Water resource analysis with artificial intelegence for urban risk mitigation management using Hydroflux

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Abstract. With so many threats of natural and non-natural disasters, flood must be anticipated with technology based management. Nowadays society 5.0 is the solution to many of the change facing Indonesia, such as implentation of artificial intelegence for early warning system and decision support system of flood disaster mitigation. So, singularity technology needs for resolve the problems. This research is a preleminary test of Hydrolux sistem. It uses computer vision technology in measuring the water level, monitoring the area, and detecting objects (garbage). The sampling process conducted with creating the AI model by collecting the garbage data, data annotation, collect the SSD object detection model, transfer learning, convert to intel OpenVINO, optimizing the model, and run the model in intel NCS2. The result of this research is an informative research frameworkd and reference point for academics, government, and practitioners.

Keywords: Flood, Artificial intelligence, Hydroflux, Urban risk mitigation

1. Introduction

On urban context, water management covers many aspects from urban resilience, flood prevention, rainwater management, and disaster mitigation (1). The water management perspective are various according to needs, such as infrastructure development, environment engineering, and regional planning.

Nowadays, time allocation and data accuration are considered in order to be able to produce water conditions analysis rapidly. Decision making by policy makers must also be based on the results of the analysis (2). This is the background for the new paradigm to manage and intervene water conditions with the latest technology, one of which is the application of artificial intelligence. The application can be carried out starting from regional planning, infrastructure development, to the implementation of water sensitive urban design (WSUD) approach in urban water management (3–5).

The trigger of flood can be caused by very large rainfall or the inability of rivers to drain water due to sedimentation, garbage, or other factors. Urban drainage also affects the ability of rivers to maintain their discharge capacity, although the variables that determine the effectiveness of drainage are also influenced by many other factors (6,7).

The implementation of technology in water management and flood disaster mitigation is not new (8), including how to incorporate it into the concept of sustainable development and green infrastructure (5,9,10). This concept is very useful for humans in intervening and making policies related to the management of flood-prone areas. Thus, sustainable flood management infrastructure requires not only technology but also policy approach (2,11). Information technology also plays an important role because data-based infrastructure management will save time significantly (12,13), and the efficiency of data analysis using artificial intelligence will increase the accuracy of the results and make proper recommendations for stakeholders (14).

Kali Bambe is located in Bambe Village and has a water guardhouse that monitors the condition of the water level regularly. With a width about between 25-60 m, the water flow are relatively high-speed. The main problem in the Kali Bambe area is the silting of the river caused by garbage and wild plants, cause reached the residential area of Bambe Village.

Fig. 1. Conditions of Kali Bambe in the Brantas Watershed

The existence of the Kali Bambe water guardhouse is not significant in anticipating the frequent flooding. This is because the technology used is still manual and relies on humans as operators, especially in monitoring. Discharge measuring devices installed on the river side are often damaged. The installation of more complex equipment has new risks due to its large size which makes it susceptible to damage due to activities around the Bambe River. Therefore, it is necessary to apply technology that can work much better and more effectively. This research is motivated by the need to apply automation technology and artificial intelligence to replace manual tools used in Kali Bambe.

2. Methodology

The water level detection system is designed with video analytic technology (computer vision), sensors, and dashboard management to monitor inputs obtained from source (CCTV and IoT sensors). It is formulated according to the analysis needs of the relevant departments. With video analytics, the system will detect the character (water discharge, water level, etc.) and the movement of the river flow so as to provide notification and alert system for the analysis.

The first step to get the water level data with traditional methods, using eyes inesfficiency and get intuition. In order to recognize the water level, remote checking using hikvision camera. Then the Hydroflux system accomodate water management with a single dashboard that makes it easy for user to get a realtime information.

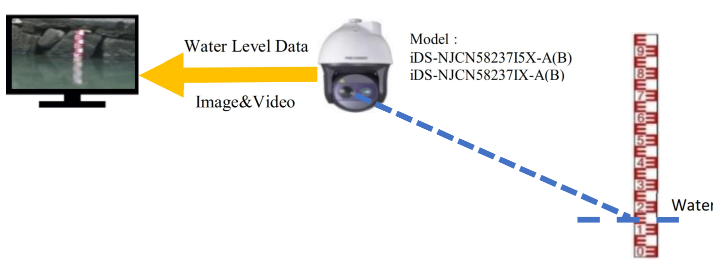

Fig. 2. Principal conceptual framework of Hydroflux

Hydroflux is installed on side of the Bambe River with a safe and affordable installation point for maintenance at any time. The installation process is carried out in the field and the control room in the supervision office. After the system is confirmed to work properly, the process by Hydrolux can be carried out. The data will be received in real-time.

Fig. 3a **Fig. 3b**

Fig. 3a shows the installation with aluminum frame construction holding the device case. When the protective case is removed, the device appearance shown in Fig. 3b.

An analysis was conducted of programme structure with spesific algorithm and used by hydroflux to operate a proper task. Hydroflux uses computer vision technology in measuring the water level, monitoring the area, and detecting objects (garbage, wild plants, etc.). The sampling process conducted with the AI model by collecting the garbage data, creating annotation, and raising the SSD object detection model. The next step is transfer learning, then converting it to intel OpenVINO, optimizing the model, and running the model in intel NCS2.

3. Result and discussion

The preliminary test of the Hydroflux in this research was carried out for 28 days. The tool works 24 hours a day and during its daily of operation. Hydroflux did not experience any disturbances or system errors. By the system, measurements do not use any sensors that enter or touch the river, instead it uses computer vision or vision based artificial intelligence methods to detect speed and use volume measurements with speed detection results. Discharge measurements validation is next important step, then it uses propeller sensors that are already owned by recording speed at time and same place.

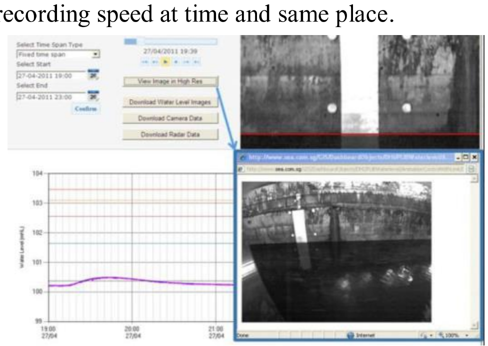

Fig. 4. Picture series of data analysis from the field shown in real time

The notable result of this preliminary test of Hydrolux are:

1. Capable to define multiple levels of interest within a frame;
2. Send desired alerts or early warning alert whenever the water begins to exceed various predefined levels of interest;
3. Records every event happens within the camera view and IoT sensors, provides real time comparison to monitor the trend of hotspot areas;

4. Capable to calculate water debit, the amount of moving flow and measured for its volume, flow rate, and flow velocity;
5. Automatically measure water level, rating curve to get exact and real time report into dashboard; and
6. Object recognition is used to detect and count garbage with RGB optical on CCTV for garbage data and analysis.

4. Conclusion

Preventive & predictive measurement is one of the keys that could not be left out in a public security and safety management system (15). That is why with the implementation of AI technology, it might help stakeholders in identifying the water level in a specific area, based on the visual characteristics of water. This information could be translated into an alert system, or visualized for further predictive analysis based on its trends.

Hidroflux is a kind of system that applies Smart Water Management (SWM), which offers near real-time visibility across the state's water assets through video analytic. It is going to be more useful when AI and sensors combined, that transmit information on water levels and flows.

Table 1. Comparation between Hydroflux and Conventional Tools

Variable	Hydroflux	Conventional Tools
Real-time calculation	Yes	No
Data collection automation	Yes	No
Contacless	Yes	No
Durability	More	Less
Installation cost	Medium	Low

From the following table we can see the comparation between the performance of Hydroflux and conventional tools from several variables.The system on Hydroflux will provide real-time information about the actual DAS brantas conditions with data input from CCTV and IoT sensors so that it becomes history for the traceability data process. With the flow charts that have been obtained, system will provide the results of the formulations that have been determined in the system. Data processing runs autonomously and provides information as a decision in taking action. The results of data processing will be analyzed with the relevant departments and are able to provide performance reports, track and trace and predictive analysis.

The application of Hydroflux as a new technology for water management, especially in flood-prone areas is very effective. With the easy installation of the tool, the implementation of this tool is very helpful in collecting data and analyzing quickly. Another advantage is the durability of the tool which is much longer than conventional tools which are still manual and usually easily damaged. With all these advantages, this tool is highly recommended to be installed in rivers that have the potential for flooding, especially in urban areas.

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