Design and Development of Automatic Embedded Device for Production of Spirulina Algae

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Abstract— Blue green algae is the most beneficial algae which is found in salt water and in some large fresh chlorine free water lakes whose pH is in between 8 to 10.5.Spirulina is full of vitamin and proteins. By producing such spirulina algae we can overcome various deceases such as malnutrition in children and infants, diabetes, high fever cancer weight loss. It has great effect on immune system and viral infection. For the production of such type of algae in large scale this embedded device is introduced so that we can produce quality of algae in minimum duration with great quantity. The health of the algae is affected by the environmental factors such as temperature, photosynthesis. With the help of this embedded device we can maintain the required temperature and pH value. This device includes DC motor, DC pump, solenoid valve.

Key words: Spirulina Algae, Image Processing, Matlab, Ph Analysis

I. INTRODUCTION

Spirulina is blue green algae with its spring like structure. This algae is very beneficial in all manners. This algae is used as medicine in various deceases because of its exceptional nutritional content which helps to cure various human health issues [3]. In today's world production of this super food is being carried out by manual process which takes great amount of time and man power.

So, for the production of this super food, the embedded device is introduced which will work automatically. There are number of researches are done on the basis of growing of spirulina algae under the various environmental conditions. By considering these conditions the embedded device will work. This embedded device consists of DC motor, DC pump, and solenoid valve, 89c51 IC and pH meter. Here the various chemicals are flowed into the mixture tank through the solenoid valve in appropriate concentration. These mixtures of chemicals are added into the particular pond. pH meter is used to analyze the pH of mixture. pH should be at around 10.5. If pH rose above 10.5 then the bicarbonate is added to reduce the pH. It is very necessary to maintain the environmental conditions during the production of spirulina algae because it affects the size, shape and quality of algae. So to check the quality of algae, image processing is used so that we can easily identify the quality and growth of algae.

II. LITERATURE SURVEY

Literature survey is done on the basis of various methods for determining the pH value. In industry all the processes required to control the pH and the production of spirulina is done manually.

In 2013 "Experimental Study on the Influence of Ph value, Illumination, Nutrient, and Temperature Factors on Cyanobacteria Growth"[1]. This study is done by Pang Cuichaoa, Zhou Jiea, Zhang Xiujib, Wu Shiqiang. It was found that the various factors had apparent impact on the cynobacteria growth behavior, and had certain regularity. In the same time, cynobacteria affected water environment to a certain extent, and made the water environment favourable to cynobacteria growth Following conclusions could be obtained from testing data and analysis: There does not exist fixed single optimum pH value favourable to cynobacteria growth in four growth stages. The optimum pH value is different in different growth phases. cynobacteria affected water pH value also to a certain extent, and made the water pH value favourable to cynobacteria growth; cynobacteria was highly sensitive to temperature. The abrupt change of water temperature affected algae growth enormously. The influence degree depends on the intensity of illumination.

In 2010**,** Tao Chi and Ming Chen proposed a paper on "based on Transcendental Knowledge of Neuron Model to Achieve PH Detection and Control in Hydroponic Environment" [2]. Here artificial neural network system can learn to deal with these problems by learning specific examples and give good answer, in view of the highly non-linear and changeable problems existing in the PH neutralization. The paper proposed completing the PH value examination and the control operation which based on transcendental knowledge with the union neuron control and analyzed the reason why PH value sometimes is able to have the oscillatory occurrences. The experiment proved that this method may effectively control the neutralization processes which have the serious nonlinear response property. By means of adjusting neuron gain, it eliminated and reduced the object which had non-linearity and non-determinacy that had the adverse effect to the neuron study and has satisfied the control request in PH neutralization process. Through the artificial neural network has been very widely used in actual production its inherent disadvantages greatly hinder its application. So it needs further research and development.

In above proposed paper, it is clear that several parameters in our surrounding like temperature, illumination and nutrient are responsible for maintaining health of algae, Hence in this proposed work, maintaining these parameters is important. All the process for controlling pH value is done manually. So there is scope for production of spirulina is done automatically so that the manpower and time consumption will be reduced.

III. PROPOSED SYSTEM

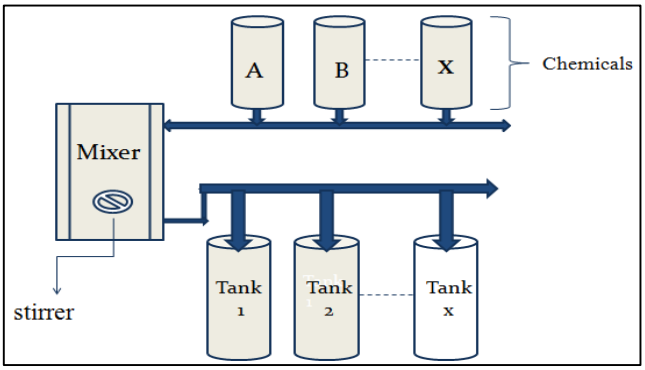

Fig. 1: Block Diagram

In this proposed system the number of chemical tanks used along with the solenoid valve flow meter. Initially the chemical A is added in the mixture tank through the solenoid valve. Similarly chemical B, Chemical C up to the Chemical X is added to the mixture tank as in Fig1. The flow meter is used to control the flow of the chemicals. Decided concentration of chemicals is filled into the mixture tank then the stirring is done. Stirring is the second important part so that the all chemicals will be mixed properly. There are number of chemicals which are easily resolved into the water and some chemicals takes time so because of stirring process, the chemicals mixed throughout. After mixing, the mixture is send to the particular pond. The pH of the water in that pond will be analyzed with the help of pH meter.

Image processing is the second important part in the production of spirulina algae using image processing we can check the quality of spirulina. Spirulina is very sensitive to the environmental factors so the little changes in water can cause the contaminated algae which are dangerous to human being so it is necessary to check the quality of spirulina time to time.

IV. WORKING METHODOLOGY

In this embedded device our main aim is to provide the all environmental factors in proper amount to avoid the bacteria contaminated algae. There are number of algae are there, some of them are beneficial but maximum of them are very dangers to human health so it is necessary to differentiate them properly to avoid any hazards. This automatic embedded device is designed in such a way that it will takes care the all factors which affects the heath of algae.

In this system there are number of chemical tanks which are useful to develop the spirulina culture. These chemicals are brought to the mixer through the pipe with the help of solenoid valve and the flow meter, so that we can control the flow of the chemicals as per required concentration. All the chemicals with proper concentration brought to the mixer. Some of chemicals are easily soluble but some of them are thick which takes more time to dissolve hence the stirrer is used, so that chemicals should properly mixed. This mixture is send to the particular pond as the instruction is given from the panel.

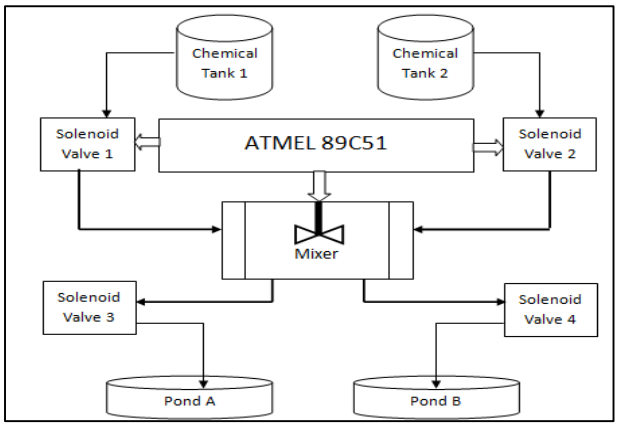

Fig. 2: Block diagram of system

We are using the following components in hardware

- 89c51 Controller
- DC motor 12v supply for speed
- DC pump 12v
- Solenoid valve 12v
- Relays of 5v to control the solenoid valve
- Battery-12v 5amp because of High load
- pH meter to analyze the pH of water

In the system 5v relays are used to control the 12v solenoid valve. The flow meter is used to control the flow of the chemicals so that we can easily carry out exact amount of chemical. Flow meter is the flow sensing device which sense the flow of fluid and it is corrosive resistant of plastic so it does not cause any damage to the system. The 12v solenoid valve is used to control the chemicals. The 12v dc motor is applied to the mixer so we can control the speed of the fluid. Speed of the chemicals remains constant because of this motor.

In this system the 12v, 5amp battery is required because the solenoid valve takes maximum power to switch between on and off. Because of this high load the maximum voltage battery is required. In such way the chemicals send to the particular pond as per command given to it. The pH meter is already fitted to the pond so that we can easily check the pH of water. If the pH is not as per requirement then again the required amount of chemical is added to the pond and checks the pH again until the required pH is obtained.

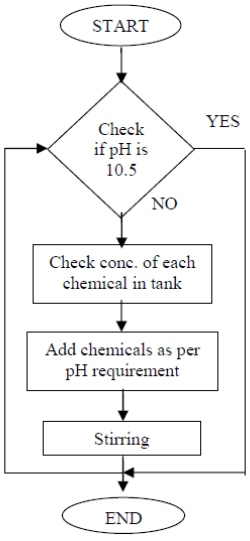

Fig. 3: Flow Chart of System

V. IMAGE PROCESSING

It is very necessary to get the healthy algae because it is directly related to the human health. It is not necessary that all blue green algae are spirulina algae. This spirulina alga is known from its spring structure so it is necessary to check the structure of the algae alternate days. The morphological structure of spirulina is analysis through the image processing. In image processing the algae passes through the several stages. Initially the picture of spirulina is taken then under the microscope, the size and shape is analyzed. There are several steps such as image binarisation, segmentation and check morphological operator.

A. Image Binarisation:

Binary image is obtained from the original image and red, blue and green color is converted into the gray color using greythresh function as follows:

$$B(i,j) = \begin{cases} 1 & I(i,j) \geq \text{threshold} \\ 0 & I(i,j) < \text{threshold} \end{cases}$$

In fig. 4 the impurities are eliminated using spur function which is shown in gray skeleton.

B. Morphological Operator:

Morphological operator includes the trichome width, height, angle and helix pitch. More the spiral maximum replication is done. The helix pitch is calculated from the slope of helix curve denoted by 'h'. This h should be in between 12 micron to 72 micron

$$h=2\Pi rcot\alpha$$

The processing and controlling operation carried out by Matlab and ride software.

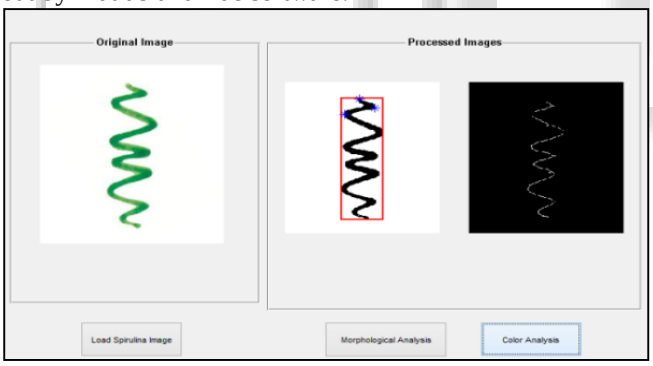

Fig. 4: Binary Image

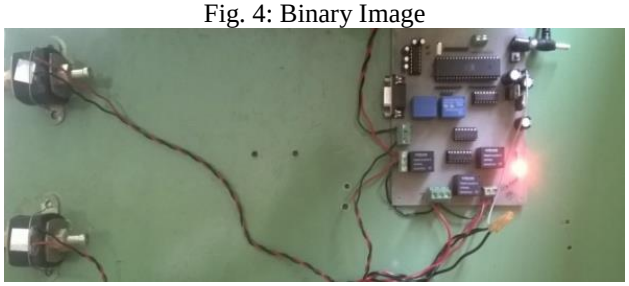

Fig. 5.1: Hardware Module of system

Fig. 5.2: Solenoid Valve

VI. RESULT

In this sections all the results are obtained by considering chemical tanks and number of ponds. Innitially chemical from tank 1 in given amount is flowed to the the mixer. Simmilarly the chemicals from tank 2 and tank 3 is added one bye one into the mixer. The ultrasonic sensor is used here to measure the level of chemicals into the tank.

After that, by using start stirrer button, the stirring process is started. All the chemicals will mix throughout. after some time the stop stirriring action is performed. By selecting the start pump there is small window will pop up which shows the which pond we want to feel. By selecting pond, all chemicals added to that selected pond. Here we chose Pond 3. Hence out of 4 pond only pond 3 shown by green color. Remaining are in red. The water tank is there to flush the all chemical particals from pipe so that it will not affects the change in pH value of water in pond.

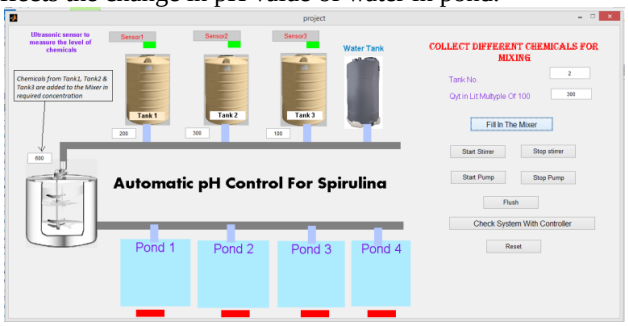

Fig. 6: Fill Mixer

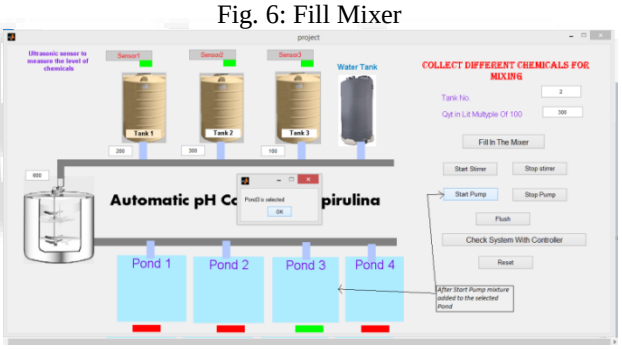

Fig. 7: Selection of Pond

The all the setup is reset. At this point the all valve will closed

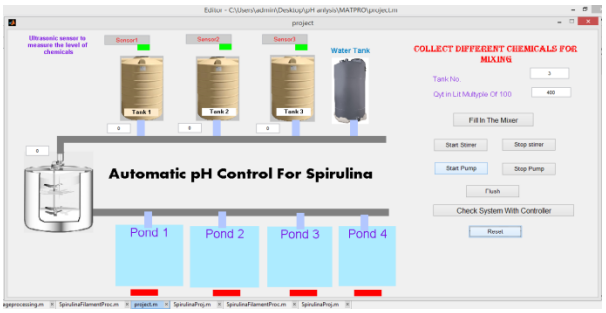

Fig. 8: System Reset

To check the quality of the algae the image processing part is introduced. In this part we will observe the all morphological operator such as trichome width, height, angle and the helix pitch. If our structure is met with its specified value that means algae is heathy and bacteria free. So in fig. 9 explain the width, height, angle and the helix pitch of the algae.

The color analysis is added to check the red green and blue proportion of algae. The healthy algae should be in

deep green color so the color analysis ia also the important part.

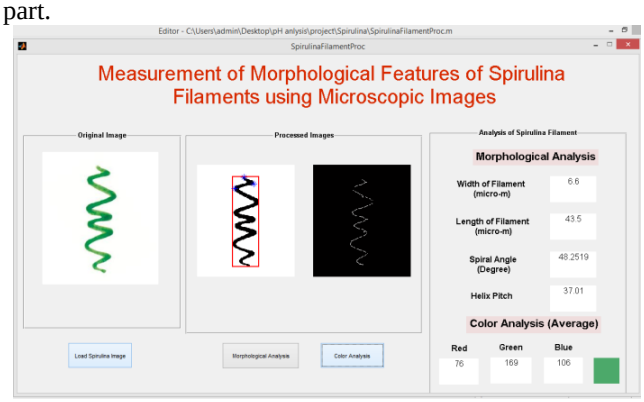

Fig. 9: Morphological Features

VII. CONCLUSION

In this system we have to maintaine the pH value at around 10.5 with respect to the enviromenatal factors such as tempreture, photosynthesis, illumination, nutrient condition. If the pH rose above 10.5 we can add sugar or bicarbonate to decrese th pH. Here the sample of the dry algae is processes in the lab to check the quality of algae whether algae is growing in proper condition or not. To check this condiotion the morphological feature is obeserved. As more the spiral it is easy to spirulina to replicate, so by checking the spiral we can get spirulina in large scale. This algae is very benficial for verious dieseses such as high fever, diebities, malnutrion. So by producing such algae in large scale we can overcom such deseases. By introducing this automatic embedded device we can produce spirulina in large scale with minimum time.

ACKNOWLEDGEMENT

I would like to take this chance to express my gratitude to all those who extended their support and have guided me to complete this paper. First and foremost, I would like to thank Asst. Prof. Apeksha Sakhare for his kind support and encouragement. Also I am thankful, Department of Computer Science Engineering, for their motivation, inspiration and co-operation towards completion of this paper. Finally, I sincerely thank to my parents, family and associates who provide me advice and financial support. The product of this paper would not have been possible without all of them.

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