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LITERATURE SURVEY ON DAM AUTOMATION

Anita P[1] ,Prajwal R[2], Pratham R Shanbhag[3], Preksha S[4], Sanjana V[5]

Assistant Professor, Dept of ECE, K.S Institute of Technology, BENGALURU, INDIA[1]

Dept of ECE, K.S Institute of Technology, BENGALURU, INDIA[2]

Dept of ECE, K.S Institute of Technology, BENGALURU, INDIA[3]

Dept of ECE, K.S Institute of Technology, BENGALURU, INDIA[4]

Dept of ECE, K.S Institute of Technology, BENGALURU, INDIA[5]

Abstract: Management of dams today involves use of dam monitoring ecosystems that incorporate various technologies such as automation of pumps, detection of cracks, as well as pollution control of water bodies The proposed architecture works as a system on top of comprehensive interfacing with the sensors and also in real time protecting the walls of a dam. Raspberry pi, ultrasonic sensor, turbidity sensor, flex strips, rain sensors are interfaced with microcontroller to send the water level and open the walls of the gate and turn on the pump automatically and the buzzer goes before opening the walls. Flex Strips are used to detect the crack in the dam hence notify that through GSM module and send an SMS . Hence with the above working makes dam work automatically in real time application.

I. INTRODUCTION

Dams are critical infrastructures that play a vital role in water management, flood control, and hydroelectric power generation, making their structural integrity paramount for safety and environmental protection. However, the challenges of deterioration over time necessitate effective maintenance strategies, as traditional inspection methods can be labour intensive and may overlook critical issues such as cracks. Recent advancements in automation technologies have begun to transform dam monitoring, enhancing the efficiency and accuracy of inspections through innovative techniques like image processing, deep learning, and remote sensing. These methods not only facilitate the early detection of structural anomalies but also reduce human error, paving the way for more reliable and proactive maintenance practices.

II. LITERATURE SURVEY

L RaviKumar, Jayalakshmi Rajeevan, Kavya Baiju, Manish Varghese, Nimmy Agnes, S. Gajendra Babu proposed “Dam Automation and Application Using IOT-(A Prototype Model Study)” where a Nodemcu is integrated with a pump, ultrasonic sensor and a relay module. The proposed automated mechanism of water level monitor ,control and alerting system using sensor, NODE MCUV2 in dams ensure efficient as of available water resources and it will generate more precise and accurate result which is one of the best method overcome manual judgement. There is no requirement of manual effort to monitoring the level, everything is automatically operated.[1]

Kesthara V, Chandan Sharma B R K, Suhas S Kashyap, Prajwal Telkar, Pradeep S proposed “Automated Dam Controlling System Using Draught Analysis” Microcontroller(Arduino UNO R3) is programmed initially to check the soil moisture sensors data as well as overall Dam water present with ultrasonic sensor , the data was matched with the algorithmic data and based on optimum values of algorithm the solenoid valve would open or close with help of relay based on moisture values present at the particular area , the data would be then sent to database through Wi-Fi connection with help of Wi-Fi module(ESP8266) module which sends the individual soil moisture data at the places installed as well as the Dam water which would be allocated to respective channels. An algorithm to be built for Dam water distribution across different channels and testing of the algorithm to its efficient use to be done.[2]

Vishal Wankhade, Aniket Thakker, Dishant Vakte, Harish Sadashiv Motekar proposed “Smart Dam System” where an Arduino with temperature sensor, ultrasonic sensor, piezo sensor, lcd to monitor normal water level and temperature the green LED is lit and the doors (micro servo) is closed. Lcd displays normal temp and message. High water level and normal temperature .
The red LED is lit, the piezo is triggered and the door opens. Lcd displays alert. Normal water level and low temperature, the red LED is lit, the piezo is triggered and the door opens partially.

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High water level and low temperature. The red LED is lit, the piezo is triggered and the door opens partially.[3]

Dr. Nagesha Shivappa, Aishwarya S Rao, Aishwarya T,Jahnavi S Athreya, Mandakini H. proposed “Dam Automation using IoT” where the entire system is switched on and a link is developed between the network and the raspberry pi. The sensors take reading of the respective parameters which are placed on different positions of the dam. Water flow sensors are placed at the dam gate exit and the
amount of water flowing out is displayed on the command window. Turbidity sensor is placed inside the dam and monitors the suspended particles. Metal corrosion sensor is also placed inside the dam and it indicated a message when it come across any metals. All the above data is sent via cloud to Thing-Speak and the data can be viewed by the authority.[4]

Watanabe Naoki, Takago Ryuei, Suzuki Masako, Hadama Satoru proposed the paper "AI Utilized Dam Optimal Operation System" discusses the development of an artificial intelligence (AI)-based system designed to optimize dam operations, particularly for hydroelectric power generation, flood control, and water distribution. The system integrates AI algorithms to analyze historical data, weather forecasts, and water flow patterns to predict the most efficient dam operation strategies. By using machine learning models, the system enhances decision-making and adapts to real-time conditions, aiming to maximize energy production, improve water management, and reduce the risk of flooding or dam failure.[5]

Yandamuri Sai Prudhvi, K. Santhoshi, K. Umesh, C. Nihanth, Yarram Prathyusha “Water Level Monitoring And Dam Gate Control Over Iot”. The prototype of the proposed idea has been implemented using Ultrasonic sensor, Flex sensor, Arduino and servo motor. The first stage of the implementation was to determine the level of water using ultrasonic sensor. The ultrasonic sensor was mounted on top of a water container to determine the distance between the top of the container and the surface of the water. If the distance goes below a certain point it indicates that the water level in the container has reached a threshold value that is setup and the IOT module sends message to inform the concerned authorities as well as the residents near the dam warning them that the shutters will open soon. After that the shutters are opened by servo motor. When the water level goes below the threshold value that is setup the shutters are closed.[6]

Yang Chao ORCID, Chaoning Lin, ORCID, Tongchun Li, Huijun Qi ORCID, Dongming Li and Siyu Chen proposed the paper "An Automated Framework for the Health Monitoring of Dams Using Deep Learning Algorithms and Numerical Methods" presents an integrated system combining deep learning and numerical methods to monitor the structural health of dams. The framework utilizes sensor data, including stress, strain, and vibrations, processed by deep learning algorithms such as CNNs to detect anomalies and predict potential failures. Numerical simulations, like Finite Element Analysis (FEA), complement this by modeling the dam's physical responses under different conditions to validate predictions. The system operates in real-time, issuing alerts for maintenance when abnormalities are detected, offering a proactive approach to dam safety. This automated framework ensures efficient, accurate, and reliable monitoring, reducing risks and enhancing structural integrity management.[7]

Biao Liu, Xiaohui Gong, Tao Meng, and Yufei Zhao the paper “Research on Key Technologies for Intelligent and Fine-Grained Construction of Earth–Rock Dams Based on Artificial Intelligence” outlines the development of key AI-driven technologies for the fine-grained construction of earth–rock dams. It emphasizes the use of advanced data collection systems, such as IoT-enabled sensors and drones, to monitor construction parameters in real time. AI algorithms process this data to provide insights into material distribution, compaction quality, and structural stability. Machine learning models are employed to optimize resource allocation and predict potential risks during construction. Additionally, the study introduces automation technologies, including autonomous machinery and robotics, to ensure consistent and precise construction practices. By integrating these AI-driven solutions, the paper demonstrates how intelligent systems can enhance safety, reduce human error, and achieve high-precision outcomes in earth–rock dam projects. The research offers a blueprint for adopting AI in large-scale infrastructure development, paving the way for smarter and more sustainable construction practices.[8]

Ramakrishnan Raman, Trupti Rathi “Management Using Cloud-Based Data Analytics and LSTM Networks” The system proposed in this combines IoT sensors, cloud computing, and machine learning to optimize dam water management. Real-time water level and flow data are collected from sensors and transmitted to a cloud-based platform for storage and processing. Using historical and real-time data, an LSTM network—a deep learning algorithm designed for sequential data—predicts future water levels and inflow patterns with high accuracy. These predictions are used to automate dam gate operations, ensuring optimal water release for flood prevention and resource allocation. The cloud infrastructure enables seamless monitoring and decision-making, providing stakeholders with a scalable and efficient solution for dam management.[9].

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Prof. Atul Atalkar, Mr. Shivajiroa. S, Mr. Harshvardhan Rethrekar, Mr. Kunal Bauskar, Mr. Abhishek Chindane Manjare "Dam Automation Using IOT". This paper introduces an IoT based dam automation system. In this paper they have interfaced an ESP32 microcontroller to a level sensor and a turbidity sensor. Using ESP32 and specialised sensors, set up continuous monitoring to get exact data on flow, turbidity, levels, and corrosion. Reducing mistakes and dangers related to manual data gathering while enhancing data accuracy through the integration of modern sensors. Creating an early warning system to identify departures from norms so that possible problems may be addressed in a timely manner. Data analysis and well-informed decision-making are facilitated by the seamless integration of data into Thing-Speak for storage and accessibility, or Cloud Integration. By giving interested parties access to an Android app, quick action is ensured by allowing them to monitor dam conditions, examine historical data, and get alert messages.[10]

Dhananjali Singh, Ansh Jadaun , Ashish Sharma , Mohit Pratap Singh proposed the paper "Arduino based Dam Automation" This research paper explores the application of Arduino-based systems in dam automation to enhance operational efficiency and safety. Dams are critical infrastructures that require constant monitoring and control to ensure proper functioning and mitigate potential risks. Traditional dam operation methods often rely on manual intervention, which can be time-consuming, error-prone, and risky. By leveraging Arduino microcontrollers and associated sensors and actuators, dam automation systems can provide real-time monitoring, data analysis, and automated control, leading to im- proved efficiency, reduced operational costs, and enhanced safety measures. Here an Arduino is interfaced with level sensor to sense water level and update via Blynk. [11]

Mr. Pramukh J S, Mr. Prajwal H B, Mr. Prajwal S B, Mr. Sagar K M, Dr. Trupti S Tagare "Review on Different Methods for Smart Dam Operation and Water Monitoring".This study leverages IoT technology to create a real-time monitoring and control system for dam water levels. The proposed system employs sensors to measure water levels, microcontrollers for processing data, and actuators to control dam gates. The automation process ensures timely gate adjustments based on predefined water level thresholds, reducing the need for manual intervention. The model emphasizes the potential of IoT in improving safety, optimizing water flow, and preventing structural damage or flooding. Through a small-scale prototype demonstration, the study validates the feasibility of implementing such systems in real-world dam infrastructure, highlighting their practicality and efficiency.[12]

Kristina Huddart, DAM Specialist and Consultant published "The State of AI in DAM 2024". This report summarizes key findings from a survey of over 200 Digital Asset Management (DAM) users, consultants, system integrators, and AI vendors. It provides insights into current AI capabilities utilized in DAM systems, challenges faced, and future expectations, highlighting the intersection of AI and digital asset management.[13]

III. CONCLUSION

Dams are an important structure in many parts of the world and their security is paramount. Automation dam systems are useful as they allow the operator get real time information via the multimedia platform on the conditions of water flow, the structure and even the environment. With access to critical information, the operator is able to reduce human errors and perform the necessary maintenance. Crack detection techniques such as sensors, drones, and deep learning have made an easy task of detecting any fault on a dam, thus aids in repairing it before it is too late. In general, these technologies are useful for improving security, improving resource allocation, and reducing maintenance for both environment and communities, and infrastructure. With time, the future of development will improve the sustainability and resilience of the dam.

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