally and the quality of health services is good. However, the recording and management of assets in hospitals carried out manually often causes data errors, information mismatches, and also assets are only known by the manager without being explicitly recorded. In overcoming this problem, the researcher aims to develop a hospital asset detection system architecture using an iterative and incremental methodology approach. The stages of this system development include identification of needs and conceptual models, logical architecture design, conceptual architecture design, logical architecture, physical architecture, technology selection, and evaluation. This system utilizes YOLO model reading technology for asset detection and identification, storing detection results into a local database using SQLite3, sending data to a central server via API, and post-processing data by selecting the highest confidence score stored in a MySQL database and then using the data to manage asset management and asset visualization. The implementation of this system successfully reduces manual recording time, improves asset visibility, and optimizes resource usage, thus contributing to the improvement of efficiency and quality of health services.

Keywords: System Architecture, Healthcare Asset Detection, Asset Management, Asset Data Collection, Asset Processing

I. INTRODUCTION

In the current era of modernization where information technology is an important part of almost all areas of life, including in the health sector which includes service provision, medical facility management such as asset management that can be integrated with information systems. Asset management itself is a series of decisions in managing assets optimally which includes planning, demand, procurement, inventory, ownership or legal verification, valuation, operation, maintenance, minimizing operating costs, and ensuring asset availability and maximizing its use [1][2][3]. However, there are still obstacles in the management of asset management, especially in data collection which is still done manually which can cause errors and data mismatches, as well as the lack of direct monitoring and supervision of hospital assets [4].

A health asset is something used by a health institution that can generate economic value and can contribute to the delivery of health services [5]. All assets in the hospital such as medical equipment, technological devices, and other inventory must be managed properly to support the administrative process. However, there are obstacles in managing these assets. One of the obstacles in managing assets and recording these assets is done conventionally where the recording is still done manually or based on the knowledge of the head of the asset manager without being explicitly stated [6]. One of the other obstacles is that when you want to know the distribution of asset locations, you still have to check one by one, as well as the lack of a system that is able to collect, manage and process asset data efficiently [7].

The use of manual methods in recording assets can cause other obstacles such as long asset searches and also discrepancies and differences in data in the field and data records. In addition, this manual recording is carried out only when needed, after the need is completed, this asset record will become an archive in the hospital and is not updated regularly, making it difficult to find and manage assets effectively [8].

In dealing with the above problems and obstacles, this research proposes a system architecture that aims to help detect health assets in hospitals. This system architecture uses data collection for data collection and data processing so that the data collected can be processed according to the

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information needs to be used. In this data collection, data collection is carried out and data processing is carried out for information extraction through organizing, indexing, and also data manipulation [9]. The system is designed to automate and optimize the process of identifying, tracking, and managing hospital assets. The main focus of hospital asset management.

The development of this system aims to create a solution for the collection, data processing and visualization of asset distribution in hospitals. By automating the process of data detection and post-processing, this system is expected to improve asset recording, facilitate better asset tracking and ultimately support more informative decision making in hospital asset management. With the implementation of this system, hospitals can gain better visibility into the location and status of assets, reduce the time spent on manual asset recording and can optimize the use of existing resources. Ultimately, this increased efficiency is expected to contribute to improving the overall quality of health services.

II. RESEARCH METHODOLOGY

In this systematic problem solving using the Systems Development Life Cycle (SDLC) method, namely the iterative incremental model. The iterative incremental method itself is a software system development approach whose models are made gradually and repeatedly [10]. In iterative incremental there are approximately several iterations. In this design there are five iterations, among others:

- Iteration 1: Identify Needs
- Iteration 2: Initial Conceptual Architecture Design
- Iteration 3: Physical Architecture Design
- Iteration 4: Solution Technology Selection
- Iteration 5: Evaluation

III.. RESULTS AND DISCUSSION

A. Need Identification & Conceptual Model

At this stage, the needs of one of the hospitals in Indonesia were identified. Some identification of needs can depart from the identification of problems. In general, the data collection of hospital assets is still manual recording which allows errors to occur in written asset data collection. This manual recording results in errors in data collection such as errors in recording asset information and expired assets are not included. That is what can affect the difference in data in manual recording with actual asset data [6].

Another problem is that this manual data collection is carried out by staff who are directly responsible, where when there are damaged or lost assets, they will be written in the asset inspection report book. This manual bookkeeping is not optimal because when an asset recording error occurs, the staff must do the data collection and rechecking. That way there are often discrepancies between manual recording and actual asset data which will be difficult to track and check [7].

Other problems also occur in hospitals in asset management, namely in efforts to optimize hospital assets such as delays in mapping asset positions, lack of direct monitoring and supervision related to assets, doctors, staff, and patients. In addition, asset position mapping still uses manual methods that are prone to delays and the potential for errors [11].

Based on the identification of problems, we can describe the needs by creating a conceptual model of the system to be developed. The conceptual model can be seen in Figure 1.

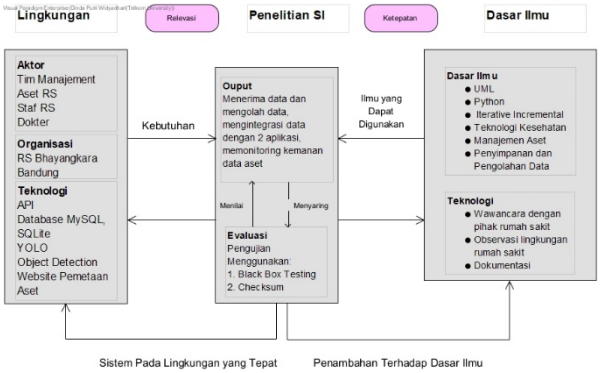

Figure 1 Conceptual Model

The figure above explains the flow of the conceptual model used in this research. This research begins by identifying business needs that exist in the Bhayangkara Hospital environment which is the research location point. Based on the identification of business needs is done to design a hospital asset management information system. The analysis carried out aims to produce solutions that are relevant to the problems that exist in the research environment.

In the research environment there are supporting components such as actors, organizations, and also technology. The result of this research is a website-based asset management information system. Capturing data from sensors that use the object-detection method using the YOLO model where the detection results will be stored in a local database using SQLite and then will be sent to the server with the help of the API. Then the data is collected in a container that uses a MySQL database. In the database all sensor capture data is processed and classified as needed. After the data has been processed, it will be saved to the MySQL database and then ready to be used for asset visualization in web-based applications.

The actors involved in this implementation are the asset management team at the hospital, hospital staff, and doctors. Based on the results of interviews and observations, the asset management team is responsible for collecting data, recording and labeling assets which will provide an identity for each item or asset which is useful for making it easier to track and monitor assets. Hospital staff and doctors can only see and check the position of the assets to be searched.

The final goal of this research is to produce a more efficient and integrated asset management information system using a website-based application that is able to provide accurate and real-time asset position information about assets owned by the hospital.

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B. Logic Architecture Design

This logical architecture is an overview of the design logic that occurred during the design that will be used and implemented. This architecture can support asset management by integrating local data collection and server processing to provide relevant and manageable information.

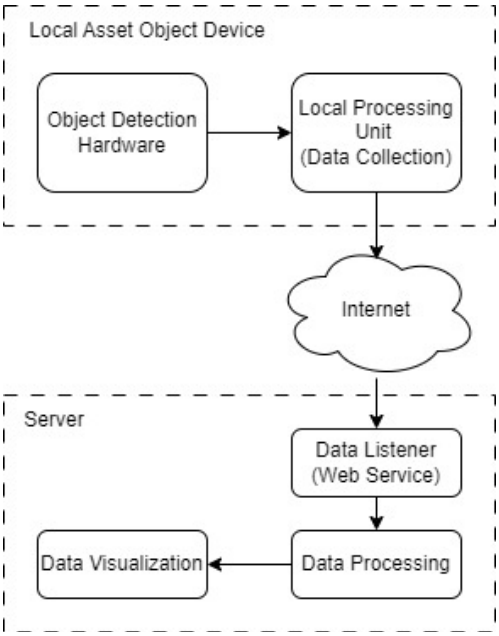

Figure 2 Logic Architecture

In Figure 2 above, the logic architecture consists of two main parts: local logic and server logic. This local logic may include capturing asset data or detecting asset data using object detection hardware such as cameras, performing data collection and processing locally, then sending the data to the server via the internet. Server logic includes receiving data, and processing using data filtering as needed, storing the processed data, and the processed data will be visualized to facilitate asset management.

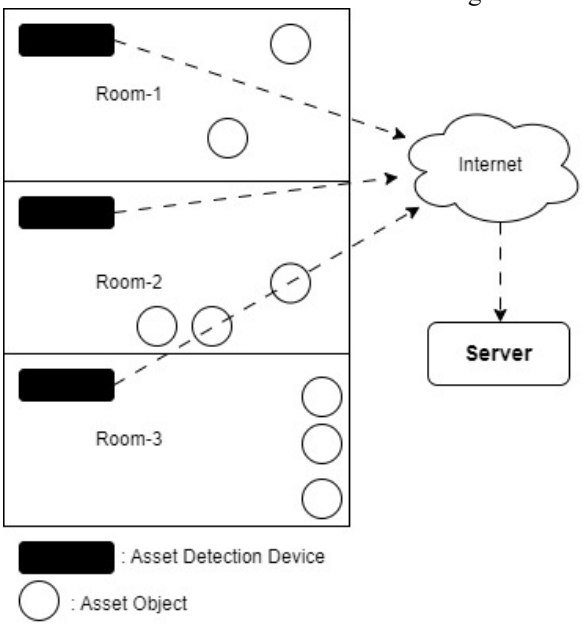

Figure 3 Flow Logic Architecture

Figure 3 explains that there are several devices that will be deployed to each room in the hospital. Each of these devices will perform asset detection. This device will scan assets using certain technologies, for example YOLOv8, to identify assets in each room in the hospital.

All data from this asset scanning will be stored or collected first in the local database. After that, all scanning data information will be sent to the data center (server). After that, on the server the data will be processed and processed as needed such as taking the highest confidence score for each asset and then stored in the database. The data that has been processed will be used to visualize assets, which can make it possible to clearly know the position of assets detected in each room. With this visualization, it can be clearly seen the types of assets that exist in each room along with the specific location of each asset.

C. Physical Architecture Design

In carrying out the physical implementation, the following proposals relate to the physical architecture.

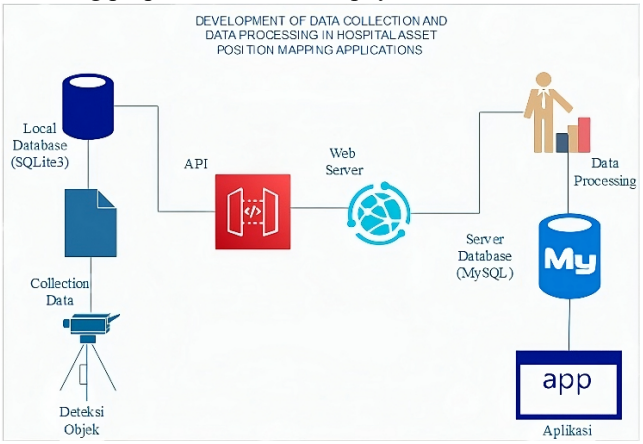

Figure 4 Physical Architecture

Figure 4 explains the system architecture regarding the flow of data processing and data collection. This camera is an object detection, where this object detection process identifies assets using a machine learning approach. The process in this web application includes several systems in several stages, at the initial stage it will run a service for object detection and get the identity of the asset along with other related information. Object detection itself refers to the retrieval or detection of an object [12]. At the next stage, there is a service that will send the data to the server. On the server, an API or web service has been developed that can receive requests from the service. After the API receives data from the service, the results will be stored in the MySQL database.

In the next stage, post-processing is carried out on the existing data. The purpose of post-processing is to optimize and purify the data received from the local database. From the detection results stored in the local database, the data with the highest confidence score in each asset data will be selected, thus ensuring that only asset data with the highest confidence score will be stored and used for further analysis. In addition, the goal is to eliminate the same duplicate asset data and maintain database efficiency. With this post-processing, the latest data for each asset that has

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been cleaned and optimized is ready for further analysis for mapping the position of hospital assets.

D. Technology Selection

In the selection of object detection technology, it is proposed to use machine learning technology in this application using deep learning technology with YOLOv8. To develop this, several datasets are needed which are assets in the hospital. As an example of the dataset used can be seen as in the picture below.

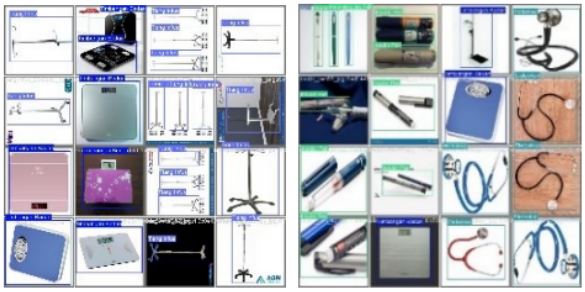

Figure 5 Dataset Collection

In Figure 5 above, it shows that each image will be labeled according to the asset category such as stethoscope, hand sanitizer, mask, and others. From this dataset, training is carried out to get a model. The results of this model will be used to carry out the testing process to identify assets. To help detect assets, processing is done on the device where the data will be stored locally in a local database. For local database technology, you can use SQLite. On the device, a service is also developed that will send the scanning results to be sent to the cloud server.

To get data on the server, a data listener is developed in the form of a web service or API. This web service API will be proposed using open source technology such as using PHP with certain frameworks such as YII. The results of this web service reading will be stored in a database server that is proposed to use a MySQL database.

E. Design

In the design stage there is a web service design. This web service design was built using the YII framework and designed using an API approach that aims to ensure efficient and structured communication between the scanning device and the central server. The use of this API is to make it easier for system functions to be accessed programmatically [13]. This web service serves as a receiver of data from the scanning device, performs post-processing, and stores the data into a MySQL database. In addition, this web service provides different endpoints for each handling various operations such as data storage and data retrieval with the highest confidence.

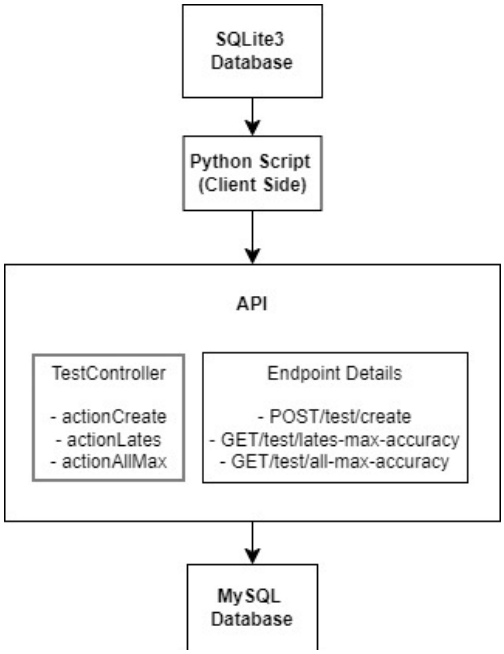

Figure 6 Web Service Design

Figure 6 is an overview of the backend implementation which consists of several parts, namely Python scripts to store detection results into the SQLite database and also send data from SQLite to the server, and PHP scripts in the Yii framework to handle requests and data processing on the server. The Python script stores the detection results into SQLite, then retrieves the data from SQLite to be sent to the server using 'request' in the form of a POST request. When the data is successful (status code 201), the 'is_sent_to_server' status will be updated in SQLite if the data is successfully sent to the server. The controller in Yii can receive and store data from the request body ('actionCreate') and also retrieve data with the highest confidence score for post-processing ('actionLatesMaxAccuracy' and 'actionAllMaxAccuracy').

The development of data collection and data processing is made to capture, collect, and process data obtained from the model and will be used in web-based hospital asset mapping applications. In this research, the implementation of the object detection model from YOLO is exposed in detecting and identifying the name of the tool along with other information such as the confidence score detected on the asset, then the data will be stored in SQLite3. In this data filtering process where the data obtained from object scanning results will be taken based on the highest confidence score in each detected asset and then stored in the MySQL database.

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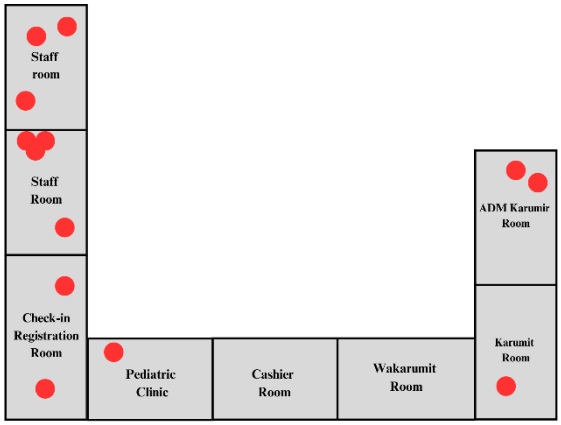

Figure 7 Visualization Of Asset Distribution

In Figure 7, we can see the distribution of asset data according to the place of the asset. In the picture above is a visualization of the distribution of assets carried out during the initial asset scanning. The data that has been processed will be taken and used to be visualized to make it easier to find assets in each room in the hospital.

F. Comparison with Previous Researchers

Table 1 Research Comparison

Aspect	This Study	Feibe Lawalata dan Eko Sediyono [14]	Ardiansy dan Effiyaldi [15]	Febriani et al [16]
Main Focus	Automated asset detection and management using AI	Spatial asset management	Website-based hospital management information system	Enterprise architecture of asset management information system
Method/Framework	Iterative incremental with YOLO implementation	Quantum GIS dan Web-GIS	Waterfall	Zachman Framework
Main Technology	AI (Model YOLO), Web service API	GIS, Web-GIS	Website	Enterprise Architecture
Data Storage	SQLite (local) dan MySQL (server)	MySQL	MySQL	MySQL
System Scope	Asset detection, asset management, visualization	Mapping and management of spatial assets	Registration, inpatient, outpatient, pharmacy	Hospital asset management
Level of Automation	High (automatic detection and processing)	Medium (manual input with automatic visualization)	Low (manual input)	Medium (framework for automation)

Based on the comparison with previous studies, this research shows some significant advantages and innovations in the implementation of hospital asset management systems. First, the use of artificial intelligence (AI) technology with the YOLO method for automatic asset detection is a breakthrough that has not been found in previous studies. This results in a much higher level of automation compared to other systems that still rely on manual input.

Second, the integration between AI and web-based asset management systems creates a more comprehensive solution. This approach combines the automation of AI with the accessibility of a web-based system, providing added value not found in other studies that tend to focus on one aspect of the technology alone.

The methodology used, Iterative Incremental with YOLO implementation, provides a flexible and adaptive approach while utilizing the latest AI technologies. This method supports incremental and iterative system development, which is well suited for the implementation of complex technologies such as AI. This approach differs from the more rigid waterfall method or other enterprise architecture frameworks used in previous studies, providing flexibility and immediacy in system development.

Overall, this research shows significant innovation in the application of AI for hospital asset management. The resulting system offers a more automated and integrated solution compared to the traditional approaches found in previous studies. This opens up new opportunities in improving the efficiency and effectiveness of hospital asset management in the digital era.

IV. CONCLUSIONS

This research successfully developed a health asset detection architecture in hospitals. The detection system will work automatically using technology selection in the form of machine learning with the YOLO model. The system is also proposed to be integrated with the SQLite3 database as a local database. The system saves the detection results automatically into the SQLite3 database on the local device and then sends the data to the central server via API. On the central server, the received data will perform post-precessing to select and store data with the highest confidence score in the MySQL database. The results of this implementation show that the system speeds up the data processing process and reduces manual recording errors. This automation in data collection and transmission can reduce the time and risk of errors that often occur in recording using manual methods. With more accurate data and precise analysis, this system can support better and more efficient decision making in asset management, improving the efficiency of recording and tracking hospital assets.

V. SUGGESTION

This paper discusses the architecture of an object detection system for health assets. In the future, an implementation can be built for each module. The first module is related to object detection using YOLO-based deep learning. The second module is data collection and data processing. The third module is data visualization in

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the form of an application. The implementation of these modules can enable the system to detect objects more quickly and accurately, can manage hospital asset data in real time, and can also present the information more interestingly.

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