Quick cleaning device for small water blooms in landscape water bodies

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Abstract. For small urban landscape water algae bloom clean up the problems, designed a self-cleaning device bloom quickly. The device has: 1) for the urban landscape water algae bloom clean up, eliminate manual cleaning defects, breaking the city clean blind; 2) intelligent management control, real-time monitoring to meet the demand for manageable; 3) incorporated a variety of algae, view full clean water; 4) after processing cyanobacteria organic processing, and re-use waste resources.

1. Development background and significance
Characteristics of urban landscape water in a small community parks and other places are widely distributed, with a shallow, small size and dispersion, low water interference. Due to the large waters into the domestic sewage and industrial wastewater along the residents, the city lake eutrophication serious, frequent water bloom.

Table 1. Water quality of some urban landscape water bodies in Wuhan

| Survey location | Xinghu | Happy Bay water park | Huangpi District | Optics Valley | South lake |
|-----------------|--------|----------------------|-----------------|---------------|-----------|
| Algae content   | $1.639.83 \times 10^3$ | $1.298.26 \times 10^5$ | $1.334.75 \times 10^5$ | $8.76.58 \times 10^5$ | $1.753.64 \times 10^5$ |
| Situation       | Floating | Formation | Formation | Proliferation | Floating stage |

According to the survey, did not make effective treatment for the clean-up of the water landscape water blue-green algae and floating debris. Existing algae boat and more targeted at large-scale garbage waters of rivers, sea and so on. Therefore, the current cyanobacteria urban landscape water unattended. Urban Landscape Waters become the city clean blind, landscape water pollution problems become more and more prominent, endangering the health of residents. Therefore seek efficient and convenient new way to clean up is imminent.

2. Design plan
Through research, determine the design requirements: 1) having a mechanical salvage mechanization and rapid flocculation of algae extrusion techniques, along with an ultrasonic algal depth function; 2) satisfies a remote control, an orbital cruise demand, real-time monitoring; 3) clean energy energy supply mode provided supporting solar charging station.
According to the design requirements, design a small city applied bloom landscape water fast cleaning device. The work can be divided into two parts: cyanobacteria processing module and intelligent monitoring management module. The processing module includes a mechanical transmission cyanobacteria salvage module, the module was stirred flocculation, dehydration squeezing and ultrasonic module alg module. A stepping motor main intelligent monitoring module by the host computer, the lower hull and a control microcontroller unit operation components.

3. **Overall workflow**

When residents found water bloom occurs, place and circumstances uploaded to the units, the units clean water bloom location reasonable scheduling staff to carry vehicles and algaecide device will go according to occur.

During the algae removal process, the short-distance part of the line uses the operation control button on the intelligent management interface to realize the hull travel, and at the same time, the cleaning function is turned on to complete the short-range surface blue-green algae salvage work. The remote water surface can plan the travel path through the intelligent management platform, breaking through the clean-up blind area of the central water surface, and controlled by the user from a distance.

When the amount is less than when the algaecide device, automatically returns to the starting point through the solar charging station for charging. When the level sensor detects the collection box is full after collection of cyanobacteria, the device automatically returns the starting point, transferred to a storage bin on the vehicle by means of high concentrations of algae pumping pulp algae on the vehicle.

4. **Cyanobacteria processing module design**

4.1. **Mechanical transfer salvage module**

Mechanical transmission module shown in FIG salvage, the filter is fixed to the chain, the sprocket is rotated, so as to drive the chain is rotated together with the screen is achieved by the motor via a bevel gear transmission filter holder. Water and debris to salvage cyanobacteria, preliminary filter and then transported to the flocculation tank dewatering process. Filter design is "\(^{\text{\textquotedbl}}\)" type, vertical transverse angular web designed to intercept the water cyanobacteria, bottom-up design diagonal net picked cyanobacteria. Is a hydrophobic nylon filter, can solve the adhesion problems during transit cyanobacteria, the small-diameter hole filter is designed to intercept the water filter cyanobacteria, algae achieve the initial water separation.
4.2. Flocculation Settling Module

FIG stirred flocculation entire module shown in FIG. The flocculant is sepiolite, and the flocculation time is 1-2min. Workflow: alginate slurry stream from the top left of the conveyor apparatus, the motor driving the inner cylinder is rotated, flocculants when thrown into the tank opening in the inner cylinder and the outer cylinder openings coincide. The motor drives the bevel gear to rotate the stirrer. Algae algae slurry is gradually integrated condensate flowing bulk cyanobacterial groups condensed from the right end of the spout.

Figure 4. Flocculation Settling Module  Figure 5. Simulation diagram

Fluid flocculation using Fluent cartridge simulation analysis. 5, in Comparative plurality of sets of flow state is determined 200rpm stirring effect is best when the impeller speed.

4.3. Squeeze dewatering module

Extrusion dewatering module algae flocculated dewatered slag formed Moor meet transport requirements. The group of cyanobacteria enters the squeeze module through the check valve. The squeeze push rod drives the squeeze plate to compress the algal slurry. The excess water is filtered through a three-stage filter.

Figure 6. Squeeze dewatering module  Figure 7. Tertiary filter  Figure 8. Check valve

4.4. Ultrasonic Algae Suppression Module

Algae algal ultrasonic transducer module consists of a signal generator, power amplifier and ultrasound. By this means the solar panels and solar energy into electricity stored in the battery, a portion of the power delivered to the ultrasound signal generator module to generate a signal of a specific frequency, the power amplifier, the ultrasonic transducer into a particular frequency ultrasonic wave applied to the algae and the outer wall of the rupture, death.

4.5. Ultrasonic Algae Suppression Module

Solar rechargeable movable post shown in FIG. The solar photovoltaic panel using four 100W size is 1200 * 550 * 30 working voltage of 17.88V monocrystalline solar panel assembly, a hinge connection between the frame and, on both sides of the supporting hydraulic rod, work to expand the panel becomes a bunching status.
5. Intelligent control module design

5.1. Overall scheme design
This project to the control section STC89C52 microcontroller core, the wireless module NRF24L01, putting electric motor module and the hull. The PC communicate wirelessly over a wireless module and NRF24 SCM control system operator can be sent via the PC key corresponding signal to the microcontroller, the microcontroller emit different duty cycles of the square wave to drive the motor module depending on the received signal, the drive to complete the hull, Stirring, flocculation and squeeze action.

5.2. Wireless communication module
The wireless communication module by a wireless module NRF24L01, NRF24L01 to TTL module and a USB module NRF24L01 turn. Implemented by the microcontroller and PC connection between the wireless communication module, a remote communication device implemented. Through USB to the PC module NRF24L01 NRF24L01 master module connection system for data transmission, thereby to control the system.

5.3. Motor module
The module consists of a conveyor belt motor, the motor flocculation tube, stirring motor and two drive motors, mainly enable the collection of cyanobacteria produce flocculant, cyanobacteria and stirring function driven hull.

6. Feasibility Analysis

6.1. Comparison of instant algae removal effect
After a completed device, we carried out experiments in actual algaecide experiment waters Huazhong Agricultural University. 11, FIG. 12, which salvage effect is more obvious, the device traveled a significant occurrences of clean water.

6.2. Experimental study of actual continuous algae removal effect
Contrast test of pumping with this device: Experimental site: Nojiri Lake; Subject: Blue algae; Experimental materials: a set of pumps and a rapid bloom cleaning device; Experimental plan: Use this device and pump to pump similar Two adjacent waters, the statistical data is analyzed; the timer
records the time. After 30 minutes, the two devices stop working, and the algae water content in the collection box is detected.

| Table 2. Water quality of some urban landscape water bodies in Wuhan |
|---------------------------------------------------------------|
| | Test Cycle (d) | Algaecide area (m²) | Algae removal time (h) | Dehydration rate (%) | Power consumption (kW·h) | Algae before experiment (m³) | Algae before experiment (m³) |
|---------------------------------------------------------------|
| Pump suction device | 6 | 70 | 0.5 | 0 | 0.3 | 1.83*10⁸ | 1.84*10⁸ |
| This device | 6 | 70 | 0.5 | 60 | Solar energy | 1.83*10⁸ | 1.38*10⁸ |

7. Conclusion
This device is mainly through technology with intelligent management control, salvage and other machinery, the urban landscape of blue-green algae to clean water is fast, compact device structure, light and flexible, in time to meet the transport needs of different algae control scheduling waters inside the city. As can be seen from the experimental data of this work to clean up a good bloom effect, dehydration rate, the device will have a good prospect in the future.

References
[1] Liu Jieling, He Yang. Status and causes of eutrophication of urban landscape water bodies [J]. Green Technology, 2017 (12): 73-74.
[2] Wu Yuewei, Li Youhua, Liu Xinnian, et al. Bibliometric analysis of lake eutrophication and cyanobacteria bloom outbreak mechanism in China [J]. Wuhan Branch, National Library of Science, Chinese Academy of Sciences, 2008.
[3] Jiang Dengling, Ni Guozhen, Gao Lin, et al. Effects of low frequency and low power ultrasound on algae growth [J]. Journal of Ecology and Environment, 2009, 18 (5): 1732-1735.