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Design of Automatic Water Laver Harvesting System

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ABSTRACT

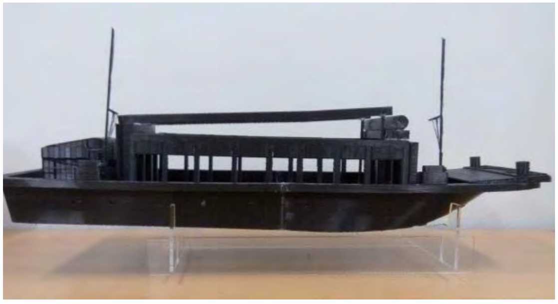
In North-East asian countries, laver cultivation has been an important marine industry in coastal areas as well as fishery because laver (Porphyra) is nutrient-rich food and has been used in many Asian cuisines. Laver is characterized by high concentrations of fiber and minerals, a low fat content, and, in some cases, relatively high protein levels. In this paper we inplimented design of fully automatic laver harvesting, nowdays most peoples are used to collect a laver harvesting by human, it is very defficult working, due to wind, waves, and the weather conditions which is hard to stand on the ship and holding the seaweed nets it can be injurced human, this is the reason to we are developed automatic harvesting method, in this project we proposed automatic harvesting collect method which is operated without human. Mainly we design and developed automated ship, This ship is devided in to three parts frist part is supporting roller, second part is drum screener, thried part is lifting mechanism. Thise are operated with hydro pnumatic equimpment, this divice are control with micro controller. The system prototype has implemented and satisfied by the performance to realize the further level.

1. Introduction

In Japan and other Asian countries, laver cultivation has been an important marine industry in coastal areas as well as fishery because laver (Porphyra) is nutrient-rich food and has been used in many Asian cuisines. However, laver cultivation is vulnerable to natural disasters such as typhoons and tsunamis. If those disasters hit laver cultivation area, laver cultivation structures would be devastated and scattered around the coast. This will affect not only owners of the laver cultivation structures but also the free passage of ships around the area. Laver (Porphyra tenera) is traditionally consumed in Asia, particularly in Korea, Japan, and China, but is only occasionally consumed in other parts of the world. However, the increasing popularity of orie-ntal cuisine in Western countries in recent years has increased the demand for this marine vegetable. Laver is characterized by high concentrations of fiber and minerals, a low fat content, and, in some cases, relatively high protein levels. Consumption of seaweeds, including laver, increases the intake of dietary fiber and lowers the occurrence of some chronic diseases such as diabetes, obesity, heart disease, and cancer (Bocanegra et al.,2009). Recent studies have re- ported that seaweed extracts have strong antioxidant properties. Red seaweed, including laver, is considered as a rich source of antioxidants, such as polyphenols, phlorotannins, and fucoxanthin. In the traditional laver farming there are used in the two main cultivation methods. The traditional “racks” method used for high quality laver that is similar to naturally grown laver, and the “floating rafts” method used for mass production.The traditonal water laver cultivation as shown in Fig.1. Therefore, monitoring laver cultivation area is important.

(Fig 1) The traditional underwater cultivation system

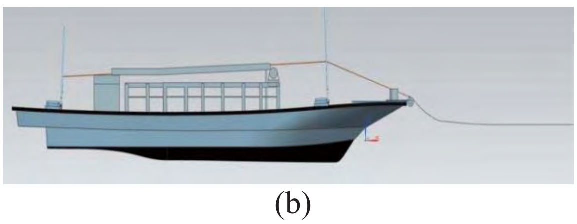
Now way days, Synthetic aper- ture radar (SAR) has been proven to be one of the most useful sensors and therefore used in a variety of areas because of its all-weather and day-and-night observation capabilities with high resolution (Mitsunobu et al.,2012). In our test site of laver cultivation,every year starting from October, cultivation nets are placed at approximately 10–20cm below the sea surface with supporting floats with laver spores attached to the nets, grow during winter, and the grown laver is harvested in next April. Through, this process, the nets are sometimes placed above the sea surface to promote photosynthesis. In order to harvest the laver the new system is proposing to realize it. This system consists of automatic harvesting and acidic processing system. The prototype of the proposed harvesting system is shown in Fig.2.



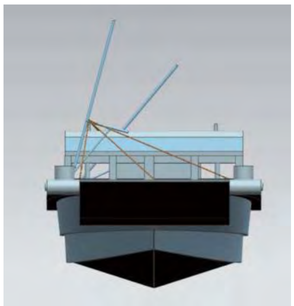
(Fig 2) Prototype of the proposed automatic harvesting system

2. Design of Automatic HarvestingSystem for Laver

The design of the Automatic Harvesitng system as shown in the Fig.3. This system consists of boat, roller, control valaves, hydraulic actuators, and ropes. Initially the rope is moving through the support of the hydraulic actuators. Whin hydraulic actuator connected with the two lifting bars. These two are fixed at thefront and rear ends of the boat to pull the rope on the boat through the support of the roller.After getting the rope on the boat, the laver is cutting down into the bottom of the boat. After collecting the laver, the rope will get outside of the boat, the process will be begun at the front end bar and ends with the rearend bar. This process runs continueously until the laver collecting finished. The mathematical equations of the lifting bar as follows (Yamaguchi., 2005, Farid et al.,2010). The proportional integral (PI) controller can be expressed as in (1).



(b)



(d)

(Fig 3) Design of automatic harvesting system, (a) Side view, (d) Front view

$$PI = K_p + \frac{K_I}{s} \quad (1)$$

where Kp is proportional gain, KI Intergral gain and PI is proportional integral (PI) controller.

The force balance equation for the lifting bar 1is used for opposing a load force FL in the z direction expressed as in (2).

$$F_L = A\left(P_A - P_B\right) \quad (2)$$

where FL is load force, A is the area of the piston, PA Pressure level A, and PB Pressure level B.

The pressure expressing equations at level PA and level PB as in (3) and (4).

$$P_A = \frac{K_q}{K_c} x_m - \frac{A}{2K_c} \dot{z}_{out} + P_{s}/_{2} \quad (3)$$

$$P_B = -\frac{K_q}{K_c} x_m + \frac{A}{2K_c} \dot{z}_{out} + P_{s}/_{2} \quad (4)$$

where PA Pressure level A, PB Pressure level B, Kq is the flow gain, Kc is pressure flow coefficient, xm is displacement, and ps supply pressure.

The ideal actuator where force and volume efficiencies are one as expressed in (5).

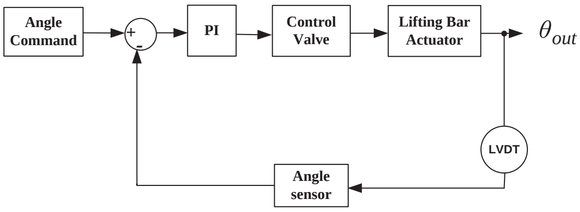
$$F_L = 2\frac{Ak_q}{K_c} x_m - \frac{2A^2}{K_c} \dot{z}_{out} \quad (5)$$

where FL is load force, Kq is the flow gain, A is the area of the actuator piston, Kc is pressure flow coefficient, xm is displacement, and ps supply pressure.

The transfer function of the lifting bar expressed as in (6).

$$\theta_{out} = \frac{K_r K_q\left(K_p s + K_I\right)}{s^2 A_m - \left(K_p s + K_I\right)\left(K_r K_q K_f\right)} \quad (6)$$

where Kr is control valve gain, Kq is the flow gain, Kp is the proportional gain, KI is the intergral gain, Am is the area of main spool and Kf is feed back gain.



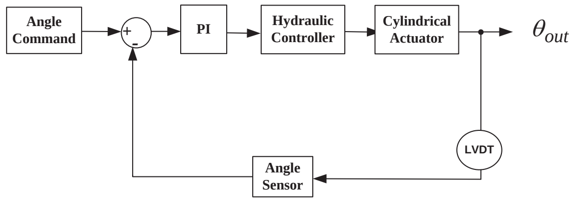
(Fig 4) The Block diagram of the lifting bar

The block diagram of the lifting bar as shown in Fig.4. It consists of PI controller, control valve, lifting bar linear actuator, and LVDT with feed back sensor. When user define the command through the algorithm, it gives to the PI controller which is control to adjustable flow to control valve to lift he lifting bar which is a linear actuator is an actuator that creates motion in a straight line, in contrast to the circular motion of a con-ventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor. The lifting bar output will feedback by the linear variable differential transformer (LVDT) (also called linear variable displacement transformer, linear variable displacement transducer, or simply differential transformer) is a type of elec- trical transformer used for measuring linear displacement (position).

The transfer function of the hydraulic actuator is expressed as in (11).

$$\frac{\omega_{out}}{\omega_{desired}} = \frac{2\frac{AK_q}{K_c}h}{K_f\left(1+T_c s\right)\left(Js^2+\frac{2A^2}{K_c}s\right)+2hL\frac{AK_q}{K_c}} \tag{11}$$

where $T_c = \frac{A_m}{K_q K_p K_f K_r}$, A is the area of actuator the piston, Kq is the flow gain, Kc is pressure flow coefficient, h is the transducer gain, Tc is the constant, KI is the intergral gain, J is the moment of inertia, h is the transducer gain, L is the load, and Kf is feed back transducer gain.



(Fig 5) The Block diagram of the Cylindrical actuator

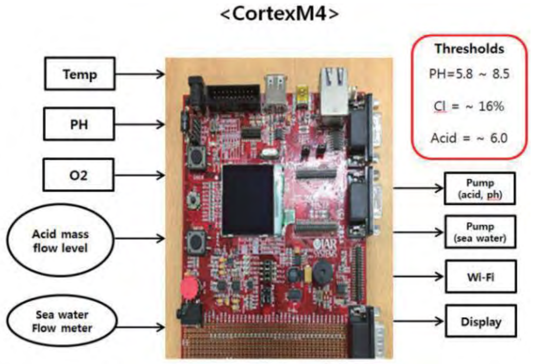
The displacement is only along the axis of the piston. Typically hydraulic actuator is a device controlled by a hydraulic pump.

$$\frac{\theta_{out}}{\theta_{desired}} = \frac{2\frac{AK_q}{K_c}h}{K_f\left(1+T_c s\right)\left(Ms^2+\left(D+\frac{2A^2}{K_c}\right)s+K_L\right)+2h\frac{AK_q}{K_c}} \tag{12}$$

where A is the area of the piston, Kq is the flow gain, Kc is pressure flow coefficient, h is the transducer gain, Tc is the constant, KI is the intergral gain, h is the transducer gain,and Kf is feed back transducer gain.

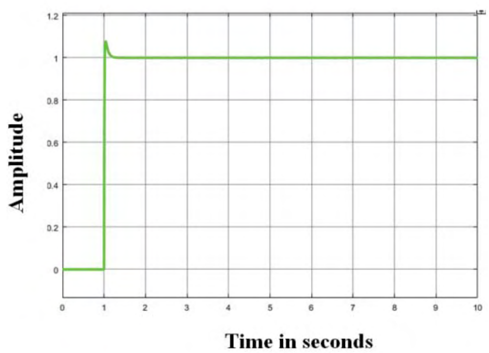
The block diagram of the hydraulic motor actuator as shown in Fig.5. The block consists of angle command, PI controller, hydraulic controller, cylindrical actuator, LVDT, and angle sensor. The transfer function of the cylindrical actuator is expressed as in (12). The hydraulic controller which is a liquid pipeline-pressure controllers. A device that uses a liquid control medium to provide an output signal, which is a function of an input error signal. Pneumatic actuators, or pneumatic cylinders, are similar to hydraulic actuators except they use compressed gas to generate force instead of a liquid. They work similarly to a piston in which air is pumped inside a chamber and pushed out of the other side of the chamber. Air actuators are not necessarily used for heavy duty machinery and instances where large amounts of weight are present. One of the reasons pneumatic linear actuators are preferred to other types is the fact that the power source is simply an air compressor. Because air is the input source, pneumatic actuators are able to be used in many places of mechanical activity. The downside is, most air compressors are large, bulky, and loud. They are hard to transport to other areas once installed. Pneumatic linear actuators are likely to leak and this makes them less efficient than mechanical linear actuators. The output signal which is fedback by the LVDT through the angle sensor.

3. Hydraulic Bar and Actuator

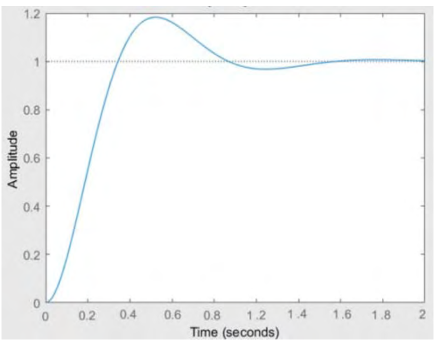


(Fig 6) Board configuration applied to Hydraulic Cylinder and actuator

The simulation analysis of the lifting bars such as lifting bar1 and lifting bar2 as shown in the Fig.8. When the lifting bars are lifting the system stable time is very fast. The simulation analysis of the hydraulic actuator is shown in Fig.7 8. It shows on the x- axis taken as time and on the y-axis taken as amplitude. It is the pressure flow analysis while moving the hydraulic actuator.



(Fig 7) The simulation results of the lifting bar



(Fig 8) The simulation results of the hydraulic actuator.

4. Conclusion

In the conclusion, in Japan and other Asian countries laver cultivation has been an important marine industry in coastal areas as well as fishery because laver (Porphyra) is nutrient-rich food and has been used in many Asian cuisines. Laver is characterized by high concentrations of fiber and minerals, a low fat content, and, in some cases, relati-vely high protein levels. So that, the auto- matic harvesting and acidic processing system for underwater laver cultivation has proposed. This automatic system consists of design of the boat with hydraulic, cylin-drical, and linear actuators, and also acidic processing system consists of sensors which are used to maintain the certain level of the acidic nature of the water. The system prototype has implemented and satisfied by the performance to realize the further level.

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