A Study on Development of Tire Identification System (ICCAS 2005)

Ki-Seong Lee*, and Tae-Woon Jeong**

* Department of System Engineering, Hankook Tire co.,ltd., Daejeon, Korea
(Tel : +82-41-750-5431; E-mail: 8400372@hitel.net)
**Department of Electrical Engineering, ChungNam University, Daejeon, Korea
(Tel : +82-42-821-5653; E-mail: twjeong@ee.cnu.ac.kr)

Abstract:
The Bar code, RFID in the standard recognition method for the goods automation of tire manufacture process, sometimes problem occurs with the damage due to a high tension, high fever. So it has problem that needs many instruments to attach it. In this paper, in the letter of tire's surface the Mold ID which has a specific feature it proposed the algorithm for the location detection of acquisition and Mold ID of the image which uses 3 dimension cameras. It described the method which recognizes the each letter of Mold ID from the location which is detected.

Keywords: Tire, Mold, Character Identification, Laser profile sensor

1. INTRODUCTION

To classify tire according to its kinds, the necessity of identification system is keenly felt. But we cannot classify many kinds of tire by its physical elements-outdiameter, inner diameter, width, weight and so on. For that reason, recognition method of raised characters on tire surface started. In case of character recognition algorithm, already there are many technologies and methods invented. And they have been put to practical use. But in case of tire, it is very hard to get clear picture using popular camera. Because of tire's blackish character rises in the same color ground. To get clear Images, we carried out study on many kinds of illuminator like infrared light and on the angle of irradiation. But because of various size and multifarious form of curved surfaces, optimum condition of illumination is unobtainable. In this study, we used established camera that didn't affect by lighting condition. The camera established with angle between laser. we succeed to get clear image data by 3-dimensional measurement of raised character on tire's surface while rotating with static velocity. We made a selection of a mold code using a acquired image data. The mold code used in this paper to classify a sort of tire.

To recognize this mold code, we develop (1)algorithm that finds the location of the mold code in lots of image data by rotation at a angle of 360 degrees.(2)algorithm that founded location of mold code by character recognition algorithm. In this paper, we will describe these algorithm and its materialization.

2. TIRE STANDARD RECOGNITION

To recognizes the standard of the tire, there was so many trial and error in the past time. Also the affix and Scanning method of the bar code label it will be able to approach easily were attempted. The Scanning device from affix process of the case bar code of barcode method and the process which uses this bar code information is necessary. Composition of system is not hard. But in tire Curing process, the problem (color of barcode label changed, damaged, destructed, etc.) occurred by high temperature and strong. And in process operation coat problem point also the problem point where the immediate shift of oneth person product standard shift hour barcode label does not become accomplished occurred and it is difficult to site application.

Fig. 1 Bar Code in the Past and Vision System Method

It respected a tire standard recognition and also one reading was the method which recognizes the letter that is projected to the tire surface.

Fig. 2 Tire’s Mold number

The environment condition of the camera became an important question in this method. Especially in tire, the difference of color is not large. But the Recognition systems have to recognize projected letter in black surface of tire. The original image highly affected by illumination of location. Generally tire has various size and form. Therefore it is impossible to adapt an angle of illumination to tire.
So, letter recognition method promoted using profile sensor based on laser that has good property with disturbance. There are many letters on tire’s surface, but specific letter that can divide each product is not many. There is DOT number which shows tire’s manufacturing company, a standard, the date of manufacture, but it written only one side of tire.

So Mold number that exists both sides of the tire with the letter which has the feature it will be able to divide the product selected.

3. Tire mold number Recognition

3.1 Identification System Construction

In this system, the Profile sensor which is composed of the Laser illuminant and the camera roles most important. To get a 3-dimension image data, as picture0, The Laser Line projected vertically, and the Digital Camera can read the profile of the subject that made by an angle of inclination.

![Profile Sensor using Laser Line Projector](image)

This profile sensor set up on upper side of tire and can rotate with range of 360. During 1cycle rotates, It acquires the image of motive making 8192 frame in pulse signal of the Encoder of 2048 resolution which are established in the sensor rotary axis and this image Array becomes the conversion with three-dimensional data which have letter information of the tire surface.

![System that recognized tire’s Mold number](image)

Generally, vision system has sensitive response to external illumination. But in here, laser that has no effect on disturbance used. It is proper method about tire manufacture process that has many disturbance, noises.

Profile Sensor linked with computer by IEEE 1394 interface. And computer carry out processing for letter recognition. The tire the product At quality of manufacture process of tire, each product is different. But there is a case which uses the same mold. In this case, It cannot divided just by Mold number. So color recognition sensor additionally installed to recognize color line printed in Tire.

![Process flow](image)

3.2 Recognition System Process

The image of tire surface is obtained from Profile Sensor of Bytewise. Bendy shape on tire’s surface reflected by Laser Beam obtained by camera and obtained image digitized.
X coordinate in Fig.7 tire’s surface of 512 resolution and Y coordinate is the height to express projected letter 3-dimensionally. It is a data from 1 point of the tire and if the whole of the tire to scan, 8192 pictures are acquired. It is similar as image acquisition method of Line Scan Camera.

![Whole Image of tire](image1)

Fig. 8 Whole Image of tire

It was acquired from the Sensor, it arrays each image 8192thing, like Fig. 8, become 2 dimensional images and the each pixel mean the height where is not the image, it means that made a 3-dimensional images mean came to make.

In Fig.8, it is expressed with easy to see data of each pixel by visual image. Red means high value and blue shows low value data.

The graph which is indicated on lower part of Fig. 8 is the Track View which it sees from the color line which rakes up from the specific horizontal plane of the image which is acquired. In Track View graph, we can see crossed letter in each location, the height measured and expressed.

![Track View in mold number location](image2)

Fig. 9 Track View in mold number location

Find the location of mold number is most important to recognize mold number. In general, when we recognize specific letter and signal by image processing, define the characteristics and carry out the algorithm to find defined characteristics. First, To recognize mold number in this system, its characteristics have to defined.

The mold number is composed of 2 lines letter, left, Right, At, Under. It is a margin of schedule quantity caught a feature in standard of recognition.

![Mold number with decimate grid line](image3)

Fig. 10 Mold number with decimate grid line

In Mold number(K406 03152), in order not to be limited a feature in only specific letter, generalized as picture 0 and it amended.

![characteristic simplification of mold number](image4)

Fig. 12 characteristic simplification of mold number.

To simplify the high resolution image, original image downscaled with 1/16 width, 1/4length. This means 8192x512 Pixel data simplify to 512x128. This called Condensing Method.

Condensing Method designed to decrease the processing time and to find mold number’s feature. In original data 15x4 pixel data converts 1point pixel data. 60 pixel data in this area, among 0 and 1, if 1 is above 35%, became 1, and the other side, became 0. In this part, 35% is known number from experience with many tests.

The image of picture 0 location of mold number the place where it searches becomes the standard data which is used from the whole video data of the tire.

![Filtering by 2-dimensional FFT](image5)

Fig. 13 Filtering by 2-dimensional FFT
Image of original of picture 0 it uses the FFT and Inverse FFT.
In real tire’s Radial direction, because this is a filtering to recognize shown letter on flat surface with elimination of Runout components and horizontal bend of tire, Hi-Pass Filtering composed in this system. And to eliminate the high frequency noise component Low-pass section used.

Obtained data is 8192x512. For it’s too many, to find the location of mold number, compressed to 512x128 resolution. And the compressed image converted to simple image like figure.14 by thresholding.

From image data of Figure.2, characteristic of mold number simplified standard pattern. And compared standard value with that pattern shifted X,Y axis. Standard pattern and obtained image already became threshold. So matching 1,0 to them, and made the Score map in X,Y axis location by correspondent amounts. After above process, coordinate that has most high Score is mold number that wanted to read.

The Score it depends to the map and is confirmed a character recognition from location of the mold number which it starts. It respected character recognition and the many algorithms were proposed even in existing. Tire Mold number the size and font of letters similar are is a strongpoint. But for the difference of each mold and tire form made with the rubber, the height and width of letter are various. Its a weak point. Consequently, in spite of with the font which is identical and the size is similar, read letter from the sensor are various. So, each letter and number arranged Database.

Even the letter which is identical, but the images which acquired are various. So, It may recognizes to similar character. For example, 8 and 9, R and A, 0 and C, etc. In this system, obtained letter saved Database and all registered same character overlapped. Additional value was calculated in each pixel.

In same character, many overlapped pixel must be additional value is high. And the other is must low. This standard letter compared with recognized letter by additional value array. Likewise in each letter, score map by additional value used. According to map, most high scored letter recognized by this method.

4. TEST RESULT

It is a tire Mold number recognition test result due to the method which are proposed above.

K406
02481
K40602481

Fig.17 Character Database in the Screen

Fig.18 Additional value Array in each Pixel

Fig.19 The letter which is acquired character recognition
Table 1 Character recognition and Score Map

Each letter is found by weight matrix of letter and database in the Score which is calculated the most high one and inside Uss u the Score and difference of similar letter are remarkable and appears. So, almost there was not a case which it recognizes by mistake.

5. CONCLUSION

The bar code, RFID, letter recognition using camera in the standard recognition method tried for the goods automation of tire manufacture process, problem in controlling, expense, low recognition rate occurs. So, its cannot realized.

In past, in method used camera, the Recognition systems have to recognize projected letter in black surface of tire. The original image highly affected by illumination of location. But in this system, laser profile sensor that has no effect on disturbance, oscillation, illumination used. It solved the above problem.

Also appearance computer based on high speed-CPU processing time saved. It spent many time in bygone days, but now the processing time within 2~3 seconds spend.

So, this system was able to apply in field.

with development of the system which it sees the many help will become in tire manufacture process automation.

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REFERENCES