# Design a Robot for Controlling Carrier Dump Trucks in Mining Affairs of Copper Complex Shahrbabak

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**Abstract**
Today, with the advancement of technology, most of the work done in the past by human hands is simulated by robots. Humanoid robots endure the difficult conditions of the work environment and can perform operations better than humans without any errors. Welding robots at high altitudes perform well welding operations. The control robots of the melting furnaces do the correct operation of the furnace control, and so on. In this paper, a robot is designed to control the dump of the mine tracks of the Copper Complex, Shahrbabak, in place of the man-controller, which has the capability to record tracks on the basis of their vehicle identification numbers. The recording by these robots eliminates the data recording errors, and there are no environmental conditions or factors that can reduce the efficiency. Since it can instantaneously store information about the trailer dump traffic in the server's database, it allows the server to prepare reports online for mining experts. In this research, suggestions are made to improve the security and reliability of the project.

***Keywords:***
*Wireless Connectivity - Image Detection - Control Robot - Identify the plaque*

## 1. Introduction

Every day, new sciences are added to the universe. Each science is the source of a new science. Some sciences link from a tendency to another trend and provide a way to reject information between two scientific trends. Robotic sciences are more likely to be presented with the same purpose. An industrial robot serves in every field of the industry and is a way of connecting the robotics with the industry. The surgeon robot makes robotics and medical sciences easier [14]. In this paper, there is also a connection between robotics engineering and mining engineering. In mining engineering, a lot of work can be done with robotics. In the field of mine control and control, there is a unit that registers the traffic of dumpers, and finally, based on this information, calculates the tonnage of freight transported from one source to a destination. This tonnage is calculated quantitatively and the exact amount is not noticeable. Also, based on the traffic flow statistics and the activity of their drivers, at the end of the month, the calculation of their rights is based on the same statistics. The recording of data is done by people who stand in certain paths of the mine and, by visiting a dredger, will record the identification number and the date and time of the passage of that route. At the end of the work shift, this information, which was recorded on the report paper, is stored by computer operators in Excel files. At the end of the month, logging of Excel files should be done manually. With a thumbnail account and the calculation of the percentage error of data recording by the person, we find that the information is logged and edited once by the controller, once by the operator and once by the reporting. So there is a lot of error in these statistics. Hence, the design of a control robot instead of human can have some interesting benefits. In this paper, a robot controller is designed for mining operations that has the ability to record information on central servers.

The robot presented in this article should identify the dummy of the tracks on the road based on their identification number. The identification number of the dump tracks is in a mineral complex, such as the license plate number of a country. The method for detecting the identification number of the trailer dump is also based on the identification of the license plate

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number. So far, there are many methods and algorithms for identifying vehicle license plate numbers, which explains how these algorithms are implemented.

Seyyed Razizadeh and Veisi provided an automated method for the separation of Persian letters in Persian-language images, which is one of the main units of the Farsi-language OCR system. This method is based on finding a state machine that retrieves information from a single row of entries as inputs, replaces its state, and eventually announces the separation of letters in appropriate locations. Kohon's self-organizing mapping neural network (SOM) has used text-to-column tags in a text line and uses a genetic algorithm to find a suitable separator state machine. The optimality of each state machine is determined by running the mode machine on the training data. The accuracy of this method was 99.5% on the test data of 8,000 letters. In addition to the high precision, the other advantage of this method than the similar methods, all of the automation of the steps is that with the training data, all the steps can be done without changing the new data [2].

The caretaker and inspiration for car license plate systems write: Identifying and reading the license plate is one of the topics discussed in traffic control, and a license plate number recognition system has the ability to automatically recognize the license plate and read its number. Vehicle number is one of the information items for automobile authentication. The license plate recognition system is a mechanized system that extracts the license plate number by photographing them. "He has provided a two-part method to identify the license plate. In the first part, using the edge detection and morphological operations, the location of the plaque is identified, and in the second part, using the hybrid network, stack generalization, the characters are identified. This method has been tested on different images in terms of background, distance and viewing angles, and the correct extraction rate of the plaque was 98.8%, as well as the correct reading rate of the plaque was 96% [1].

Qasemi Mazobani and Muthani write: "Today, FPGA's modern platform has provided hardware and software infrastructure to build chip-based systems. In this situation, the designer can customize with the choice of accessories and functions, or the use of new hardware. Design your own other hardware feature, accelerating the computational capabilities of the system's specific applications. Such a mechanism will increase efficiency and reduce power dissipation. On the other hand, video surveillance systems on urban traffic have played a significant role in improving the transport control process over the past few years, which has increased the approach to such systems in metropolitan areas. "In this paper, the algorithms of plaque Read the car on the FPGA and examine the results [3].

Saberi and Tossi Zadeh write: "Analysis of textual information in the images allows for the conduct of activities such as identifying car plates. Detecting and translating the search terms of the content of the videotape images in the video sequences and the text-based indexing of images automatically provides images. . In realistic images, due to the font size variation, text size and text color, and the complexity of the field, there is no possibility of using standard OCR optical characterization techniques, and extraction of text in this category of images is one of the challenging issues in image processing. "This article focuses on searching and recognizing text in real images. His proposed method is to read the text in a particular object contained in the image. In order to display the results of the algorithm, it is used to solve the problem of reading the gas meter numbers automatically. The proposed method consists of three main steps in the preprocessing of finding the counter location using the MSER algorithm and classifying the numbers of the area desired by the SVM algorithm. Despite the complexity of the problem, the proposed method presents good results and provides a short computation time. It can be used in applications as well as mobile devices [4].

## 2. Controlled dump truck:

The dumper operation includes: Traffic Dip Traffic Control: This operation involves registering the tracking dummy identification number along with the route of that device in a specified date and time. Basically, the dumper tracks run from an operational step to a tailings dump or crusher. The operational step is the place where the material is harvested, and the tailings dump is the place where the material is deposited without a matrix. Crusher is also the destination of high quality materials that will be used as feed for the plant.

Detecting the empty or dummy trap: Since the weight transported by the dump tracks is a specified weight and with a tolerance of about one ton, then if the dump truck contains material, then the loading weight of the dump trailer should be in save the database. It is very easy to find out whether the load dump is a load carrier. If the dumper is moving from the operational step to the dumper or crusher, then it is the load carrier and otherwise it is not. The dumper identifies tracks coming from the stairs as load carriers and records the rest without load.

Submitting reports to the control unit: Traffic dump tracking information is recorded by the dumper on the report form. At the end of its shift, the dumper will submit the report forms to the mine control unit. There, a computer operator is required to register the report forms in the statistical files prepared in Excel.

The first task of damp chi is simulation and simulation cameras. The camera can capture an image of the track dump and process the information on that image and determine the load state within the dump truck based on the route it traverses. This camera looks at the operational step. If you see a dump truck from the front, then the dumper is carrying the load, otherwise the dumper is empty on the move. So the second task can be modeled by the same camera.

The third task is provided by Internet technology. The log file is sent to the central server by the Internet, after viewing the dump truck and processing the status of that dump truck. This information is registered by the server and does not require an employee or other computer operator. The software on the server side has the task of validating and storing information in the database, and has the task of reporting.

## 3. Identify dump truck:

Image processing operations in a plaque identification system are composed of three main parts. Find the location of the plaque in the image, separate each element and read each single element. In the process of locating a license plate, we can identify vehicles other than the trailer dump and do not perform image recognition for those vehicles. The problem with light-sensitive cameras is thus eliminated.

### 3.1 Plaque location:

At the stage of recognizing the place of the plaque, the image is first turned into Grayscale or Gray mode [7]. In this case, the image colors turn into a range of black and white. In these images, a plaque can be found more quickly [8]. Then, noise cancellations from the image, finding edges, image wear, filling the cavities and extracting plaques are done in the following order.

### 3.2 Remove Noise:

After converting the image to the gray level, the Gaussian filter is applied to eliminate possible noise in the image. The Gaussian function checks all the pixels in a row and, based on the color of the pixels in the side, reinforces the color of that pixel. This operation is performed for all lines of the photo. If the image has a noise color, the noise will be lost with this operation [6]. The Gaussian function is defined as follows:

$$W(X,Y)=1/\ 〖2ΠΣ〗\ ^2\ \ E\ (X^2+Y^2)/(2Σ^2\ )$$

Equation 1. Gaussian function to eliminate image noise

In Equation 1, the order of x and y is the number of rows and columns that we have chosen for the pixel. X is the row number and y is the column number.

### 3.3 ind Vertical Edges:

The edge is a sudden change in the brightness of the image. The license plate has a lot of vertical edges because of the numbers and letters on it. It is also used to find the location of the plaque in the image. Different methods and algorithms have been developed to find the edge in image processing. In the meantime, the Seville operator has a good performance due to its high speed and low processing capacity. The Seville method is, in fact, the use of the Seattle mask. In general, Seville has two horizontal and vertical edge detection masks, as shown in Figure 1. In the proposed method, since numbers and letters have many vertical edges, only a vertical mask is used, assuming that the input image does not have a rotation too much. The image obtained by applying the editing process is a binary image, with the pixels associated with the edges being specified in a value of 1 [5].

$$\begin{bmatrix} -1 & 0 & 1 \\ -2 & 0 & 2 \\ -1 & 0 & 1 \end{bmatrix} \begin{bmatrix} -1 & -2 & -1 \\ 0 & 0 & 0 \\ 1 & 2 & 1 \end{bmatrix}$$

Figure 1. Vertical and horizontal mask (left) of Seville

The result of the rendering operation is a black image that shows the edges of the image in white. With this account, we see the largest edge in the license plate because the most color variations are in the dummy tracks section.

### 3.4 Find the number of edges per row:

After finding the vertical edges of the image, the histogram chart is assisted and the horizontal histogram of the edge image is found. For this purpose, for each row of the image, the number of points with the gray level is counted and a graph is formed, the horizontal axis of the image rows and its vertical axis are the number of points counted. Figure 2 shows an example of a horizontal histogram diagram of the edge image [10, 11].

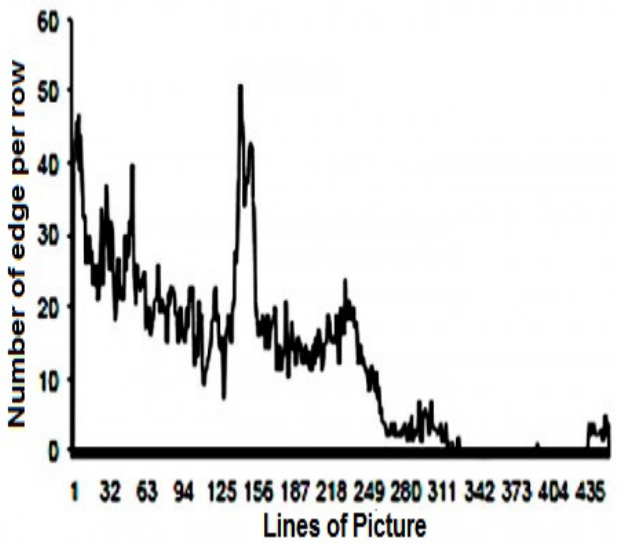


Figure 2. Horizontal Histogram Vertical Edge Image

In general, the rows of the dumper tracks are located in the uppermost horizontal histograms. So the next step is to find rows that make up 55% of the upper histogram. The placenta rows are then determined. The amount of 55% was obtained experimentally and with trial and error [12, 13].

### 3.5 Image wear:

To apply the image to the image obtained from the editing step, we apply Equation 2 on the image.

$$AoB=\{\vdash x\dashv |(B)x\in A\}$$

Equation 2. Image wear

The abrasion A and B is the set of all points x, which if B is displaced to x; it also falls completely inside A.

**Horizontal expansion of the image:**

After the abrasion operation, a horizontal expansion is performed on the image. The horizontal expansion of the image is done according to the following: expansion A with B is a set of X that x (B) and an overlap at least one non-zero element. X (B) is the symbol B around its own center, and then it is transmitted with X [15].

### 3.6 Extracting plaque:

At this stage, we first select the holes that are not selected from the image. That is, the image of a plaque that should be in the form of a rectangle should be considered and we select all points not selected in the stage of abrasion and horizontal expansion [16]. Now we have a sleek rectangle in the center of the image that exactly specifies the location of the track pad dock. The output of this step is the dummy track plate image. Figure 3 shows an example of a plaque written on the trailer dump.


**Figure 2.** Example of dumper track plate

If the image taken by the camera is shooting a dap track, then we will output at this stage and we can see the image of the plate. But if the image is from an object or another, there will be no output at this stage. But this algorithm also identifies other license plate numbers for vehicles and vehicles. In this step, we refer to the specification of the plate number of the dummy tracks, which has 4 numbers and other plates have more numbers and numbers. So, based on this feature, you can identify the dump tracks from other vehicles.

### 3.7 Separating Characters:

To distinguish characters, we use the spaces between those characters. Trailer plaque contains four numbers spaced apart from each other. We use histogram for separation. In each column, we counted the number of colored houses, and in the chart the histogram indicates the number of colored houses and columns indicating the corresponding column number on the image. Now a diagram is obtained that repeats the rise and fall operation at four distances [17]. Now, based on this chart, we find the distance between the maximums of the histogram and consider it as a separate image. Finally, we have 4 separate images, each with a single number. So we separated the dummy track image characters.

### 3.8 Character Recognition:

Hopfield's network is a kind of recurring artificial neural network that was invented by John Hopfield [18]. Hopfield's network can appear as a system with dependent memory including binary constituents. The convergence of the Hopfield network to one of its minimum positions is definite, but the convergence to the previously recorded response, although highly probable, is not certain. In the Hopfield network, the output of each neuron is fed to other neurons, and the communication weight between neurons determines the network rule. Pay attention to all. The output of each neuron does not respond to itself. In this first output network, the next input is given back to the system, which itself produces another output, and again it repeats, the final common result is obtained that does not change from one period to another. Inputs In the Hopfield neural network, it is bipolar (1, 1). To identify

characters in this thesis, Hopfield's neural network is used [19, 20]. The input of this network is the image of each single character isolated in the previous step. In the dumper plate, tracks are used from 10 numbers; these 10 can be individually located in each of the four quarters of the plaque. For each of the 10 numbers that are between 0 and 9, we must have at least 10 random-numbered images for the Hopfield network. Now, Hopfield, in a comparative way, separates the separated characters and his educational imagery, recognizes the character and returns it as output [21]. Now we have 4 numbers that put together these numbers together with a license plate number from the track pad.

## 4. Verification of performance:

After the plaque has been detected, the issue that arises is the reader's plate read correctly and correctly? After the characters are removed from the image and the OCR function is read, the error rate is declared. Most of the bugs and obstacles in plain readings are due to incorrect imaging (such as the reflection of sunlight on the camera) that introduces unwanted images for diagnosis. There are many solutions to increase reliability, such as:

Using multi-shot cameras, several photos are taken quickly and sequentially from the car and sent to identical detection systems that analyze and process images in parallel.

This algorithm uses a number of non-identical plain identification systems in parallel and together to identify the plaque. Finally, the response of each system is specified and using the maximum number of algorithms, the final answer will be obtained.

Use of non-identical plate recognition systems as backup; in this case, if the first-line detection system is not capable of detecting or that the diagnosis has a low confidence, identification to the second or subsequent system will be referred. Finally, if none the systems were not able to detect with high confidence. By using the majority algorithm, the answer could be to check all the systems, and if the majority insisted on an answer, the answer would be considered with a relatively high confidence as the final answer.

### 4.1 Send data to server:

If at the character separation stage, the number of 4 characters associated with the dummy track number is read, the project has been able to detect a track dump. At this stage, after identifying the characters associated with the tracking dummy identification number, the software must send the information about that device to the server. The data sent to the server includes the track pad dump number, date, time, and route.

The dummy track plate number is identified by the image recognition algorithm in the previous section. The date and time are sent according to the date and time that is set on the control robot. The trajectory of the trap dynamics is determined by the characteristic of the operational step, which has already been set up by the supervisory experts. This characteristic is set for each step, and includes two values for staggered stairs. If the camera specification is registered on the main stage, it will introduce the data of the dump truck to the crusher in the mode of transport. And if the characteristic of the waste stack is defined, the information sent to the server records the trap dump to the tailpipe and to the tailpiped dump.

Since the way the controller robots are connected to the central server by wireless connections, measures should be taken to improve the reliability of wireless networks. Wireless networks have the ability to communicate with other nodes to a maximum of 100m without obstacles [5]. If the distance between two nodes is higher, then a nodal switch must be used. The central server is located in the mine control room and robot management software is installed on the same server. Now, for connecting robots to a central server that is more than 100 meters in length, one switch must be used per hundred meters. The switch in wireless

networks is required to send information from one node to another and then amplify and then transmit information that is weakened by noise.
By using the interface switches, the reliability of the robot's wireless connections can be increased with the central server. Now we need to think about how to send and receive information. The information received from the server consists of the operational step characteristic, which is defined at the beginning of the installation of the control robot at the input of a step. This attribute remains as a variable in the robot memory and is always sent to the server along with the records sent. In order to send information and how to send information, we need to consider the following points: The sent information includes tracking dummy identification number, date, time and route. Light-sensitive cameras start the imaging operations from the very first moment of the dump track, and the control robot executes processing based on these images and sends the information to the server. This operation is performed until the last point of the track pad's license plate number. There may be more than one thousand records to be registered in the database during this period. Sending all these records to the server reduces the wireless connectivity and raises network traffic. To fix this problem, we suggest sending the last record that we read for a dump trap to the server. During this time, the information is read only as the last record, and if the last record is not received for more than 5 seconds, then the information sent to the server. This will only be done once with the server and only one record is sent and network traffic will be reduced as much as possible.

Due to the electrical and magnetic noise generated by inorganic vehicles, the ability to send accurate information on the network is reduced. To ensure correct sending of information, a balancing bit is considered, which can be used to verify the accuracy of the information submitted based on this balancing bit. The balancing bit is a control identifier for the sent information that is determined by the characteristics of the sent information and is checked on the server side after receiving the information. If the received information is not correct, this bit of equilibrium is not proportional to the information received and we have to request to send the information back from the server. This routine is performed on all computer networks.

### 4.2 Simulation code for OCR:

In this section, the simulation codes that are described for the image recognition algorithm in the preceding sections are explained along with the description. These codes, written in the C++ programming language, receive an image as an input and deliver a text as output.

```
#include <stdio.h>
#include <conio.h>
#include <stdlib.h>
#include <graphics.h>
#include <file.h>
main (void){
char* filename;
char* id;
int x,y;
int sidex[1000], sidey[1000], finalx[1000], finaly[1000];
filename="c:\\picture.jpg";
filestream fs=new filestream(filename,"rw");
fs.open();
image img=new image(fs,"grayscale");
for (x=1;x<=img.X;x++)
for (y=1;y<=img.Y;y++)
if (getcolor(img.getpixel(x,y))<=0.75)
img.setpicel(x,y)+=0.25;
for (x=1;x<=img.X;x++){
y=1;
while ((y<=img.Y)&&(img.getpixel(x,y)==0))
y++;
sidex[x]=y;
while ((y<=img.Y)&&(img.getpixel(x,y)!=0))
y++;
finalx[x]=y;
}
for (y=1;y<=img.Y;y++){
x=1;
while ((x<=img.X)&&(img.getpixel(x,y)==0))
x++;
sidey[y]=x;
while ((x<=img.X)&&(img.getpixel(x,y)!=0))
x++;
finaly[y]=x;
}
id=img.gettext(sidex,sidey,finalx,finaly);
```

```
if (strcat(id,img.textjust())
printf("OK");
else
printf("Not succesfull");
}
```

In the end, to compare the algorithm response, the output plain number is compared with the image recognition function of the graphics.h library. The textjust function called on the img variable only detects and returns the text within the image. The strcat function must be used to compare the two strings. The output of the Hopfield neural network and the output of the textjust function, which are two texts, are compared, and if both are identical, the algorithm's success will be declared with the OK message. If the read text is not the same in the two functions, the message not successful is displayed.

## 5. Conclusion:

The advantages of this design can be studied based on the characteristics of controller humans in mining affairs and the characteristics of the controller robot. The conditions in the work environment reduce the efficiency of work by controller humans. Writing reports manually causes write and write errors. All of this makes the robot superior to a human being. In this section, each of these advantages is presented as the advantages of the controller robot of the dump of mining tracks, and for each explanation it is expressed.

- Mine environment is very cold in winter and very hot in summer. This cold and warm air will dampen the efficiency of controlling humans. Rain and snow rains also cause dirty dirt to be trapped, with their identification number some of which are not visible and the possibility of incorrect registration of this identification number also exists. This is because the controller robot does not feel any cold or warmth, and this does not reduce the robot's performance. In the case of image recognition algorithms, because some of the photographs of the cultivars are as educational in the Hopfield algorithm, the probability of success in reading the dummy track number identification number is high.
- Since reports are handwritten by humans, and then these mining reports should be re-typed by people, then there is a possibility of data recording error. But the control robot calculates the data as digits and sends it to the server. This operation eliminates the error of recording information.

- The ability to report online is another benefit of using the controller robot. According to the rules of the robot, it takes less than 5 seconds to record information on the server. So the output reports of this software are online. That is, after 5 seconds of observing the trap dump by the controller robot, you can see a variety of reports in the server software. This is the case if reporting on a system that has been a controller man was done sometimes after 24 hours.

- Time and cost savings can also be one of the benefits of a controller robot. If we consider three shift shifts to control an operational step in which one person must perform controller operations in each shift, then three people need to control the dump tracks in an operational step. Now, if we consider the salaries and benefits of these individuals for a one-year period, it is much more than the cost of setting up a controller robot. But when a person needs reporting and logging, it's much more than a robot.

- Since control bits have been used to send information through secure bits and secure connections, the security and reliability of the plan is high, and thus there is no way to record misplaced data in the database.

We must now state the disadvantages of this project. Certainly, every technical project has advantages and disadvantages. Successful projects have more advantages over their disadvantages. The biggest disadvantage of this

method, which is also found in the human control method, is the dirty surface of the dummy tracks, and that they are not read by humans or robots. The mining area has dirt roads. Since the weight of the vehicles traveling on this range is very heavy, and then there is no possibility of asphalting these routes. Also, these routes are continually changing, and it is possible that a route will be operational within a few months and will generally disappear. So the dirt paths that heavy cars run through can create dust and dust. Hence, the sprinklers are continuously watering the mine area to reduce the amount of dust in the mine. This watering creates mud and mud and the mud that penetrates the surface of the plate and body of the dumper tracks will cause the reader to not read the correct tracking dummy identification number. This disguise is also a disorder for the person to read the track pad number by humans. The solution to this flaw is to provide cleaners with tools for cleaning up the surface of their vehicles. This prevents the reader from reading the license plate number correctly, and both the man and the robot are able to read the dummy track number.

This project has a disadvantage and five advantages. It seems that the advantages of this project are more than its defects, and it is possible to say that the project is successful in controlling the movement of the dump tracks of the mine.

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