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doi:10.15199/48.2024.11.20

Enhancing the Cultivation of *Moina* sp.: An Integration of Aeration System with Green Water Detection and pH Monitoring

***Abstract.** Moina sp., a zooplankton with high protein content, serves as a vital live fish meal for aquatic species, including Betta spp. fry. Nevertheless, the cultivation of this particular species poses challenges due to its limited lifespan and inadequate water requirements. Focusing to address this issue, the proposition of an inventive framework for water parameter monitoring to utilize pH and temperature sensors was applied. The detection of green algal blooms is facilitated by an artificial intelligence-driven computer vision system, which effectively notifies individuals using Blynk applications. The implementation of this partially automated technique enhances the efficiency of Moina production, hence meeting the requirements of the aquaculture industry. Significantly, this represents the inaugural Moina Aeration System (MAS) that incorporates Internet of Things (IoT) integration.*

Streszczenie.** Moina sp., zooplankton o wysokiej zawartości białka, służy jako niezbędny żywy posiłek rybny dla gatunków wodnych, w tym narybku Betta spp. Niemniej jednak hodowla tego konkretnego gatunku stwarza wyzwania ze względu na jego ograniczoną długość życia i niewystarczające zapotrzebowanie na wodę. Skupiając się na rozwiązaniu tego problemu, zastosowano propozycję pomysłowych ram monitorowania parametrów wody w celu wykorzystania czujników pH i temperatury. Wykrywanie zakwitów zielonych glonów jest ułatwione dzięki opartemu na sztucznej inteligencji systemowi widzenia komputerowego, który skutecznie powiadamia osoby korzystające z aplikacji Blynk. Wdrożenie tej częściowo zautomatyzowanej techniki zwiększa wydajność produkcji Moina, spełniając tym samym wymagania przemysłu akwakultury. Co istotne, stanowi to inauguracyjny system napowietrzania Moina (MAS), który obejmuje integrację z Internetem rzeczy (IoT). (**Poprawa uprawy Moina sp.: integracja systemu napowietrzania z detekcją zielonej wody i monitorowaniem pH

Keywords: Moina sp., live feed, Internet of Things (IoT), Aquaculture, water parameter.
Słowa kluczowe: Moina sp., transmisja na żywo, Internet Rzeczy (IoT), Akwakultura, parametry wody.

Introduction

Moina sp. is a genus of small, freshwater crustaceans known as water fleas. These tiny creatures belong to the class Branchiopoda and are often found in ponds, lakes, and other aquatic environments. They play a crucial role in aquatic ecosystems as a source of food for various organisms, including fish and other aquatic animals. *Moina* sp. are filter feeders, using specialized appendages to filter algae and other organic particles from the water [10]. They are known for their rapid reproduction and short life cycles, which makes them useful for the potential live feed supply. The production of freshwater commercial aquatic species fry such as *Betta* spp. prawn and fish larvae critically depend on the protein-rich zooplankton. *Moina* sp. commonly eats yeast, phytoplankton, and fungal cells. Blue-green algae like *Microcystis aeruginosa* boost *Moina* sp. to further synthesis [1]. Mostly, *Moina* sp. cultivation should be cultured with the presence of phytoplankton i.e. *Chlorella* sp. in the green water. *Chlorella* sp. culture was maintained with the constant supply of aerated system using a water pump. After 2-3 days, *Moina* sp. starters were added to develop a reddish flowering phase. Normally, this species survives in the water temperature (20-30°C) and pH (6.5-9.5) [2] respectively. Due to technology constraints, the industry of automated *Moina* sp. culture is not well established.

Malaysian Cultivation Trends and Traditional *Moina* sp. Aeration Methods.

Moina sp. can be survived in the range of 5–31°C water temperatures and low-oxygen settings respectively. the natural survives by making its haemoglobin for lifespan. The morphology of *Moina* sp. includes a head, trunk, and antennae and contained its haemoglobin-rich pink body. the structure of brood pouches commonly develops eggs in females. Despite being smaller, *Moina* sp. contains a protein-rich, low-fat composition that exceeds the nutrition composition of *Daphnia* sp. The unique determination of its sexual and asexual reproduction is males multiply and produce ephippia when food is scarce, while females reproduce asexually under ideal conditions. Moreover, each female can produce 4-22 broods every 2 days. *Moina* sp. eats decaying organic debris and blue-green algae, mostly phytoplankton (green water and protozoa). These species are also phytoplankton eaters [3]. Bright green algae *Chlorella* sp. reportedly contains 50% of protein, iron, fibre, multivitamins B, complex carbs, polyunsaturated fats, and antioxidants.

Fig. 1: The Moina sp. cultivation place and its setup using manual operation

Since 1940, the species of this live food has been promoted as a food alternative [4]. Domestic wastewater treatment ponds normally can help the growth of *Chlorella* sp. Algae in the ponds can transform wastewater nutrients into algae cell nutrition through photosynthesis. *Spirulina* sp. and *Chlorella* sp. algae can recycle through these wastewater nutrients and endure environmental changes [5]. During the intense phase, phytoplankton-like green algal blooms are visible. When blooms are weak, water is muddy, or multiple species exist in shallow water, it becomes less significant. Using a red filter in those cameras to simulate the plant's light absorption helps detect green algae blooms. NDVI between 662 nm and 680 nm can detect red Moina blooming. NDVI cameras can show water blooms. Blue filters improve detection because phytoplankton use blue light for photosynthesis [6]. Another study [7] suggested utilizing UAVs with a typical red-green-blue (RGB) camera to detect algae. High-resolution imaging detects algae and vegetation better than commercial satellite imagery [8].

Population Survey of Betta Breeder In Malaysia

Table 1: The number of registered culturists in the fishery from every state in Malaysia

States	The Number of Culturists	Percentage (%)
Perlis	10	1.48
Kedah	9	1.33
Pulau Pinang	39	5.78
Perak	330	48.89
Selangor	10	1.48
Negeri Sembilan	6	0.89
Melaka	4	0.59
Johor	119	17.63
Pahang	19	2.81
Terengganu	36	5.33
Kelantan	70	10.37
Sarawak	3	0.44
Sabah	17	2.52
W.P. Labuan	3	0.44
W.P. Persekutuan	0	0
Total	**675**	**100**

Table 1 displays the states in Malaysia with 675 Betta fishing culturists [9]. Perak had 330 culturists, 48.89% of the national total, whereas W.P. Persekutuan had none. The data shows that most Malaysian states are adept at raising or growing aquatic life. Like state culturists, Moina cultivation helps the country produce cash.

Limitation of Manual Operation

The manual detection of green water, *Chlorella* sp. and red-blooming water, *Moina* sp. necessitates oversight from aquaculturists. Occasionally, the individuals that study the culture of this species may encounter limitations in their schedules, resulting in the inadvertent neglect of monitoring the actual presence of green water and the subsequent failure to identify the optimal period for *Moina* sp. harvesting as a consequence of human fallibility. The potential consequence of this situation is a decrease in the efficiency of *Moina* sp. production.

Hence, a proposed methodology involves the utilisation of sensors to monitor water conditions, along with the application of computer vision techniques and artificial intelligence algorithms to detect the presence of green water and the *Moina* sp. blooming phase. This strategy aims to address the challenges associated with time-consuming processes and human negligence. The suggested concept employs a web camera as a sensor to detect the different colours of water through the application of computer vision techniques.

Moina Aeration System (MAS)

Figure 2 illustrates the practical application of a camera and a specially developed algorithm to detect green water and red *Moina* sp. blooms. This detection is achieved by utilising certain threshold areas. The camera is utilised to take photos, which are subsequently processed on a personal computer (PC) through the use of the Python programming language. Upon successful identification, an internet gateway communication is initiated to Blynk, thereby informing users about the occurrence of green water and red *Moina* sp. blooms. The process of monitoring water conditions entails the utilisation of pH and temperature sensors, specifically the DS18B20, to ascertain the ideal circumstances for the growth of *Moina* sp. Webcams are regarded as cost-effective and adaptable instruments for facilitating visual communication, as contemporary iterations boast remarkable resolutions such as 720p or even 1080p.

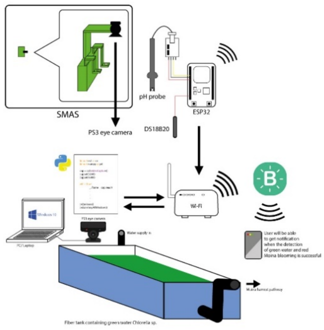


Fig. 2: The designed idea of MAS for detecting the green water and the red *Moina* sp. blooming plus monitoring the water conditions

Python is selected as a programming language due to its extensive collection of libraries and its high level of efficiency in the domain of image processing. The process encompasses several sequential actions, including the collection of camera input, the conversion of frames to the HSV colour space, the application of colour masking techniques, the removal of unwanted noise, the identification of certain colours, the delineation of contours, and the achievement of real-time detection. The Blynk platform serves as a means of establishing a connection between microcontrollers and applications, enabling the seamless transmission of video captures in real-time from Python programming language to Blynk applications. When the detection process is successful, Python commands are executed to initiate the sending of alerts through Blynk, indicating that the green water is ready.

General Architecture of The Proposed System

The flow of the system seen in Figure 3 is represented by the functional block diagram. This system utilizes a camera as the input sensor to receive picture signals from real-time video capture. Subsequently, these signals are transmitted to the central processing unit, generally referred to as a PC or laptop. Python programming is utilized to provide instructions for operating the camera to detect the presence of green water resulting from algal blooming, as well as red water resulting from *Moina* sp. blooming. The system employs an Application Programming Interface (API) to establish a connection between the Python programming language and the Blynk applications. This connection facilitates the transmission of analyzed data and messages to the user via the aforementioned applications. The user shall receive a notification upon successful detection of the green algal water or the red *Moina* sp. blooming water after it surpasses a specific threshold. The hardware layout depicted in Figure 4 represents the prototype of the *Moina* sp. Aeration System, whereby the camera is positioned above the tank.

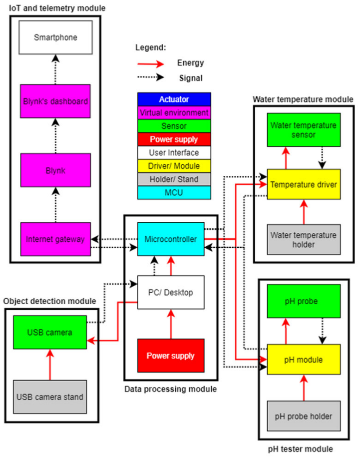


Fig. 3: The overall block diagram of the functional flow of *Moina* sp. Aeration System

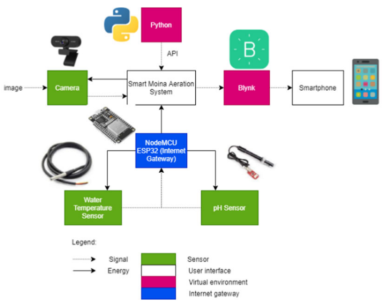


Fig. 4: The simplified block diagram of *Moina* sp. Aeration System

// ...... omitting some codes ......

```
low_red = np.array([8,8,50])
high_red = np.array([60,151,170])
rmask = cv2.inRange(hsv, low_red, high_red)
red = cv2.bitwise_and(frame, frame, mask=rmask)

low_green = np.array([66,80,80])
high_green = np.array([91,255,196])
gmask = cv2.inRange(hsv, low_green, high_green)
green = cv2.bitwise_and(frame, frame, mask=gmask)

contours, hierarchy = cv2.findContours(gmask, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
contours1, hierarchy1 = cv2.findContours(rmask, cv2.RETR_EXTERNAL, cv2.CHAIN_APPROX_SIMPLE)
```

// ...... omitting some codes ......

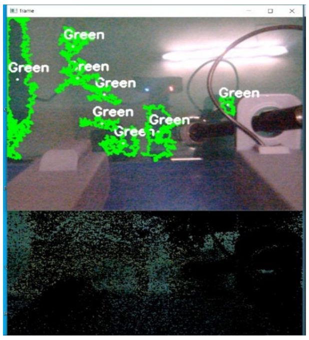
Algorithm: Green Water and Red *Moina* sp. Blooming Detection

The procedure segregates the green water containing Chlorella algae and the reddish-brown blooming Moina sp. based on their distinct colors. Each image is composed of pixels representing different colors. The RGB color model uses red, green, and blue to mix and create other colors. Adding more of each primary color makes a brighter color. Color mixing can make this difficult. Computer vision often prefers HSV color space to RGB for more accurate color detection. Hue, saturation, and value are used to define color in terms of the actual color itself, its level of white mixing, and its brightness. These parts have ranges for measuring them. To see colors better, especially in shadows or when they're mixed with other colors, These components can be modified by increasing the hue for a more intense color, boosting the saturation for a brighter appearance, and adjusting the value to reduce darkness.

***Moina* sp. Aeration System Performance**

Green Water (*Chlorella* sp.) Detection

Figure 5 shown above is the successful result of the detection using the camera by running the Python code. The green boundaries with labels on the window depict the area of the green pigments on the surface of the water.



Fig/ 5: The successful detection of the green algal blooming

Red *Moina* sp. Blooming Detection

Figure 6 above shows the detection result of the *Moina* sp. blooming. The red box indicates the area of *Moina* sp. detection which can tell the user that he or she is ready to prepare for harvesting. The message "*Moina* sp. is blooming" will be printed along with the video streaming from the static camera.

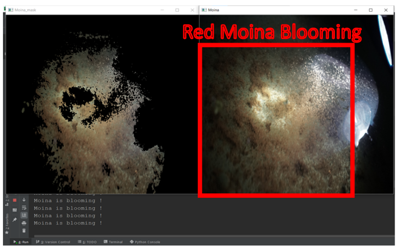


Fig. 6: The preliminary successful detection of the red *Moina* sp. Blooming

Based on the experimental findings obtained in this study, it is evident that the mean temperature and pH level of the water are 27.46°C and 8.06 respectively. The appropriate water temperature facilitates the overall growth of Moina sp. within the entirety of the tank, while the optimal pH range, as indicated by the study, demonstrates that the average pH falls within the specified range. The observed elevation in the pH measurement of the water can likely be attributed to the augmented release of waste resulting from the biological processes of these organisms. The presence of a significant quantity of ammonia can lead to an increase in the pH of water. Hence, aeration is employed to remove oxidising agents and enhance the amalgamation of water and air, preventing the water's pH from exceeding acceptable levels. Additionally, it facilitates the stimulation of phytoplankton growth and sustains the presence of food particles in the Moina sp. culture process.

Table 1: The water temperature and pH value recorded for every hour of a day

Time (hours)	Water Temperature (°C)	pH Value
1	26.2	7.8
2	26.6	7.9
3	26.5	7.7
4	26.4	8.0
5	26.7	7.6
6	26.5	7.9
7	27.1	8.2
8	27.3	8.0
9	27.7	7.9
10	27.9	8.1
11	28.6	7.8
12	29.3	8.0
13	29.1	8.2
14	28.9	7.9
15	29.2	8.0
16	28.5	8.2
17	27.9	8.5
18	27.6	8.3
19	27.8	8.1
20	27.4	8.4
21	26.9	8.3
22	26.5	8.1
23	26.3	8.2
24	26.2	8.4
Average	**27.4625**	**8.0625**

A month of *Moina* sp. production was recorded to provide a preliminary result of implementing *Moina* sp. Aeration System before going on-site. However, due to different weather conditions during the data collection. The data collection is carried out by alternating the weeks using MAS. The result provided have a slight deviation but still achieves the final result as expected.

Table 2: The total harvest of *Moina* sp. for a month-by-week evaluation using MAS

	Week		Differences	Percentage difference (%)
	1	2 (MAS)		
Total harvest (ml)	5	8	3	60
	Week		Differences	Percentage difference (%)
	3	4 (MAS)		
Total harvest (ml)	4	7	3	75

Conclusion and Recommendations

In summary, the implementation of the algorithm for detecting green water has been effectively executed, yielding satisfactory results through the utilization of Python programming. The integration of a camera system with a detection algorithm that incorporates a pH sensor, and a water temperature sensor facilitates the monitoring of water conditions in the context of *Moina* sp. cultivation. This monitoring is achieved by analyzing the pH value and water temperature data. The proposed Mobile Alert System (MAS) can promptly warn users in real-time, regardless of their location, as long as the system is linked to the Internet. To the best of our current understanding, the *Moina* sp. The aeration system is being suggested for the first time. The research could be enhanced by granting users the ability to manipulate *Moina* sp. advancement in accordance with the detecting process.

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