

Development of Wireless Smart Sensor System for Fish Image Observation

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Abstract-- The purpose of an observation platform is to send a real-time signal comprising information about oceans to an operation center. The observation platform is encased in a communication buoy. This article proposes a wireless smart sensor system for fish-image observation. The study used an image sensor to capture underwater fish images and a GPS module to receive position information. A 3G module was used for wireless transmission of the information. Moreover, an embedded system was used for power management to provide a stable power supply to maintain continual system operation. The proposed system can improve marine aquaculture and help in the monitoring of fish.

I. INTRODUCTION

In cage culture, the main environment is sea area with a radius of 20 km. The intensity of communication and the height of the coastal tower affect the reception intensity of 3G and 4G signals. The more intense the communication, the higher is the data transfer rate, which implies a higher transfer speed. The power module comprises a solar panel or wind turbine, and provides the required power for communication, data handling, and sensor operation. However, including a power supply to maintain continual system operation is challenging.

In this study, a method to develop an image observation system for ocean communication buoys was developed and experimentally evaluated. The paper is organized as follows. Section II provides a summary of the related literature. Section III presents the experiment settings. In Section IV, the implementation flow and reliability are investigated, and the observations are also discussed. Finally, the conclusions and recommendations for future work are presented in Section V.

II. RELATED LITERATURE

In recent years, wireless sensor networks have garnered increasing attention in the area of monitoring systems for marine areas, for example, using a smart sensor for monitoring information in aquaculture tanks [1] and recording videos of fish caught to determine their species [2].

In the method proposed in this paper, the system design is deployed and situated on the seabed with a cable connected to a buoy. The image data are then relayed through wireless communication to the operations center. The system is operated under the following assumptions:

- (1) The sensors must operate continually for a minimum of 15 days;
- (2) The system can be operated at a depth of 90 m;

- (3) GPS location of the system is necessary;
- (4) Data can be displayed on cell phones;
- (5) Biomass estimation and species identification is performed at the operation center.

III. EXPERIMENT SETTING

In this study, an image sensor was employed to capture underwater fish images, and a GPS module received position information regarding the fish. Moreover, a 3G module was used to wireless transmit this information. Fig. 1 shows the architecture of the system, which comprises the following components:

- (a) Control module (ARM development board)
- (b) 3G/4G USB(Universal Serial Bus) network card
- (c) USB UVC video capture card
- (d) CCD/CMOS image sensor
- (e) GPS module
- (f) 5V/12V battery
- (g) Server (operations center)

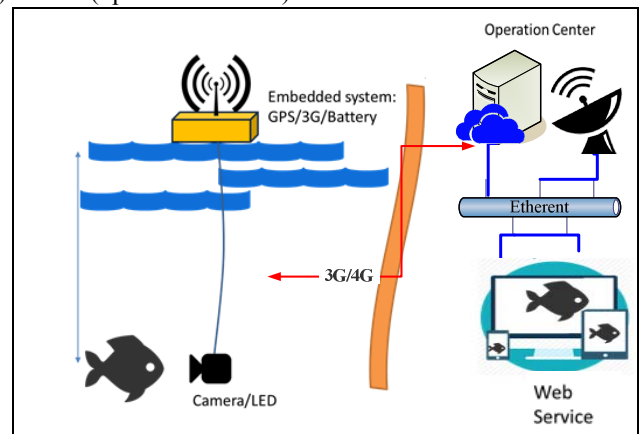


Fig1. System architecture

IV. EXPERIMENT AND RESULT ANALYSIS

We used a microcontroller unit to operate the high-power components (GPS/3G/LED/CMOS module) in a power-saving mode, as shown in Fig. 2. Consequently, we expect to reduce the power consumption of the system by 90% .

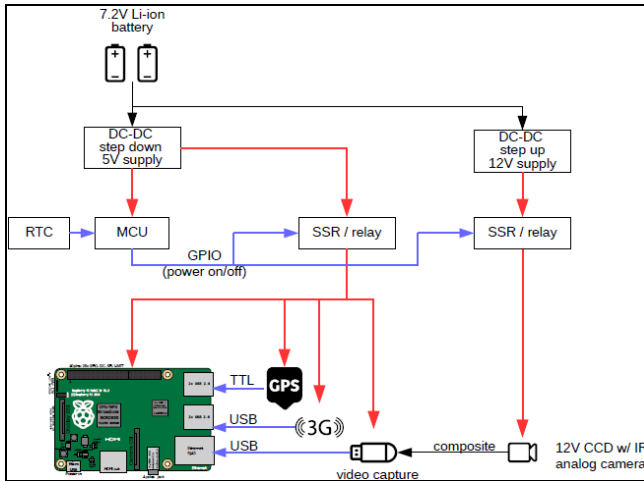


Fig. 2. Schematic of the proposed system

First, a preliminary test for peak power determination was performed, and the power module was designed. Thereafter, the prototype of the system was designed and reviewed, and an image quality test was then performed.

Floating and underwater transmission tests were performed in a pond (Fig. 3). The communication module transmitted the digital data (time and location) and images. Furthermore, communication stations and sensor networks were tested, and the GPS module was used to obtain position information for transfer to the server.

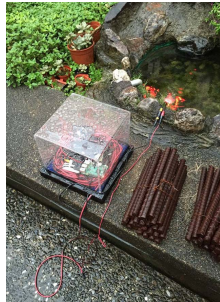


Fig. 3. Experimental testing and environment

In this study, we investigated the reliability of the proposed system in terms of the image quality, resilience, and robustness of the devices. Waterproof (IP66–67) cameras with ultra-wide-angles of 170° were used to capture images as shown in Fig. 4

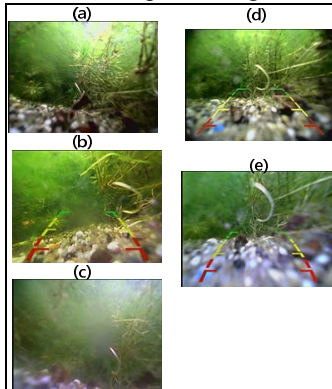


Fig. 4. Image testing

For the image shown in Fig. 4(d), the camera had a horizontal resolution of 600 TVL, and the camera lens had a large aperture with four built-in high-brightness white LEDs. The underwater images captured using this camera exhibited accurate color and high quality.

The power module provided the required power for communication, data handling, and sensor operation. Moreover, we used a multimeter to calculate the power consumption of the system. Table 1 shows the power consumptions of the individual components.

TABLE I. Power consumptions of individual components

module	Current (mA)	Voltage (V)	Power (w)
camera	130	12	1.56
GPS、3G、UVC、Control Module	340	5	4.08

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V. CONCLUSION

In this study, we investigated the reliability of a wireless smart sensor system for fish-image observation. The experimental results revealed that the proposed system had high stability.

Clearly, a 3G/4G telecommunication system with land-based power signal towers can easily achieve timely and flawless data transmission for the wireless smart sensor system. Because of the low ambient light conditions and frequent algal blooms in coastal waters, a red-light spectrum filter fitted with an ambient light detector and LED light sources are required for better image processing. Thus, the proposed system can improve marine aquaculture and help in the monitoring of fish.

REFERENCE

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