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A Study on Shrimp Farming and Surveillance

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Abstract: The present study provides a distributed monitoring system prototype and a proof of concept in this research article. Environmental control, as well as solid foundations like quality seeds and better food, are essential for successful shrimp farming. Nowadays, farmers manually and irregularly check the pond's environmental parameters, largely based on their own experience, which is time-consuming and costly in terms of labour. Monitoring is normally done only when the farmer notices an abnormality in the shrimp's condition or when the environment changes substantially. When this happens, the technique for rebalancing the farming environment is usually quite complicated and costly. As a result, environmental elements are ineffectively monitored. The proposed system is composed of a water quality monitoring system and a timer-based aerator automation system.

I. INTRODUCTION

In Thailand, traditional vast aquaculture has been practised for many years. Thailand's 2,700 kilometres coastline, warm and quiet seas, and abundant natural seed provide ideal conditions for shrimp cultivation. Initially, dykes were constructed around rice fields to keep wild shrimp seeds from invading the fields. Traditional agricultural operations along the coast had evolved as a result of the increased demand for shrimp in overseas markets. Thai farmers turned mangrove forestlands and coastal rice fields into shrimp ponds. Prior to 1984, Thailand derived up to 90% of its shrimp from natural resources, mostly the Gulf of Thailand. In the mid-1980s, a confluence of technological and economic circumstances enabled the development of a more intensive farming system based on hatchery-reared seed and formula feeds. Shrimp culture in Thailand gained up in the late 1980s, centring on black tiger prawns. As a result, the shrimp production structure steadily shifted from captured shrimp to cultured shrimp, with cultured shrimp accounting for nearly half of total production. Since then, the trend has continued, with cultivated shrimp currently accounting for 70% of total output [1].

After Nakon Srithammarat, Chanthaburi is Thailand's second-largest shrimp-producing province. Shrimp farming has grown exponentially in Chanthaburi province, as it has in other parts of Thailand since it began in the late 1980s. Shrimp farms mushroomed, boosting production by nearly tenfold from 315 in 1987 to 1,516 in 1988. With certain environmental benefits from the upper Gulf of Thailand, shrimp production in the province grew at a quicker rate than ever before, resulting in the rapid loss of mangrove forests and coastal environments. Between 1986 and 1991, a total of 12,100 ha of mangrove forest was lost (Charuppat, 1993), while the area of shrimp farms was increased by 11,675 ha. In Chanthaburi Province, there is a significant correlation between the reduction of mangrove forests and the corresponding growth in shrimp farming areas [2].

Moreover, Shrimp cultivation has progressed rapidly in the Mekong Delta in southeast Vietnam in recent years. Environmental control, as well as solid foundations like good seeds and high-quality food, are essential for successful shrimp farming. Typically, farmers manually and irregularly monitor the pond's environmental conditions. Due to abrupt climatic vacillation, which causes changes in water quality indicators, commercial aquaculture is facing a slew of problems. Manual testing is used by aqua farmers to determine the status of several water parameters. However, manual testing is time-intensive and produces inaccurate findings because the conditions for determining water quality are always changing. It would be preferable if automatic monitoring could be accomplished in some way [3].

To solve this problem, current technology should be applied to aquaculture. Technologies must support several essential application areas for rural development. For instance, living standards, well-being, and environmental change, to name a few. As a result, we must be more discriminating in selecting technologies that are fit for this type of development. In the present system, an integrated open-source IOT platform Node- MCU with an Esp8266 Wi-Fi module is employed as a data processing and storing device. As a result, there is no need for a separate Wi-Fi or internet module. Smartphones are widely available, and the majority of them now support Media Transfer Protocol (MTP). Our approach is unique since we use these and perform some analysis on the water quality factors.

II. SHRIMP FARMING INFLUENCE

The combination of coastal resources, farm inputs, and technology will not only generate shrimp but will also result in environmental issues. This study considers the environmental consequences to value the environmental costs associated with shrimp farming. Figure 1 depicts the potential consequences of shrimp farming [4].

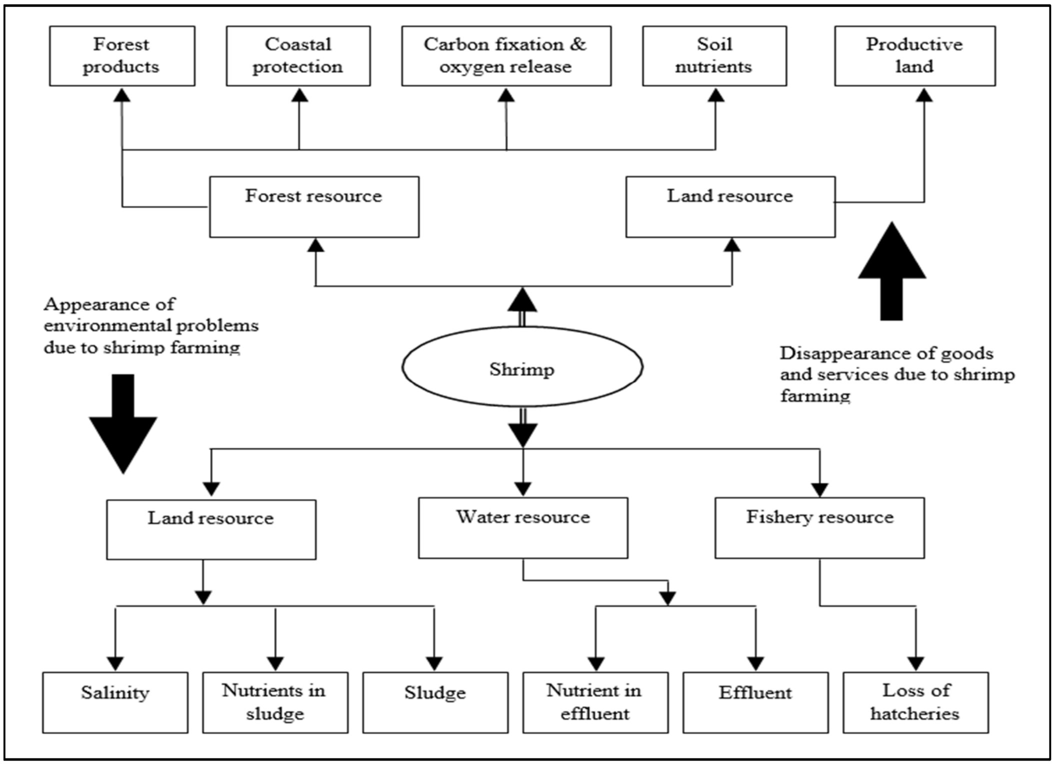

Figure 1: Influence of Shrimp Farming

A. Influence Over Land

The draining of wastewater and sludge from intensive shrimp farms is perhaps the most substantial environmental hazard. Before the pond sludge can be used for a fresh crop, it must be disposed of in some way. Sludge, which contains unconsumed feed, organic wastes, chemicals, nutrients, medications and antibiotics, solid wastes, and harmful microorganisms, is frequently disposed of in canals, marshes, and lands between farms. Soil salinization has also been recorded in Chanthaburi province as a result of shrimp cultivation. Because saline soil contains enough soluble salts to inhibit the growth of most crop plants, farm productivity suffers as a result [5, 11].

B. Influence Over Water

Generally, the load of effluent from shrimp farms surpasses the carrying capacity of receiving water bodies. Nutrients in effluent encourage eutrophication, which leads to the production of plankton in nearby estuaries or near-shore environments, as well as sedimentation. Nutrients from effluent and plankton, on the other hand, provide a possible food source for a variety of coastline fish [6].

C. Influence Over Forest

Clearing mangrove forests indiscriminately and extensively could have serious environmental, economic, and societal consequences. Mangroves and mud, in particular, play a vital role in regulating the nutrient balance in the coastal environment. Mangroves soak up nutrients as well as other contaminants before they reach the sea, while also permitting the tidal current's export of huge amounts of organic matter in the form of detritus, which supports the productivity of the neighbouring coastal environment. As a result, if any residual mangroves exist near the shrimp farm, they will operate as a "natural sewage treatment plant," collecting excess nutrients from wastewater. Mangrove forest destruction obstructs the natural processes of nutrition delivery, carbon fixation, and oxygenation release. Mangrove forests improve soil fertility by providing appropriate soil organic content, nutrients, and aeration through the decomposition of their biomass [7, 8].

D. Influence Over Piscary

Shrimp aquaculture destroys mangrove forests, which has a negative influence on fisheries production. Mangrove forests provide a home for the spawning and nursing of several marine fishes, oysters, and crabs, resulting in a fisherman's livelihood. The debris in these mangrove forest areas also provides important organic nutrients to the waterways, which serve as a rich food supply for a variety of coastal and offshore animals. The mangrove ecosystem, on the other hand, varies greatly from the submerged intertidal zone to the semi-terrestrial wetland, with significant differences in salinity, tidal regime, subsurface conditions, and water quality. As a result, the mangrove forest's contribution to fishery output is confined to subtidal and intertidal zones with acceptable water quality and a plentiful food supply [9, 10].

III. METHODOLOGY

The requirements of early detection of disease concerns and the ability to apply appropriate solutions before an epidemic becomes unmanageable for efficient shrimp pond management. Changes in the health of the shrimp in most ponds are only visible over time, depending on a combination of observations on shrimp condition, food consumption, water quality, and other factors. Moreover, any changes in the pond's environmental elements will contribute substantially to the shrimp's overall health deterioration. Environmental elements in the ponds are likewise varied and continually changing in numerous ways, depending on the region, weather, growing circumstances, and other factors. Shrimp farming has become much more difficult as a result of this. As a result, it's critical to properly monitor these conditions in terms of continuity, employing a sufficient number of monitoring sites to arrive at accurate representative monitoring. Sensor nodes can be placed inside the pond, saving money while also allowing for monitoring, control, and long-term research. In terms of systematic, responsive, interactive, and predictive behaviour, the proposed monitoring and control system should meet the following criteria:

1) Work to be done at the same place, same time eachday or each month.
2) Work to be performed and repeated at regularintervals.
3) The information must be available when required.
4) The information must be presented in an understandableuser-friendly way.
5) Allows user response based on the data collected toanalyze prospective problems.
6) Provides the ability to react promptly to theproblems encountered.
7) Data can be used for planning and decision makingin the future.

A. System Architecture

Three models of sensor nodes were used to support the scalability of the system. Initially, a sensor network was developed to collect information in each separate pond. The network will be made up of several nodes, each of which will be used to acquire important sensor data. The data is then sent to the Node-MCU via the Multiplexer. If the oxygen level is low, the oxygen pumping mechanism at each pond is controlled by Node-MCU. The Node-MCU communicates with the pond's sensor nodes. The suggested system's heart, an ESP8266-like management station, is created and is responsible for multiple functions such as gathering sensor data, managing oxygen pumps, and continuously sending data to the client-server, among others. The IEEE 802.11 standards were used for the design since it demands low power consumption. All wireless protocols used to communicate between nodes in sensor network systems are based on it.

B. Operational Principle

The data collected by the sensor nodes are forwarded to the Node-MCU, which is in charge of data transmission to the Server. The data is then analyzed and graphically presented on the Shrimp Framing Website. The data is delivered to the Node-MCU in a time frame that corresponds to each material-specific measurement parameter. According to the study of gathered environmental parameters, this time frame can be suitably altered. Figure 2 depicts the star topology for the present monitoring and control system

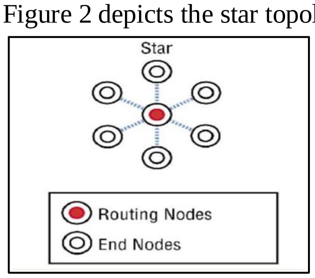

Figure 2: Star topology for the current system

The objective is to get the user to interact more with the system. The first option gives the user web-based access to information regarding pond environmental parameters. The web allows users to view data from anywhere they have access to the Internet. The online system provides users with up-to-date information about environmental conditions in the pond and allows them to control equipment remotely. It is quite useful for the user because they can obtain information or receive alerts (when the elements in the pond change and exceed a certain level). The system's implementation included protocol, hardware, and software development, according to the overall system architecture study.

C. Hardware Design

The main modules of the system consist of Analogue pH sensors, Analogue Dissolved Oxygen sensors, Water Temperature sensors, Cloud Server Gateways, Multiplexer and Node-MCU modules. The elements used are 1. Analogue pH sensors, 2. Analogue Dissolved Oxygen sensors, 3. Water Temperature sensors, 4. Cloud Server Gateways, 5. Multiplexer, and 6. Node-MCU modules.

The sensor module is used for data acquisition offering three basic environmental sensing parameters including temperature, pH level, and level of dissolved oxygen. For temperature measurement, we selected I-wire digital temperature sensor DS18B20 made by Dallas. DS18B20 measures temperature ranges from -55 to + 125°C and in the range of -10 to +85°C, the accuracy is ±O.5°C. It can connect to any GPIO port due to its digital output capabilities. For pH level measurement, we found that an "Analog pH Meter Kit" can provide us with a good solution. This kit consists of a pH sensor circuit board and a pH probe (BNC connector). It provides a full range of pH measurements from 0 to 14pH uploading data to the Internet. It works well under a temperature range from 0 to 60°C with high accuracy of ±0.1 pH. Simply connect the PH2.0 interface of the sensor circuit board to any analogue input pin of Node-MCU, we can achieve accurate data collection.

For DO measurement, our solution is based on a dissolved oxygen sensor from Atlas Scientific. This sensor device consists of the Atlas Scientific EZO class embedded D.O. circuit and a D.O. probe electrode. Together they offer a very high level of stability and accuracy. This provides a full range. D.O. readings from 0.01 to +35.99 mg/L and the accuracy is up to ±0.2. This device supports two data protocols, UART and I2C; therefore, it is compatible with any microcontroller that supports one of these two protocols. It also supports low power applications thereby reducing the power consumption on this device to only 0.995 mA at 3.3V. Figure 3 represents the overall functional design of the shrimp farming system.

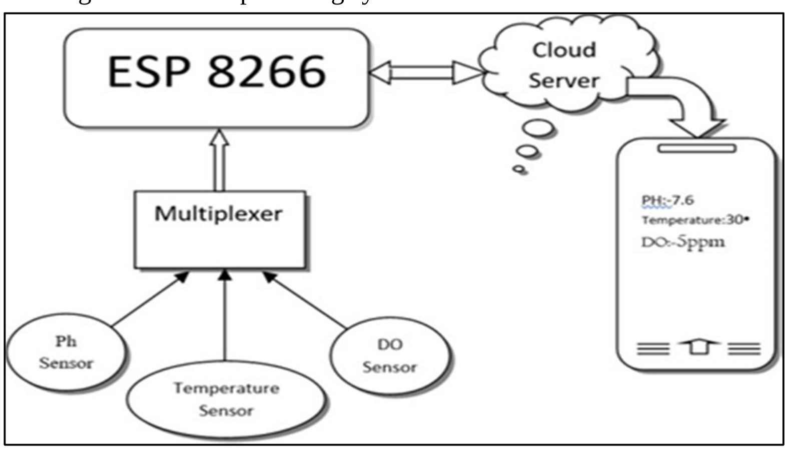

Figure 3: Functional Design of shrimp Farming

D. Software Design

This design adopts a cloud server as the gateway of the SHRIMP FARMING SYSTEM. Because the node used in this design is a Wi-Fi connection directly to the Internet, no local other device is required to forward data across the network. Therefore, cloud servers can be directly used for data processing, storage, and control commands. The system is used because it offers numerous benefits such as the system can install many development environments and operators have lower-cost control on cloud servers.

Ubidots was used to develop the monitoring software in this study. The gathered sensor data will be displayed in table form and waveform chart at the GUI front panel where the user can observe the data for up to 7 prior days. The data received will be compared with the predetermined threshold value to determine that these received values are within or out of safe range, then the system is able to give the appropriate warnings. Warning of any environmental factors will not only be displayed on and at the same time sent to the user's personal mobile phone. The status of the oxygen pumps is also displayed and this can be controlled manually on the GUI.

IV. CONCLUSION

In a developing economy, intensive shrimp farming is a classic example of a resource-based industry. It has a tremendous impact on the environment, affecting the entire coastal ecosystem. However, environmental costs are frequently overlooked, resulting in the underestimation of manufacturing costs. This phenomenon is regarded as an economic illusion resulting from the market system's failure because resource-based commodities do not reflect the full cost of production or the society's environmental impact. The present work designs execute a one-of-a-kind IoT-based aquaculture monitoring system. For convenience, Wi-Fi and the Internet are merged in this system. This research identifies a method for producing better results at a lower cost than other available solutions. Shrimp farmers can now avoid the time-consuming process of manual testing. Moreover, instant changes in the parameters of water can be detected. This will assist shrimp farmers in producing a larger number of shrimps, hence assisting in meeting the demand for shrimp. The system also offers great scalability for large-scale farming operations.

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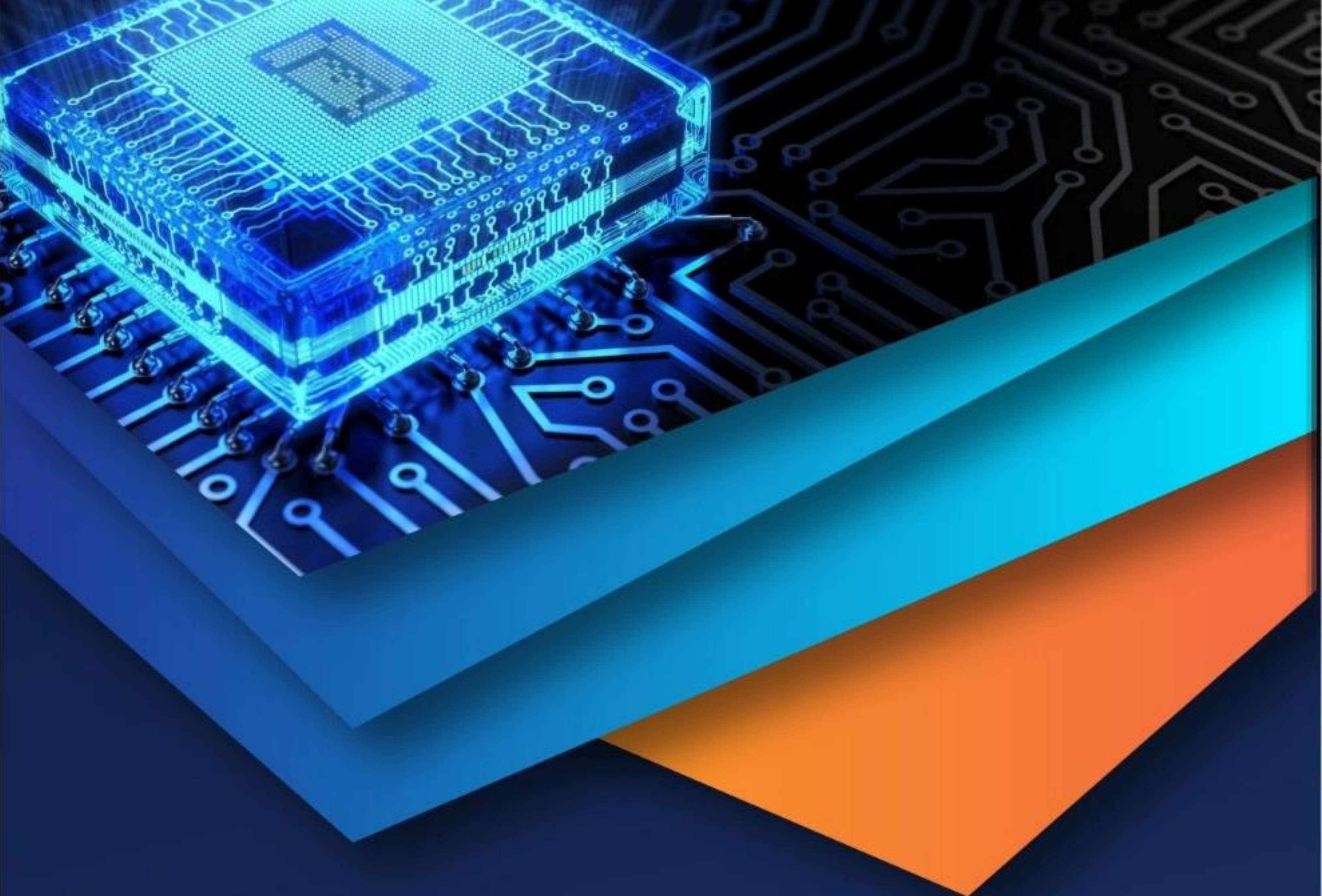

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