Position Measurement System Based on Image Trajectory Tracking Control of Directional Conveyor

S Howimanporn[1], S Chookaew[1]

[1]Department of Teacher Training in Mechanical engineering, Faculty of Technical Education, King Mongkut's University of Technology North Bangkok, Bangkok, Thailand.

E-mail: suppachai.h@fte.kmutnb.ac.th

Abstract. This paper proposes a control trajectory tracking of direction angle conveyor using image possessing. Conveyor directional is one of the most important topics in classification products. Generally, the other systems cannot be aware of real-time detection and high precision for angle tracking of object works classification. Currently, image detecting and processing systems are widely used and becoming to applying for control field in the future trend. This work installs camera webcam for visual recognition system based on using MATLAB to determine angle position and visual processing, which can recognize the area and calculate the current position of object work, incomplete angle position, and complete angle position. In the paper focus detecting directional angle to trajectory tracking of adaptive control is also responsible for enhancing angle precision between object product and position setpoint target, closed-loop control and tracking error method are designed and implemented on the programmable logic controller (PLC) for improving the efficacy of the conveyor system. The experimental close loop control presents the capability to maintain the setpoint angle position. and the adaptive error tracing with superior response of error controller. The adaptive error tracking gains using a proportional controller. The angle position control from this proposed technique can operate on the different target setpoint and improve efficiently control the directional conveyor.

1. Introduction

Images are the measure and record, that recognize and identify for control process in factory automation, it is the sent signal to the controller. In the recent past, a sensor is used to measure in real-time control such as edge pitch, edge width, color, shape search. Image processing can be determining of extracting, information for developed and control engineering field. Vision sensor is calculated faster, the development vision based on real-time control angle directional for conveyor systems is becoming a performance for maintaining angle direction a work object and many works are focused in this research area. Now a day a vision based widely researches, in [1] to design a smart car using image processing. Image processing is applied to automatic shooting scoring [2]. In [3] real-time video image is designed by FPGA, research [4] using combine between fuzzy and de ghost method for improving document images. Image processing protocol is described for infrastructure elements underwater inspection of structures [5]. In work [6] to introduces the principle and characteristics of the segmentation algorithm, scenarios of global threshold segmentation and adaptive local are applied. Many pieces of research proposal to apply image processing to control for improved performance of the system such navigate the system of robot vision-based using the white balance for hybrid color models, to connect domain

platform [7]. In [8] present a method calibration in MATLAB to realize binocular using stereo vision. Control is important for engineering field, the high-precision motion control base on image sense signal to control and implementation by PID controller for jointed manipulator [9]. In [10] presents access control an interactive is detected face based on vision processing. The trajectory tracking is used at movement or change, that means that position through feedback control, making system change follows a setpoint trajectory from any origin position such as sliding mode control by trajectory tracking control of three-wheeled mobile robot [11]. In research [12] is improved target tracking of a mobile robot based on vision. Some research design and implementation to the control quadrotors for hover and object tracking by a vision based [13]. In [14] a present sum of absolute differences blocks for stereo vision in trajectory planning for a quadcopter. The technology of position in automation requires information for image systems to determine the action to be operation. Generally, the control of the position that has been applied [14]. In [15] propose to achieve grabbing operation of the forming tray process of forming, that presents a system using machine vision for accurate positioning. There are many pieces of research using a programmable logic controller (PLC) to control and monitor machine systems [16-18]. PLC is easy to use and flexible programming to control automatic machine. PLC capable using the LAD, IL, ST, SFC and FB programs to solve the condition. Nowadays, communication support between camera processing, computer, and PLC. In research [19] present protocol is used as communication to send receive the data in automation, robot, and vision for automatic identification and assembly line. The contributions of this work can be summarized image-based trajectory tracking control project is proposed for a wheeled directional conveyor with the fixed camera setup.

2. Image recognition method

The camera vision system is installed above directional wheel conveyor for the detect motion of work object, the detection of direction wheel characteristics can be converted to the detection area and determine the center of area points. There are many kinds of detection, this work is focus used in MATLAB function. To determine the area and calculate the center of the area with sense distance of binary image on screening function are designed.

2.1. Step to detection method

Image processing as a computer or controller-based technology, operate processing can be design for detection consist of transform image from the camera into digital images after that Improve signal image, and clear noise and other unwanted. Excerpt the area, size of objects in the image. Install images to determine the area and calculate the center of the area. Find relation images between the image to the next image which depend on sampling time. As shown in figure. 1, there are three parameters to determine the area, center of area and angle of images captured by the camera.

$$Required\ Frame\ Rate\ (fps) = \frac{Object\ Speed\ (\mathrm{mm/\ s})}{Object\ FOV\ (\mathrm{mm})} \tag{1}$$

$$Resolution = \frac{direction\ FOV.(x \cdot y)}{direction\ pixel\ (x \cdot y)} \tag{2}$$

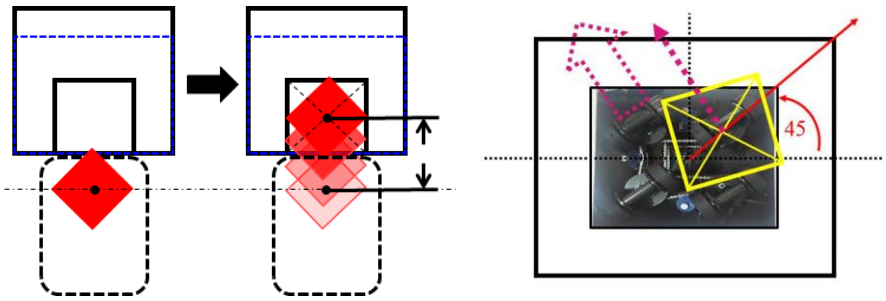

Figure 1. Detection method of object area.

2.2. Angle detection

This project, which is related to the tracking of direction conveyor. The track is applying to calculate for real-time detection with the camera image. To implement using MATLAB code for determining the center of an object in an image. The pixel of the center of the object and the angle of the object according to center, Conveyor is rotated when the error appears during the setpoint target. The rotation angle concerning x and y-axis to implement the code. The equation of resolution can be determined as.

$$Resolution = \frac{direction\ FOV.(x \cdot y)}{direction\ pixel\,(x \cdot y)} \tag{3}$$

Which direction FOV. (x) = 540, direction FOV. (y) = 410, direction pixel (xy) = 4

Resolution X = (540 / 4) x 2 = 270 *pixel* Resolution Y = (410 / 4) x 2 = 205 *pixel*

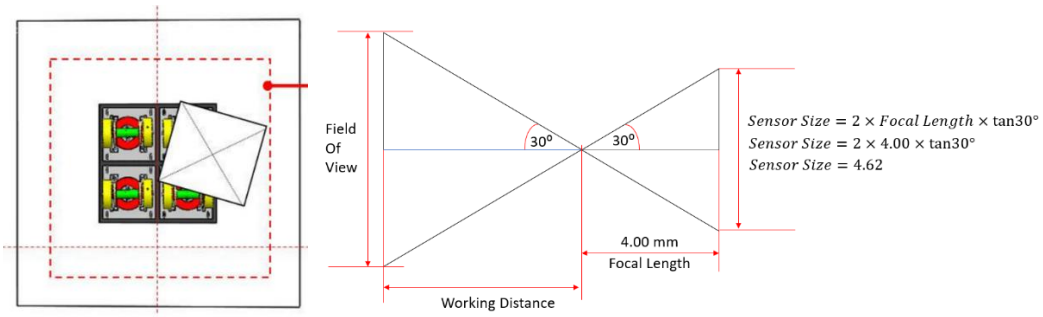

Figure 2. characteristics of conveyor detection.

In figure 2, there are four units of the directional prototype, characteristics of conveyor detection can be installed into the conveyor system. The objective in this work focuses on measure position using vision-based and to identify the work distance coordinate valve of the position and the angle of an object for control and obtain error at the target position. Working distance (WD) and angle can be determined as.

$$WD = \frac{Field\ of\ View \times Focal\ Length}{Sensor\ Size} \tag{4}$$

$$\theta = \tan^{-1}\pi\left(\frac{y}{x}\right) \tag{5}$$

The position coordinates consist of the X coordinate and Y coordinate (width and length) of image detection. Calculation and evaluation position and angle are programmed using PC based, the signal is converted to communicate between a personal computer (PC) and PLC. RS-232 module is installed for controlling. Hardware and protocol have been a configuration for communicating data such as sending and receiving on OMRON-CP1L M30-DTD and image processing system.

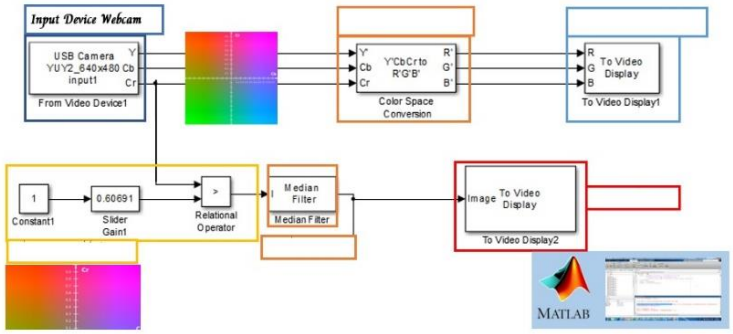

Figure 3. block diagram MATLAB programming for detection.

The camera webcam might be use MATLAB for processing consist of three steps to design and control the directional system. Step to design can be decomposed into four parts, to start from taking a picture and input image for processing, identifying and inspecting the image, calibration signal processing to recognize the image, matching, and ranking. The block diagram in figure 3 presents the resulting output can improve the source image using toolbox analysis. The method of calibration is used from the MATLAB toolbox to complete the angle position of the cameras. The block diagram presenting process is used to complete the determining, and real-time update information is calculated by the trajectory image.

3. System Design

The measurement recognition and control system consists of four parts: image acquisition with converting an image into digital and to get an increased image, data image transmission to calculate the position and angle system, communication and transmitted to PLC, the last part is a programming of close loop control target direction.

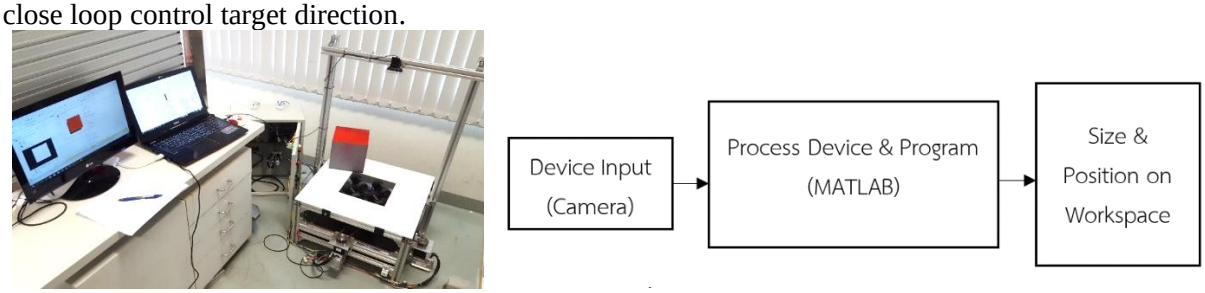

Figure 4. Experimental preparation of real time control.

The testing and experimental setup have been set up as shown in figure 4. Experimental setup and procedure for the measurement focus to improve efficiency by image. The real-time control is required in directional conveyor to maintain target position point. By using a MATLAB algorithm, the angle can be estimated using determine the size, center of area and position on the workspace. The object angle in moveable conditions is calculated. The directional angle observer value is tuned giving to the value of error object direction.

4. Experimental results

The experimental results represent that the casing can be used to support position controlling and improving product transportation. Error tracing trajectory analysis techniques is applied to control and check current position depend on sampling period but the scope of such improvement varies different target angle position we studied. The position study highlighted the importance of summarizing efficiency in the classification of the transportation workpiece.

Figure 5. Measurement of angle direction of conveyor wheel.

The directional wheeled conveyor system with a fixed camera is shown in figure 5. The results of measurement from determining a region of the workpiece by the source image from web camera, and shows the image after the median filter for data type conversion image process. Thus, we can determine the position coordinates, width, and length of the object.

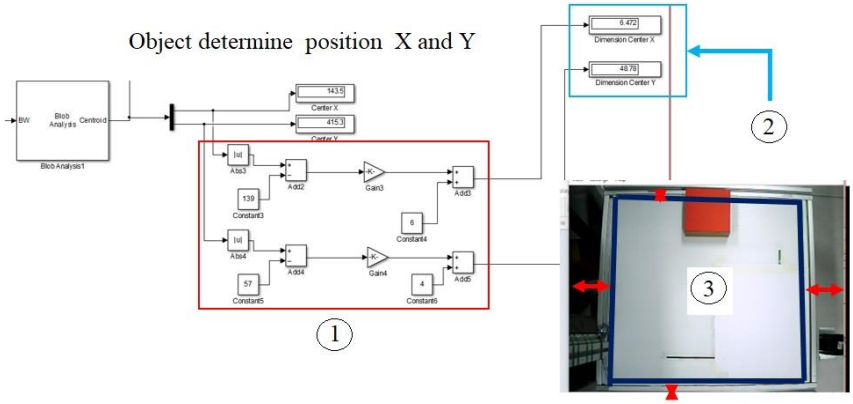

Figure 6. Experimental result of valve and image improving.

The presented image improving in figure 6 is determinedly easy and able to real-time calculation. The results can be got by the implementation, the experiments are verifying, there are valuate width and length. To implement the control, we assume that during the motion of the wheeled direction conveyor, the camera can every time detect of measure the position point, which is continuously checking error tracked by the image processing system. PLC and PC can recognize real-time image improving by communicating with serial interface features. The resulting measurement of position is shown in table 1 - 4.

Table 1. Measurement of difference object.

Position	Measurement from instrument Object (mm)		Measurement from camera (mm)	
	x	y	x	Y
1	6	6	7.4	4.08
2	25	6	25.45	4.18
3	47	6	44.61	4.89
4	6	25	6.87	23.4
5	25	25	25.9	23.3
6	46	25	44.6	24.49
7	6	45	6.47	48.78
8	25	45	25.46	48.58
9	45	45	45.18	48.26

Table 2. Measurement test of object 12 mm.

Position	Measurement from instrument Object (mm)		Measurement from camera (mm)	
	wide	long	wide	long
1	12	12	11.48	11.48
2	12	12	11.71	11.71
3	12	12	11.25	11.25
4	12	12	12.29	12.29
5	12	12	12.29	12.29
6	12	12	11.83	11.83
7	12	12	12.52	12.52
8	12	12	12.46	12.46
9	12	12	12.06	12.06

Table 3. Average error of position.

Measurement Object size (mm)		Measurement object Position (mm)	
wide	long	Position x	Position y
95.67	95.67	76.67	68.00
97.58	97.58	98.20	69.67
93.75	93.75	96.98	81.50
97.58	97.58	85.50	93.60
97.58	97.58	9636	93.20
98.58	98.58	96.96	97.96
95.67	95.67	92.17	93.60
96.17	96.17	98.16	94.39
99.50	99.5	98.22	95.09
96.9%	96.9%	93.2%	87.4%

Table 4. Position angle for difference size.

Size	Speed (m/s)	Angle setpoint (degree)	Average degree for 5 time	Standard Derivation (SD)
S	0.2	30	7.4	4.08
S	0.27	30	25.45	4.18
S	0.33	30	44.61	4.89
M	0.2	30	6.87	23.4
M	0.27	30	25.9	23.3
M	0.33	30	44.6	24.49
L	0.2	30	6.47	48.78
L	0.27	30	25.46	48.58
L	0.33	30	45.18	48.26

The experiment is operated based on real-time control using image-based. To verify the objects of directional wheel conveyor. The image vision system continues with the process in web camera through PC, PLC and connects to control motor. In figure 7 shows the result of the experimental closed-loop control using image processing. The experimental results show that the presented real-time control method proves very good efficiency for the directional wheel conveyor. The stability of angle was able to assert by the experimental result at set point 40 degree.

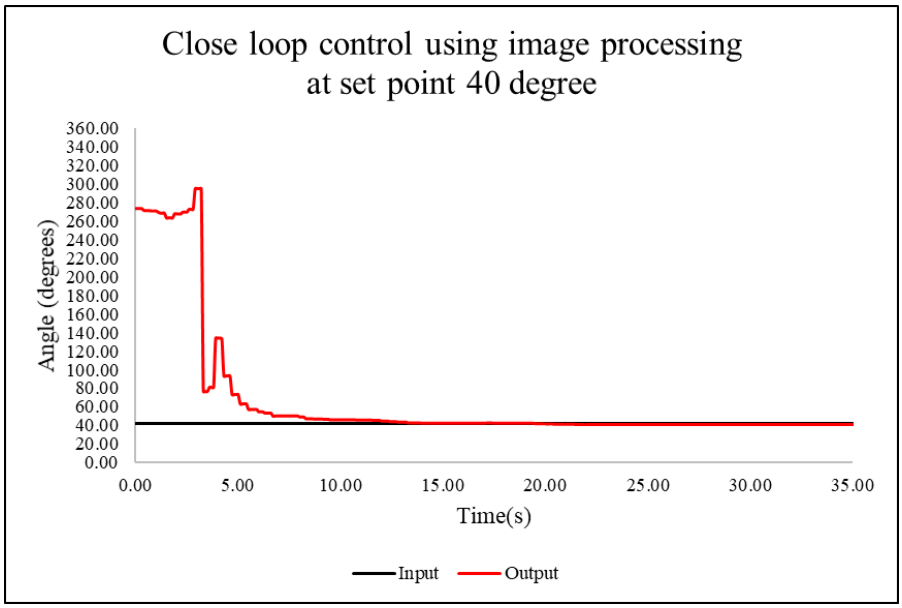

Figure 7. Experimental result of real time control using image based.

5. Conclusion

This paper proposed measurement position of directional wheel conveyor system based on image processing trajectory tracking control using visual recognition system for segregate work in conditional has been proposed, which can successfully obtain the real-time control of the conveyor. The image captured by the camera webcam has a capacity for a variety of functions. The PLC can be suitable for real-time control applications because it is widely used for industry, this paper proposed a PLC based experimental setup for high-performance industrial applications. The motion control angle problem of a maintain angle position of work object on wheels has received. This paper focuses on applying image processing measure workpiece. As future work, the robustness of the angle of directional wheel

conveyor will be improved with another controller. furthermore, develop to extend of the vision-based to other automation and robots.

6. References

[1] Chen Y. A new design on image processing scheme for smart car. In Journal of Physics: Conference Series 2018 Sep (Vol. 1087, No. 6, p. 062012). IOP Publishing.
[2] Widayaka PD, Kusuma H, Attamimi M. Automatic Shooting Scoring System Based on Image Processing. In Journal of Physics: Conference Series 2019 May (Vol. 1201, No. 1, p. 012047). IOP Publishing.
[3] Chen P. Design of Real Time Video Image Acquisition and Processing System Based on FPGA. In IOP Conference Series: Earth and Environmental Science 2019 Apr (Vol. 252, No. 4, p. 042109). IOP Publishing.
[4] Mustafa WA, Aziz H, Khairunizam W, Zunaidi I, Razlan ZM, Shahriman AB. Document Images Binarization Using Hybrid Combination of Fuzzy C-Means and Deghost Method. In IOP Conference Series: Materials Science and Engineering 2019 Jun (Vol. 557, No. 1, p. 012012). IOP Publishing.
[5] O'Byrne M, Ghosh B, Schoefs F, Pakrashi V. Protocols for Image Processing based Underwater Inspection of Infrastructure Elements. In Journal of Physics: Conference Series 2015 (Vol. 628, No. 1, p. 012130). IOP Publishing.
[6] Niu Z, Li H. Research and analysis of threshold segmentation algorithms in image processing. In Journal of Physics: Conference Series 2019 Jun (Vol. 1237, No. 2, p. 022122). IOP Publishing.
[7] Wei Y, Wang Z. A Vision-Based Navigation Robot System Using Hybrid Color Models. In Journal of Physics: Conference Series 2018 Sep (Vol. 1087, No. 6, p. 062006). IOP Publishing.
[8] Sun, X., Jiang, Y., Ji, Y., Fu, W., Yan, S., Chen, Q., Yu, B & Gan, X. Distance Measurement System Based on Binocular Stereo Vision. *In IOP Conference Series: Earth and Environmental Science* (Vol. 252, No. 5, p. 052051). IOP Publishing.
[9] Chuthai T, Cole MO, Wongratanaphisan T, Puangmali P. Enhanced control of a flexure-jointed micromanipulation system using a vision-based servoing approach. In IOP Conference Series:Materials Science and Engineering 2018 Jan (Vol. 297, No. 1, p. 012046). IOP Publishing.
[10] Shi W, Li J, Ding Y, Zhou K. Research on Intelligent Access Control System Based on Interactive Face Liveness Detection and Machine Vision. In IOP Conference Series: Materials Science and Engineering 2019 Jul (Vol. 563, No. 5, p. 052094). IOP Publishing.
[11] Yang L, Pan S. A Sliding mode control method for trajectory tracking control of wheeled mobile robot. In Journal of Physics: Conference Series 2018 Sep (Vol. 1074, No. 1, p. 012059). IOP Publishing.
[12] Ming W, Fu G, Wang H, Huang S. A Method of Target Tracking Based on Monocular Vision for Mobile Robot in Unknown Environment. In IOP Conference Series: Earth and Environmental Science 2019 Apr (Vol. 252, No. 3, p. 032200). IOP Publishing.
[13] Lee YH, Chahl JS. Design and implementation of a vision-based hovering and feature tracking algorithm for a quadrotor. In IOP Conference Series: Materials Science and Engineering 2016 Oct (Vol. 152, No. 1, p. 012015). IOP Publishing.
[14] Bugayong A, Ramos Jr M. Obstacle Detection using Binocular Stereo Vision in Trajectory Planning for Quadcopter Navigation. In Journal of Physics: Conference Series 2018 Feb (Vol. 976, No. 1, p. 012008). IOP Publishing.
[15] Dong N, Du J, Wu J, Chen H. Precise Positioning of the Tray Grabbing System Based on Machine Vision. In Journal of Physics: Conference Series 2018 Sep (Vol. 1087, No. 6, p. 062034). IOP Publishing.

[16] Nugraha E, Abdullah AG, Hakim DL. Designing a SCADA system simulator for fast breeder reactor. In IOP Conference Series: Materials Science and Engineering 2016 Apr (Vol. 128, No. 1, p. 012006). IOP Publishing.
[17] Harahap R, Adyatma AF, Fahmi F. Automatic control model of water filling system with Allen Bradley Micrologix 1400 PLC. In IOP Conference Series: Materials Science and Engineering 2018 Feb (Vol. 309, No. 1, p. 012082). IOP Publishing.
[18] Yulianto AS, Indriani A. Control Systems of Rubber Dryer Machinery Components Using Programmable Logic Control (PLC). In IOP Conference Series: Materials Science and Engineering 2018 Feb (Vol. 307, No. 1, p. 012021). IOP Publishing.
[19] Meng F, Zhang Y, Yang D. Design of Communication Among Vision System, PLC and Industrial Robot based on Modbus-TCP protocol. In Journal of Physics: Conference Series 2019 Aug (Vol. 1288, No. 1, p. 012083). IOP Publishing.

Acknowledgments
This research was funded by King Mongkut's University of Technology North Bangkok. Contract no. KMUTNB-62-DRIVE-05.