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Internet of Things Over head Conductor to Maximize a Small Hydropower Project's Efficiency

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Abstract- Smart buildings and towns quickly use IoT applications to save energy usage. Because of this development, there is presently a lack of understanding among professionals in the construction sector on how to utilize IoT to attain energy savings efficiently. An exhaustive overview of Internet of Things (IoT) applications for building and urban energy reductions is the goal of the research. By assisting professionals in the built environment in making use of IoT technology, this research contributes to the Internet of Things (IoT) area. This research reviewed the literature extensively to provide a comprehensive overview of the Internet of Things (IoT) and its potential ideas, models, applications, trends, and difficulties in the built environment. The results showed that experts in the sector don't fully understand the technologies and how to use them, which makes it hard for them to create Internet of Things (IoT) plans for buildings and cities. When it comes to the Internet of Things (IoT) and its integration with the built environment, the research also discovered endless implementation and limitations. The report concludes with several important points and recommendations for moving forward with energy-efficient IoT implementation.

Keywords-Hydroelectricity generation, Renewable energy, Internet of Things; Overhead Conductor

I. INTRODUCTION

The proliferation of Internet of Things (IOT) devices is directly proportional to the growth in demand for IOT applications. Great security issues are faced by IoT systems that use centralized server mode. One possible answer is blockchain, which depends on a distributed ledger system [1]. One potential method for accurately extracting information from raw IoT sensor data is distributed deep learning implemented in an edge computing setting. As a result of the frequent transfer of gradients, distributed training experiences substantial communication overheads among a master node and several compute nodes, limiting the training efficiency of distributed deep learning [2].

One of the biggest problems with the expanding IoT network is keeping up with all the new gadgets connecting to it and making sure the network can handle all the data they're sending and receiving. In light of the limited resources available to an IoT network, routing protocols are able to expedite route discovery as well as network maintenance [3]. Industrial Internet of Things (IIoT) networks may benefit from massive multiple-input multiple-output (MIMO) because to its high spectral efficiency (SE) with energy efficiency (EE). The instantaneous circuit gain converges to its average value via little variation due to the channel hardening consequence of massive MIMO. This allows for simplified scheduling and minimal downstream reference signal (RS) transmission [4]. In narrow-band Internet of Things (NB-IoT) systems that use orthogonal multiplexing of frequencies (OFDM), the repetition mechanism is frequently used to increase the feasible signal-to-noise ratios at the receivers by transmitting the OFDM symbols of subscribers multiple times repeatedly. Spectral efficiency has degraded since each OFDM symbol's cyclic prefix (CP) has been sent twice [5].

II.RELATED WORK

The author suggests an LBLCO, or lightweight blockchain, with little communication overhead, in reference [6]. In LBLCO, a novel consensus mechanism called HPORS (proof of reputation score using a hidden block) is suggested. Nodes with better reputation scores have a better chance of winning HBPORS. In the blockchain system, nodes' reputation scores are constantly updated via the repute score system based on their contributions and any malicious conduct.

The hidden block method may be activated when an honest node with a high reputation score gets the accounting straight. Winners may broadcast low-overhead information to various nodes instead than broadcasting the whole bundled block information to all nodes. Experiments have shown that LBLCO can handle the high volume of nodes and lightning-fast response times needed by the Internet of Things.

To increase the training efficiency of distributed deep learning and decrease communication overhead, we provide a new approach in [7] called ProbComp-LPAC (ProbComp: likelihood compression and LPAC: layer variables adaptive compression). Using a probability equation, ProbComp-LPAC applies varying compression rates across deep neural network layers. Adaptive compression (AdaComp) and lazy aggregated quantized compression (LAQ) are two competing approaches; ProbComp-LPAC outperforms them both in terms of training time and test accuracy. Finding appropriate IoT routing protocols using a qualitative technique and factors that impact network performance are the primary contributions of the

study [8]. One proposed standard that aims to address the needs of Low Power and Lossy Networks (LLN) is the Routing Mechanism for Low Power and Lossy Network (RPL), which is a proactive distance- based routing protocol. Using the Cooja simulator, this study investigates four parameters that affect RPL performance in Contiki OS. RPL performance is then evaluated based on PDR, energy usage, and overhead control message for the entire network. Considerations like as network scale, node mobility, transmission ranges, and traffic patterns are explored in this study.

While the PDR and overhead proportion rise in direct proportion to transmission distances, they fall in response to rising levels of radio interference, according to the simulation findings. From a mobility perspective, expanding the mobility nodes reduces PDR with an average of 19.5%. According to the results of the study in [9], we provide an adaptive switching strategy that can switch between utilizing downlink RS and not using it depending on the scenario by analyzing the effectiveness of the channel hardening impact in relation to the variable's fluctuations.

The signal-to-interference plus noise ratio (SINR) may be reduced and available time and frequency resources can be enhanced by not using the downlink RS. Downlink RS, on the opposite hand, may boost SINR at the expense of certain frequency and time resources. The suggested method switches modes depending on different conditions and identifies the one with the best performance. A valuable tool for improving the performance of large MIMO-based IIoT networks, the suggested approach can accomplish substantial SE improvement while little system overhead. Create a flexible CP-free repeating strategy and submit it in [10]. When symbols are conveyed several times using our method, most CP overheads are eliminated. We show clearly that the investigated approach preserves the applicability of the basic single-tap equalization for receivers, free from inter-symbol interference. The next step is to build the channel estimation technique for the CP-free protocol that has been devised. Bit error proportion (BER) and mean square error (MSE) computational simulations have been performed to verify the efficacy of the proposed approach.

III.PROPOSED WORK

1. Methodology

With the use of the internet of things (IoT), this study intends to assess and implement the blueprint for a modest hydroelectric facility situated on a stream in São Vicente, Madeira Island. Hydropower design studies make use of photogrammetry as part of a larger digital transformation that includes new ideas, models, and approaches like machine learning (ML) and big data analytics to make use of the massive amounts of available time series. There are a lot of problems with the energy with digital transition right now, but digitization and the availability of enormous amounts of data are forcing new solutions. This research presents an integrated methodology utilizing novel techniques assigned through an internet protocol system. It relies on a simple small hydropower development and uses various components that involve GIS, photogrammetry, and advanced tools.

With the help of an internet-connected drone survey, the researchers are able to generate estimates based on experiments, characterize the site in situ, treat hydrological data, perform hydraulic calculations, and estimate the economic impact of a real hydro project. Consequently, in order to find the optimal energy and digital transition solution, the Internet of Things application platform conducts hydrological variables, hydraulic analyses, and topographical surveys with the help of new tools and methods. This allows for the optimization of hydraulic structure size, as well as the estimation of the hydropower plant's performance and potential. Following the definition of the database used for the whole research and posterior assessment of the hydropower plant case study, the relevant analyses and findings are provided.

Next, taking yearly energy output into account, we estimate the costs of building, maintenance, and administration of the chosen components that make up the hydroelectric topology, and we calculate the economic balance for each. The article goes on to cover ROI in terms of both money and the planet. At last, several economic factors are considered in order to establish the project's viability, and an analysis is set up to compare the estimated costs with the advantages of hydropower production using this novel technique. Hydroelectric power generating and monitoring systems are the main topics of this article. Every day, more and more of the globe is becoming technologically advanced. This is why we should expect an even more dramatic increase in energy demand in the days ahead.

However, we have not been able to meet the adequate power demands of emerging nations just yet. At this point in time, it is a necessary evil for the 4.0 industry to endure. Utilizing the little water sources found in many multi-story structures, such as washrooms, kitchens, etc., this "Future Micro Hydro

Power" technology will produce electricity. The household uses an enormous quantity of water on a daily basis. All contemporary structures, including dwellings, have water faucets. We have shown how these little water sources may be used to power a dwelling using hydropower. The user may track their energy production and utilize it as needed from this location. The gadgets will have far better performance for substantially less money. Data showing its exceptional efficiency was obtained after the trial installation.

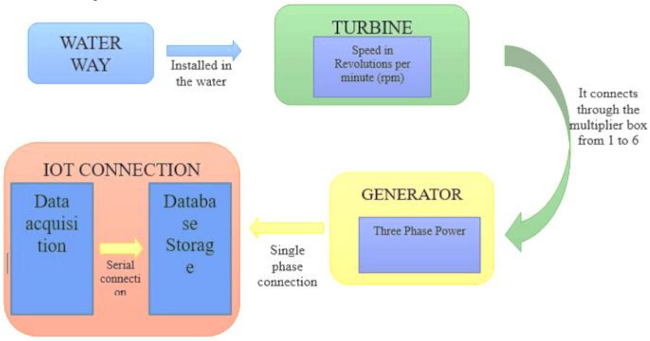

Fig.1. Hydro Power Plant Model in IoT

2. Hydro Power Plants

Factors such as hydrological radiation, transmission system, facility type, capacity, head, and purpose are used to categorize hydro power facilities. In terms of capacity, pico-hydro power production systems are well-suited to small rural communities that have occasional or occasional power demands. In most cases, pico-hydro power generating systems are limited to producing less than 5 kW. This kind of system is often seen in rural regions and is called run-of-the-river. It employs pipes to redirect the water's flow. For this system to work, the flow and the head are crucial. The water pressure that controls the water's vertical fall is the head component. This part also raises the water intake and turbine to a certain level. An essential component of using water power is the flow. The amount of water or the rate of water flow is defined. The maximum stream flow is often smaller than the estimated maximum flow in a typical situation. Due to the fact that the Pelton turbine requires a constant supply of water to operate, this project is set to be executed in the Philippine provinces of Fugato along with Aurora

3.Machine Learning

There are several aspects of the energy sector that might benefit from the widespread use of Machine Learning (ML), a digital revolution that is attracting increasing interest from management bodies, academic institutions, and businesses alike. ML encompasses new ideas, techniques, and models. Big Data analytics, the Internet of Things (IoT), and machine learning (ML) are crucial in this context because of the abundance of data that can be used for hydrologic studies and photogrammetry surveys (Brown, 2016; Cheng et al., 2019; Chiara et al., 2020). There are new possibilities for solving many of the energy sector's present problems because to digitization and the availability of enormous amounts of data.

Current techniques for analysis, modeling, and improvement in the energy industry may be improved or even revolutionized by their digital approaches and technologies (Barros et al., 2003; Bathia and Sood, 2020). Hydropower plants throughout the world are embracing digital technologies and procedures for everything from planning and building to running and maintaining their facilities. Digital control systems that are smart may make hydropower plants work better and last longer. Advanced performance monitoring analysis helps optimize operations and maintenance while reducing expenses. The effective collection and analysis of data, however, presents a significant obstacle to making full use of the information it provides. The application of ML techniques allows for the extraction of useful information from massive volumes of potentially heterogeneous Big Data, such as streaming evaluations, batch data from assessment campaigns, and metadata, therefore revealing functional correlations between variables (Mitchell, 2017). Both reservoir-based and run-of-river types of problems may arise in hydropower facilities during short-term hydropower scheduling (STHS). Storage reservoirs and run-of-river plants work together in a cascaded watercourse.

Every reservoir has its own unique hydropower plant component, which might be distinct or same, and is linked to a water intake. Both producing and pumping units may be considered hydropower. Precipitation and streams are the primary sources of intake for hydropower facilities.According to Muñoz (2014), ML is the academic discipline that enables computers to acquire new knowledge without direct programming. To say that a computer program learns from experience E in relation to a task T and a performance metric P is to say that the program becomes better at T as determined by P as it gains more experience.

For the primary goal of dataset predictions, many ML methods have been used in hydropower scheduling. Support vector regression (SVR), clustering, Linear regression (LR), and fuzzy clustering are some of the most popular methods mentioned in published works. Fileo (2023) discusses Artificial Neural Networks (ANNs). The so-called "supervised learning" category includes LR, SVM, and SVR, while the "unsupervised learning" category includes clustering and fuzzy clustering. Beyond that. More complex methods like "deep learning" include ANN. The term "supervised learning" describes a method of machine learning (ML) in which an algorithm is trained to learn the mapping of functions from inputs to outputs using both the input and output variables. An adequate approximation of the mapping function should be obtained by the learning algorithm to enable the prediction of output variables in response to newly arising input data. Because an existing dataset is used to instruct the algorithm, this method is referred to as supervised learning. After training on one dataset, the algorithm may apply its knowledge to another.

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IV.RESULTS & DISCUSSION

The study's findings and comments go over the tool's performance during testing as well as its shortcomings. Both qualitative and quantitative methods were used to analyze the tool testing data. The tool's ability to successfully store electrical energy in the battery serves as the qualitative analysis. Changes in water volume impact the quantitative

analysis presented by this instrument in the way of voltage values and water current discharge data. For future studies, the tool's limitations may serve as a benchmark. An Android-based smart phone may access the MHPP's voltage monitoring interface with the blink software. The blynk app can be found on the Google Play Store and may be downloaded for free. Launch Blynk, then go to the Log In menu, then choose New Project. Then, edit the name and device settings of the project, and finally, click Create. The blynk software's authentication code utilizes a unique token. See Figure 4 for an example of how to copy and paste the authentication code or how to send it via email. As required, we may extend the blynk application using widgets. Figure 5 shows the widget that was utilized. The water flow sensors (V1, V2, V3, and V4), voltage sensor (V6), as well as servo motor controller (V5) will all provide data to the Blynk app's widget. The equation that shows the relationship between power, head, and flow is provided by,

$$P = HXQXg.$$

Equation shows the formula for calculating the fall and elevation.

$$\text{Volx}(h/H) \times \eta = Q'$$

When determining the power, the flow along with head are the most important variables to take into account. The amount of water that is saved and then used to spin the shaft is called the flow. The height at which water will fall is called the head. A spike in the flow rate causes the water head to rise, which in turn causes a greater amount of energy to be converted into electricity. Given that the relationship between flow and head and power is linear, we may deduce this from equations 1 and 2.

In comparison to solar panels and wind turbines, hydropower turbine generators are much more efficient. The remaining energy is wasted during the conversion of the mechanical power to electrical energy, however an effectiveness of around 70% may be achieved. The total power produced by the model may be determined using equation (2). The total head of the water is the height at which the water pressure acts onto the water turbine blades, turning the shaft and producing power. The whole quantity of electricity produced is shown in Table 2.

Table 2: Finding out how high above the water

S.no	Inlet height fall (m)	Input flow rate lit/min	efficiency %	Output flow rate lit/min	Total head (m)
1	1	0.5	60	1.5	2.5

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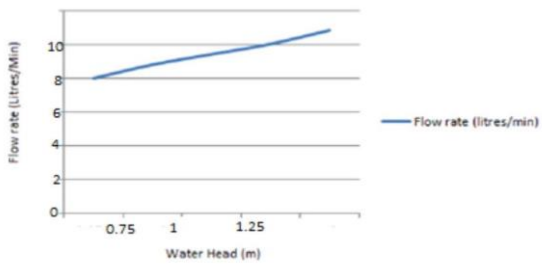

2: The relationship between the water head and the flow rate

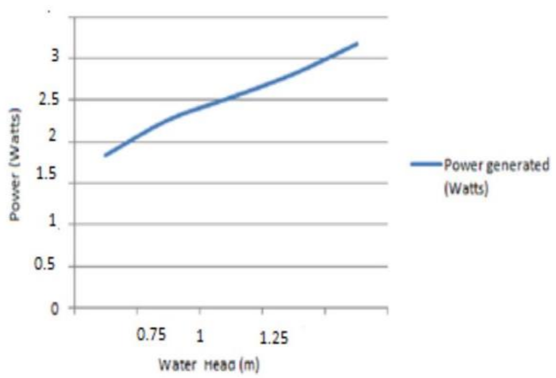

Figure 3: Power output as a function of water head in the system

The relationship between the water head and the system's power generation and water flow rate is seen in Figures 2 and 3. The graph clearly demonstrates that the power output and flow rate are directly proportional to the height of the water, or the water head. Figures 2 and 3 demonstrate that as the flow rate increases, so does the electricity produced.

V.CONCLUSION

In areas with intermittent or scarce energy sources, this project may be scaled up to a greater scale.

- It is possible to optimize the design so that it makes the most efficient use of the available head.

- You have the option to choose a more cost-effective, long-lasting, and dependable alternative material.

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