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INVESTIGATING AND INTERPRETING THE PERFORMANCE OF FLEXIBLE ROBOT IN CONTROLLING THE CONDENSATION FLOTATION OF COPPER COMPLEX SHAHR-E BABAK

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ABSTRACT

In the condensation unit of the National Iranian Copper Company, a flotation operation is carried out to improve the copper concentrate. In this operation, by adding a substance called lacquer and blowing high pressure air into the mills, the pH of the concentrate is reached to an optimal level of 11.5 to 12.5. Obviously, if the pH of the concentrate output from the mill is outside this range, copper perforation has failed and the concentrate is known as waste. Therefore, one of the most important operations in copper perforation is floatation. At present, there are pipes for drainage of lacquer and blowing of compressed air into the condensing mills, with the discharge amount monitored through the control room. The control room controls these concentrations based on the pH characteristic of the concentrate pH contained in the mill and lowers or increases the amount of lime and compressed air. Problems such as high precision, user control room, and the need for a lot of manpower will make it a way to replace the robot with a human. From the direction of operation, the addition of lighter and compressed air is controlled by the electrical keys, and also the pH of the concentrate present in the mill is also displayed on a monitor. This paper presents an idea for using a robot instead of human control, which makes the robot control the copper flotation control by flexing the arms. The robot presented in this article is simulated by Webots software and simulation results are presented with this article.

1. INTRODUCTION

The robot is a skilled kinematic system. The robot base moves to increase the size of its work space, increases its kinematic skill as the system finds degrees of freewheeling freedoms and can avoid individual faces and encounter obstacles [1]. In moving robots, the flexibility of the base motion acceleration, the acceleration of movement and the length of the links of the skilled mechanical arm and the mass ratio of the load taken by the final executor to the mass of the mechanical arm of the skilled direct relationship with the mechanical strength, the area and dimensions of the cross-section of the link The skilled mechanic arm has an inverse relationship [2] To increase the amount of work space, the base of the robot moves and links may be made without changing the longitudinal cross section [3,4]. Sometimes to reduce power consumption, increase maneuverability and use of small operators The robot will be made lighter by reducing the area of the cross-section and keeping the link lengths constant, and as a result, the flexibility of the links will increase and the links cannot be considered rigid [5].

In flotation, mineral separation is based on differences in their physical and chemical properties. In this way, after the preparation of the pulp with chemical reagents, some of them are hydrophobic and another group is watered [6]. In selected separation processes, air bubbles cling to hydrophobic particles and transfer

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them to the surface and form a stable foam layer. This foam layer can be collected from the floats located at the level of the flotation cell.

In the control room, there is a copper flotation in the control room for controlling the mill, the input and output of substances and additives such as compressed air and lye. There is also a monitor to monitor the condition of the material inside the mill, which displays properties such as the pH and the tonnage of the materials inside the mill. The controller controls the input and output of the mill based on the tonnage of the material in the mill, and, based on the pH of the material within the mill, controls the amount of milk injected into the mill. If the pH of the material inside the mill is reduced to a pH of 11.5 or more, then a larger amount of lime milk should be injected into the mill and if, by contrast, the amount of this characteristic leads to the play of the substance, 12, a smaller amount of milk should be injected into the mill.

2. METHODOLOGY

2.1. Robots unmoved

Mechanical rigid arms are widely used in industrial production. To make the instrument hard, most of them are very heavy and bulky. In order to obtain high accuracy in controlling the position of the paws of these robots, the ratio of the weight of the robot to the load weighs it should be high and the working speed is low so that the effects of the flexion have no effect on the performance of the robot. To use these heavy and massive robots, the massive energy requirement is considerable [7, 8].

2.2. Flexible Robots

The flexible arm is usually made up of lean, lightweight members with low flexural stiffness. Given the recent advances in the use of robots and the human need for high-speed and high-quality robots, the idea of using light robots has been raised. Because robots with high speed and heavy loads have a relative variation in robots, robot problem with elastic arm arises. The purpose of the design is to make flexible cracks to reach a quick movement and high maneuverability as compared to the slow motion of slow robot industrial robots. All materials have a limited hardness and shape the force and momentum. Even in robots that are rigorous, we can see vibrations at high speeds and elastic effects cannot be ignored [7, 8].

2.3. Copper Flotation

Flotation operations are carried out on fine grains produced by the crusher. Dump trucks start condensing operations after transporting loads to the crusher and discharging loads in large roller crusher. In the earliest phase of the crushing process, the minerals must be converted into fine particles of 100 microns. These materials, like powder, are considered to be feeds for the condensing plant. In Figure 1, Flow through Flow Control Flowchart is described.

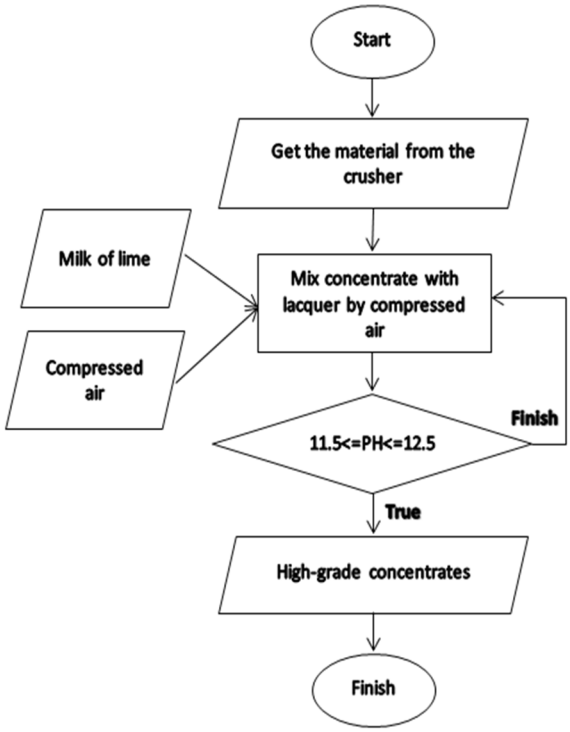

Figure 1 Copper Flotation Flowchart

The condensing plant consists of large mills that, by pressure, convert these fine particles to a liquid-like material. They are called concentrate. In order to produce mill concentrates, they should do fine-grained operations, apart from the purchase of fine grains. According to chemical tests performed on copper minerals, the pH of these minerals is converted to acidity. But for filling and refining capability at the refinery, this should move towards play. Lime is the best and fastest substance that can convert the state of matter from acidity to play. The combination of lime with any acid or neutral substance causes the game to play. The use of pressure is used to combine fine materials together (fine grained materials with lime). Certainly, the more pressure the wind is, the better it will be. The amount of limestone injected into the mill should be as high as possible in the best way. The best concentrate has a pH value of 11.5 to 12.5.

The flotation control room is required to control the pH values and monitor the composition of the ingredients inside the mill. For this operation, special lenses are used to control the amount of air blown and the lime is injected into the mill.

3. THE PROPOSED IDEA AND RESULTS

Regarding the control louvers in the flotation control room, Fig. 2 shows how the lever state changes.

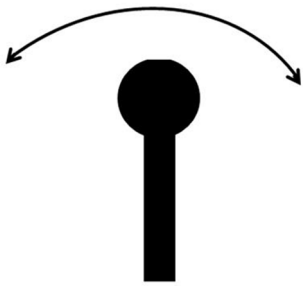

Figure 2 A view of the movement of control lever

So the arm of the robot should drive this lion forward and backward. In order to consider the flexible arm, we should consider the elastic property in the arms and legs of the robot. This is done for the slightest change in the physical shape of the control room and only a robot in the control room instead of a human being.

The control robot should have an electronic eye sensor, which can display and reasonably display the mill condition. Based on the specifications on this screen, the lions need to be changed. Hence, the embedding of an electronic eye alone is not useful, and the robot must have an image recognition algorithm to understand the terms written on the monitor. The algorithm used in this project for OCR algorithm for image recognition and resolution. After scanning an image containing the text, the computer processes the image onto the image [9]. First, the image is divided into separate sections or partitions. Then, using image processing and artificial intelligence algorithms, the letters extract characters from the text [10, 11, 12]. But your text may turn around when it's taken. As a result, the computer rotates the image a few degrees and then re-operates the image on it and gains the result. Of course, in most cases, work is not as easy as it is said, and the whole complex operation must be done on the image [13].

The robot is simulated by Webots software and the code used for simulation is written in C ++. Webots software is robotic simulation software that interacts with 3DMax, AutoCAD and Solid Work software [14]. Figure 3 illustrates the simulation of a flexible flying control robot.

For each part of the simulator that needs to be coded, the corresponding code is written with the C ++ programming language, and for each code there are descriptions.

The monitor object uses random functions to display information on its screen, and randomly selects and displays the numbers on the screen.

In the control part of the robot, we also need to write commands to control the flotation action. These commands are described in the flowchart shown in Figure 1. Here, we will better explain the operation of the robot by mentioning the functions and explanations for each one.

```
#include <Webots/robot.h>
#include <webots/camera.h>
#include <webots/differential_wheels.h>
#include <string.h>
#include <stdio.h>
```

```
 static WbDeviceTag sensor;
static int time_step = 0;
float[] info = new float[4];
int count = 0;
static void initialize(){
wb_robot_init();
time_step = wb_robot_get_basic_time_step();
const char *robot_name = wb_robot_get_name();
sensor = wb_robot_get_device("camera");
wb_camera_enable(camera, time_step);
}
```

The Initialize function is required to launch the robot to begin the operation. This launch includes the start of all parts of the robot. The eyepiece is started and all the flexible arms are in neutral position.

```
void process_pictur(){
string status = wb_OCR(sensor.value);
int i;
for (i = 65; i <= 91; i++)
status = strchg(status, chr(i), NULL);
for (i = 97; i <= 123; i++)
status = strchg(status, chr(i), NULL);
status = strchg(status, ':', NULL);
int j = 0;
string temp = "";
for (i = 1; i <= 4; i++){
while (status[j]!=''){
strcat(temp, status[j]);
j++;
} info[i] = float(temp);
temp = "";
}}
```

The process_Picture function processes the screenshot that is read by the eyeball and sorts the profile of that page. Initially, the function WB_OCR divides the display value by image processing and extracts its characters. Then, by removing the lowercase Latin letters, sets the remaining numbers in an array to separate each of the rows of the screen. The first row is the material's tin in the mill. The second row is the pH value of the material inside the mill. The third and fourth lines are used for the current system's current date and time, respectively.

```
void main(){
initialize();
while (true){
```

This loop indicates that the robot must work from the moment it starts to infinity and has no end point.

```
while (info[1] < 2000) {
hand1.distance = 100;
process_picture();
} hand1.distance =0;
```

The Hand1 Handle is used to empty copper rocks into the mill. These commands activate the liver until the volume of the material in the mill is less than 2000 kilograms.

```
while (info[1] < 2700){
hand2.distance = 100;
process_picture();
} hand2.distance =0;
```

The Hand2 is used to drain the milk into the mill. Since the amount of milk in the mill must be one third of copper, then seven hundred kilograms of lime milk is discharged into the mill.

```
while (info[1] < 2905){
hand3.distance = 100;
process_picture();
}hand3.distance =0;
```

Lever Hand3 is used to drain compressed air into the mill. These orders discharge 205 kg of compressed air into the mill. 205 kg of compressed air is equivalent to 200 times the air pressure.

```
process_picture();
if (info[2] < 11.5){
Count = 0;
float ton = info[1];
while (info[1] < ton + (ton / 4)){
hand2.distance = 100;
process_picture();
} hand2.distance = 0;
} else if (info[2] > 12.5){
count = 0;
float ton = info[1];
while (info[1] < ton + (ton / 4)){
hand1.distance = 100;
process_picture();
} hand1.distance = 0;
} else count++;
```

We are now looking at the PH characteristic on the monitor, and until the value is set to between 11.5 and 12.5, we continue to add lime and copper rocks. This should remain constant for up to 10 steps in order to ensure proper flotation.

```
if (count == 10){
while (info[1] > 100){
hand4.distance = 100;
process_picture();
}hand4.distance = 0;
}}}
```

After verifying the correct operation of the flotation, we must remove the mill from the Liver Hand4. The milling takes place as long as the material is larger than 100kg. This remains due to the fact that the concentrate has adhesion properties and the likelihood of a concentration of concentrate to the mill walls.

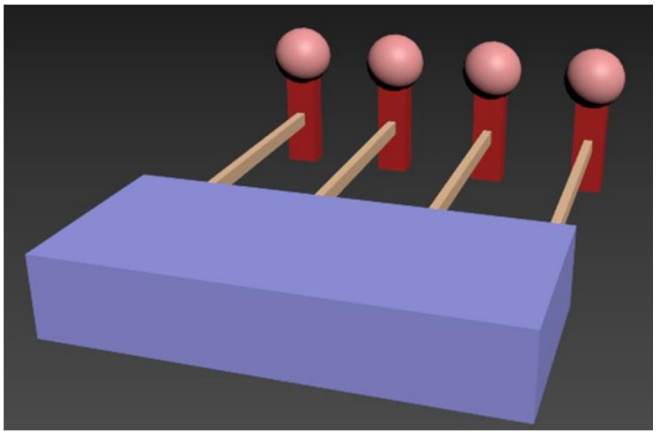

Figure 3 Robot simulation view

4. CONCLUSION

Of course, any idea in technical projects has a result. Now this result can be disadvantages or benefits. Since the robot is simulated in this thesis, we will describe the simulation results in this section.

According to the implementation of the simulation codes mentioned in the previous step, based on the information shown on the screen, which are completely random and used to test the flexibility of the robot arms, the controller robot was able to create a magnetic field On the flexible arms, the louvers change the control and work as easily as human with these lions.

Expressing the advantages and disadvantages of any work requires proof. First, we will mention the benefits and then the disadvantages by proving the claim.

- Saving Manpower: The principles of the work of robots and electronic machines are helping people to do that. Everything a robot can do to help a man and not reduce the quality of that work can save you money. However, this will save costs such as monthly salaries, salaries, food and housing for manpower. Assuming that there were 3 people in the control room in different shifts. By calculating the salary and overhead costs of these employees, the monthly staff costs a cost of seven thousand dollar. But this cost reduction is not always accepted, and some managers ignore this and pay more attention to the principle of human work to address the problem of unemployment.
- Increased accuracy and performance: A robot has no feelings. That means the robot will not get sick and will not be saddened by people around you and friends. These feelings are a factor for a human being to have errors in their performance. If a person makes an error in the work due to the sadness of losing his acquaintances and creating distractions, and produces the produced product in a non-quality manner, it can be justified. But if a robot does this, it does not have any justification. Because the robot has been working solely for the purpose of optimal production. So the robot never produces decent quality concentrates.
- Efficiency in any situation: Human being controls what is required in the month to have compulsory and compulsory leave. These leave are at the official holiday and the employee cannot do his job during this time. But the robot does not need a vacation and the work environment does not prevent its operation. Environmental conditions include factors such as strike or adverse weather conditions that an employee cannot do at work despite these conditions.

Any technical project that is being undertaken will open a way for research in future periods. The disadvantages of each project are to clarify these paths. The control robot that is designed in this dissertation needs to work in the control room. This robot only controls the controls based on the characteristics of the flotation mill. If the mill can be made in such a way that the robot operates on the mill and requires the control room and the cost of construction and additional equipment such as the characteristics of the mill characteristics, the control room ventilation, additional electronic force to control the robot, etc., it seems Save the flotation control to the optimum level.

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