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EFFICIENT WEB TAPE SPEED CONTROL SYSTEM USING PID

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ABSTRACT

In most of printing press industries, tension control is considered to be the most critical mechanism. This is common in tape/similar belts where roller movement is controlled through a closed loop system. The rotation of rollers is directly related to tension of tape during the winding process to maintain a balanced rotation. In order to improve the performance of this system, PID controllers are used in this project. This controller is used to compare with the measured speed-tension values with the threshold value and accordingly controls the device. The advantage of PID control helps to maintain a uniform movement of rollers. The expected outcome of this project is to keep the system cost effective with an efficient tension control mechanism.

Keywords: PID, Web Tape, Web Tension.

I. INTRODUCTION

In the printing and packaging industry, tension control system is an extremely important part, especially for the web press. Good tension control can ensure good print quality and increase printing productivity. Web press tension is affected by many factors, such as changes in the diameter of the paper roll, the out of round roll, roll jitter, printing speed, web press paper tension system is a nonlinear, strong coupling, time-varying complex system [1]. Establishment of an accurate tension system mathematical model is premise in the design of tension controller and application of advanced control theory. On this basis, designing tension controller, optimizing algorithm of tension controller and considering various tension factors lay the foundation for the intelligent control system constructed on the press [2]. In the actual project, the most widely used control strategy is PID control, which is simple, robust and reliable. But the actual industrial production process is often nonlinear, time-varying systems, due to the difficulties in PID parameter tuning, conventional PID control is difficult to achieve the desired control effect. The basic theory of fuzzy control is a control method using fuzzy mathematics to simulate person's fuzzy thinking. According to the actual situation of the controlled system, fuzzy adaptive PID controller inferences using the control rules for fuzzy expert system and adjusts PID control parameters online, to make the system a good dynamic and static performance. By studying web presses unwinding motion, one unwinding tension mathematical model was built, MATLAB simulation model was constructed, fuzzy adaptive PID controller was designed, and that system was simulated and analyzed in this paper [3].

II. LITERATURE SURVEY

There are many devices have been developed in printing tension control and speed control areas. Some of the systems that are available are not efficient up to the level but some of them are truly efficient in whole manner. The most efficient systems that are available have high cost of manufacturing and thus the market price is also high. So many researchers are still on their work for finding a low cost system for controlling the tension of web tape .Web press supplies printing material in the form of coil. Web press has very extensive application in the newspapers, books and periodicals, as well as exquisite products.

In a review of a system which uses PID technology for controlling the speed and tension, it describes the whole printing process and how the tension varies in different conditions. It describes that, in order to achieve the work of paper printing, paper tape must keep flat and moderate degree of tension before entering the printing device, which is to keep a certain paper tension.in that system a fuzzy logic is used for controlling the tension. If the degree of tension is not appropriate, a series of slips will happen, such as shifted, wrinkled, broken or torn paper tape,

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imprecise overprint, as well as wrong position of top/down margin, resulting in paper tape waste, affecting the machine efficiency, increasing the intensity of labor, and ultimately affecting the quality of production. When the paper tape tension is too large, it will produce certain deformation of printing network, and longitudinal folds and even transverse cuts of paper tape; when the paper tape tension is too small, it can cause imprinting fuzzy, imprecise overprint and transverse folds; when the paper tape tension is instable, it can also cause imprecise overprint, double image, longitudinal folds and other printing failures, affecting the printing production. So during the web press printing process, paper tape must have a certain tension, in order to control the movement of the tape, and the paper tape tension should be ensured constant in the process of printing. There are many reasons resulting in the change of paper tape tension and the influence of various factors has different results [4].

The shape change of paper roll in the process of manufacture, transportation, and use will cause the paper roll to shake and skew. Unequal and oblique winding of paper roll in the process of manufacturing as well as squeezing of paper roll in transportation and storage can all result in paper roll shape changes, such as being off-center and irregular outside circle. In addition, in the use process, paper roll will be smaller and smaller in diameter. As for the same tape drive, when the paper roll diameter is not the same, the paper tape tension would be different. When the diameter of the paper roll is reduced, paper tape tension will then become bigger. In order to keep constant paper tape tension in the process of printing and satisfy the requirement of printing work, paper roll brake must be able to automatically adjust according to the paper tape tension fluctuation, to ensure that the paper tape goes into the printing device constantly and smoothly. During the steady running of the machine, paper roll brake should guarantee the stability of paper tape tension on the given value; during starting and braking, it should prevent paper roll overload and loose roll. In the process of production, as the paper roll size decreases continuously, the braking torque needed adjustment in order to keep the paper tape tension constant [5].

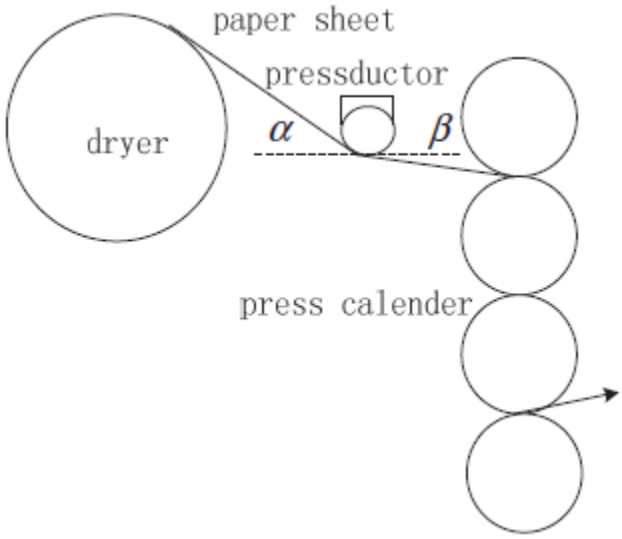

Figure 1. Pressductor based tension controlling

There are systems which uses a tension measuring device inside and based on that it can control the tension efficiently.

The tension meter selection it uses a direct tension control way, using ABB produced the superior performance of the tension measuring device (pressductor), the precise determination of the tension of the sheet. Figure above shows the system which uses pressductor [6].

III. OVERVIEW OF THE SYSTEM

In practical engineering, the regulator control rule most widely used is the proportion/integral/differential control or PID control (also known as PID adjustment). The PID controller is of simple structure, high stability, reliable operation, and easy adjustment and has become one of the main techs in industrial control. When the structure and parameters of the controlled object are not fully grasped, or precise mathematical model cannot be obtained, or other technology of the control theory is difficult to use, in these situations the application of PID control technology is most convenient. In others words, when workers don't fully understand a system and the controlled object, or cannot obtain system parameters through effective measures, then PID control technology is most suitable. PID controller uses proportion, integral, differential to calculate control quantity and to accurately control, according to the system error.

There are mainly three parts of operation they are, proportional control, integral control and the differential control.

Proportional control (P)
Proportional control is one of the simplest control methods. The controller output error signal is proportional to the input error. With only proportional control, system output will have steady-state Error.

Integral control (I)
In integral control, the integral of controller output error signal is proportional to that of input error signal. For an automatic control system, if there is steady-state error after entering the steady-state, this control system is then called having steady-state Error or is called system with steady-state error for short. In order to eliminate the steady-state error, the controller must introduce "integral item". Integral item depends on the time integral of error. With the increase of time, integral item will increase. In this way, even if the error is very small, integral item will also be increased with the increase of time, and promote the output of the controller, further reducing the steady state error until it is equal to zero. Therefore, with proportional and integral (PI) controllers controlling at the same time, the system could get rid of steady-state error in the steady state.

Differential control (D)
In the differential control, the differential of the controller output error signal (i.e., the rate of change of error) is proportional to that of input error signal. Automatic control system might vibrate or lose stability in the adjustment process of overcoming the error. This is because there is a big inertia component (link) or a lag (Delay) component which inhibits the action of the error and its change is always behind the change of the error. The solution is to advance the change of action that inhibits the error, namely when the error is close to zero, the action that inhibits the error should be zero. In short, the only introduction of "proportion" in the controller is often not enough. The role of proportional is only to amplify amplitude of error and now it needs to add the "differential" which can predict the trend of the error change.

In this way, a proportional and differential (PD) controller can advance to make control function that suppresses error be zero, even negative, so as to avoid the serious overshoot of the controlled. For controlled object with large inertia or lag, proportional and differential controller can improve system dynamic characteristics in the process of adjustment [7].

PID control system block diagram is shown below. Error e is difference between the actual output value and the given tension. Speed n is derived after calculation. The value of tension is detected through the tension detecting device so as to form closed-loop control. The discretization of PID calculation formula and including it in programs will help to realize the tension control. And for a more accurate and stable system, the torque control module is introduced, also in the form a closed loop control, to complement PID control [8].

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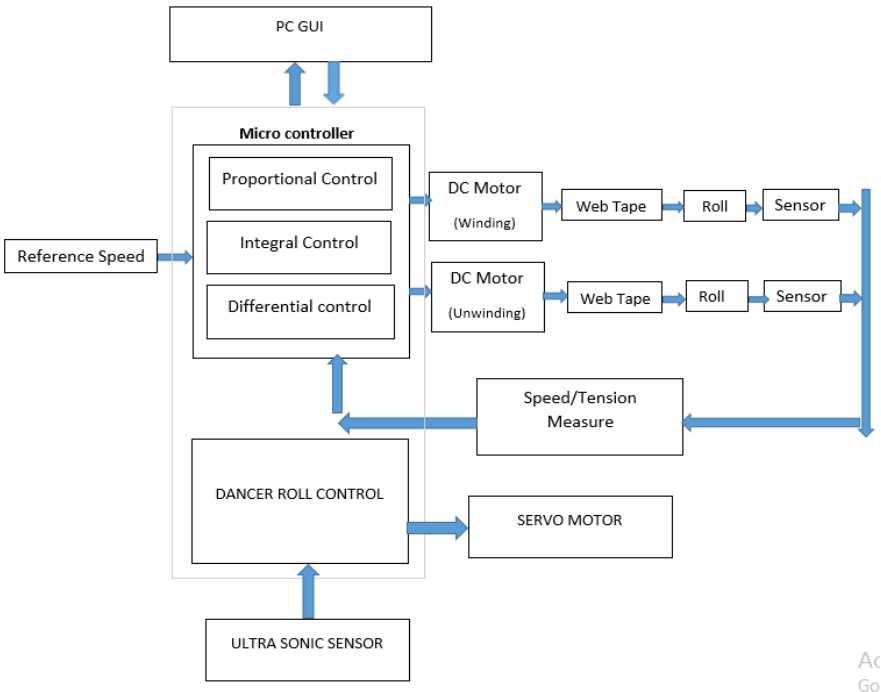

Figure 2. Block Diagram of Proposed Idea

IV. METHADOLOGY

A proportional integral derivative controller (PID controller) is a generic control loop feedback mechanism (controller) widely used in industrial control systems, a PID is the most commonly used feedback controller. A PID controller calculates the ``error'' value as the difference between a measured process variable (Measured speed) and a desired set point (Reference speed). The controller attempts to minimize the error by adjusting the process control inputs like speed and PID variables. A PID controller consists of a Proportional element, Integral element and a Derivative element, all three connected in parallel. Kp, Ki, Kd are the three gains of P, I and D elements respectively.

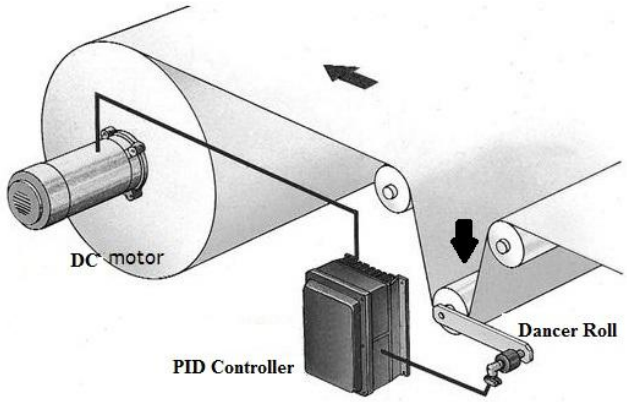

Figure 3. PID Based Controlling System

In Figure above the schematic of a system with a PID controller is shown. The PID controller compares the measured process value with a reference set point value. The difference or error, e, is then processed to calculate a

new process input. This input will try to adjust the measured process value back to the desired set point. The alternative to a closed loop control scheme such as the PID controller is an open loop controller. Open loop control (no feedback) is in many cases not satisfactory, and is often impossible due to the system properties. By adding feedback from the system output, performance can be improved. It also uses dancer rolls for a constant tension and provides a smooth tight on the paper without allowing to damp. The dancer rolls are also controlled by servo motors based on the result from an ultrasonic sensor. The function of ultrasonic sensor is to measure the damping. The entire controlling is done by the Arduino based system.

V. RESULT AND ANALYSYS

Unlike a simple proportional control algorithm, the PID controller is capable of manipulating the process inputs based on the history and rate of change of the signal. This gives a more accurate and stable control method. The basic idea is that the controller reads the system state by a sensor. Then it subtracts the measurement from a desired reference to generate the error value. The error will be managed in three ways, to handle the present, through the proportional term. Recover from the past, using the integral term. Anticipate the future, through the derivative term.

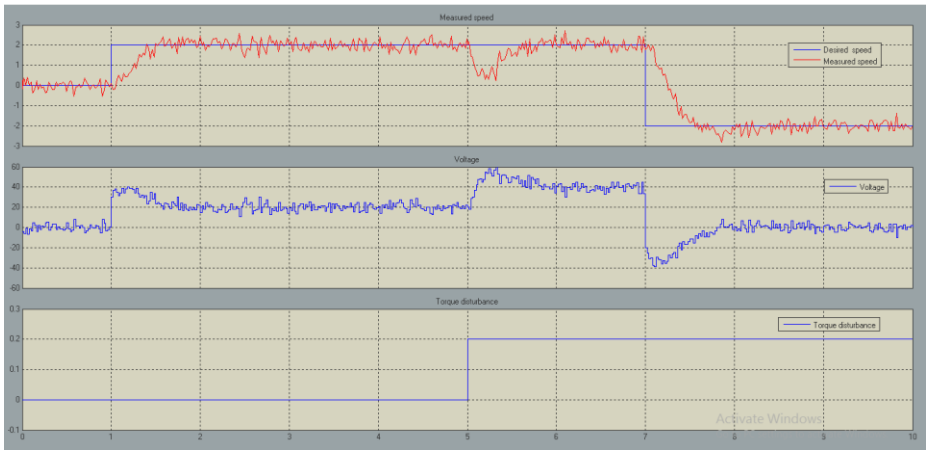

Figure 4. Analysis Result Graph

The result of the analysis part is made by plotting measured speed with desired speed (plot 1), output voltage level graph (plot 2), and the torque disturbances (plot 3) shown on figure above. It shows that the system provides a constant speed even if the external noise is present.

VI. CONCLUSION

Tension control system is one of the most important parts in the printing and packaging industry. The difficulty of solving the problem of coil tension control is to reduce as far as possible the influence of speed, roll diameter and others in the process of winding. Tension control system is a system with large time-varying, strong coupling and much interference. The traditional PI control law is very difficult to get ideal control effect, so control strategy must be improved. Integral separation PID and speed change integral PID can be used in start process, automatic roll change, and parking process. Variable PID control can effectively reduce the change intensity of system damping ratio in the winding process. Compared to a single PI control law, the damping ratio changes much more slowly, so that the stability of the system can be obtained.

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