Automation In Drilling And Sorting Through Image Processing

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Abstract

In the field of automation, an effort is taken to design and fabricate an automatic drilling machine, but testing accuracy of drilling is done manually. Our paper aims to design computer aided drilling machine with accuracy testing and sorting by image processing with the help of embedded system and JAVA Computer Vision (JavaCV). Keeping in view the importance of reducing the lead time, total cost and manual work this project is accomplished.

Work pieces are queued on the conveyor and sensed by the sensor to stop the movement of the work piece at the required spot for the drilling process to be carried out. For testing image is captured by simple web cam and image processing is done by JavaCV.

1. Introduction

Automation is a technology by which a process or procedure is accomplished without human assistance. It is implemented using a program or threads of instructions combined with control system that executes the instructions. To automate a process, power is required, both to drive the process itself and to operate the program and the control systems. Although automation can be applied in a wide variety of areas, it is most closely associated with the manufacturing industries. It is ironing that nearly all the model of applications of automations are controlled by computer technologies.

Controller units in assistance with computer make the control calculations and execute the instructions by transmitting the proper commands to the actuating device. The commands send by the unit are carried out by means of electromechanical devices, such as switches and motors called actuators. The transmitted signals are by means of low voltage signals. Hence information's are processed on the basis of inputs given to control the algorithms.

1. 1. Actual Process

As far as this project is concerned, a microcontroller is used as the main control unit. It controls three stepper motor which performs the required operation at the correct operation sequence. A stepper motor is designed to rotate a precise fraction of a turn for each pulse received from the controller. Since the motor shaft is connected to the lead screw, and the lead screw drives the work table, each pulse converts into a

small constant linear movement of the table. Here three stepper motors are employed. One controls the rotation of the conveyor which carries the work piece. The other drives the fixture and the other controls drilling mechanism. Hence all the three stepper motors are programmed in correct operation sequence; inputs are given to the microcontroller through PC.

After drilling operation conveyor stops at one location to drill another work piece at the same time, camera takes the image of drilled work piece. This image is processed in JavaCV and detects accuracy of drilling and if it is out of defined tolerance work piece is discarded.

2. Structure

This machine is an electromechanical device controlled with computer system. It is composed of a mechanical system of conveyor, drill head mechanism system, a control station, sensor system, a DC power source, camera, software and relay system.

2.1 Conveyor mechanism

conveyor mechanism of this machine used for the material handling purpose. Nylon conveyor belt is used for the material handling.

2.2 Drill head mechanism

In this machine drill head can moves in x, y, z axis. x and y axis movement are necessary to fixed the drill position. The rack and pinion gear assembly is used to speed up the x-y movement and two DC motors are used to move the drill head along x and y directions. Drill head consist of two motors that are connected to the slider. One DC motor of 30 RPM is at upper end of slider which is just used to move the drill head in up-down position and to act the maximum torque on to the drill chuck. Stepper motor is connected to the drill chuck and one DC motor for sorting mechanism.

2.3 Fixture mechanism

Fixture mechanism is used to hold the work piece while drilling operation.

2.4 Structure of image comparison

one web camera is mounted above conveyor belt at certain location to take the image of drilled work piece when it stopped by the sensor.

2.5 Sensors

TSOP sensors are used in this machine. There are two sensors are used first one is used to stops the conveyor during drilling. Second one is used to take the image by camera and send this image to server (PC) The range of TSOP sensor is up to 15 cm.

3. Working Procedure

The automation mechanism of this machine is the combination of four parts.

- Work piece handling.
- Positioning of drilling head.
- Drilling mechanism.
- Image processing to test accuracy
- Sorting mechanism

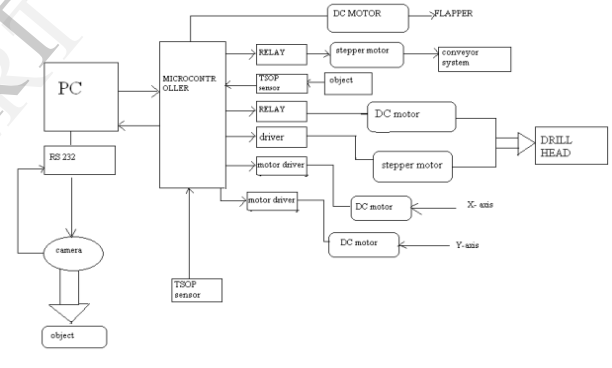


Figure 1. Block Diagram

3.1. Work piece handling

In this machine conveyor system is used to convey work piece to be drilled for drilling and drilled work piece for testing from one section to another section. Here stepper motor is used to drive the conveyor belt. We can vary the speed of conveyor belt by using stepper motor. TSOP sensor is used to position the work piece on drill bench. TSOP sensor is an IR sensor which sense the work piece when IR rays are reflected from work piece and digital pulse to the microcontroller and microcontroller sends the logic 0 to the motor driver L293D, which sends low level signals to all four control lines of stepper motor and stepper motor stops and fixture mechanism starts and it hold the drilling work piece.

3.2. Positioning of drilling head.

Position of drilling head controlled in two dimensions i.e. in x and y direction. Drilling co-ordinates are given from computer by using GUI.

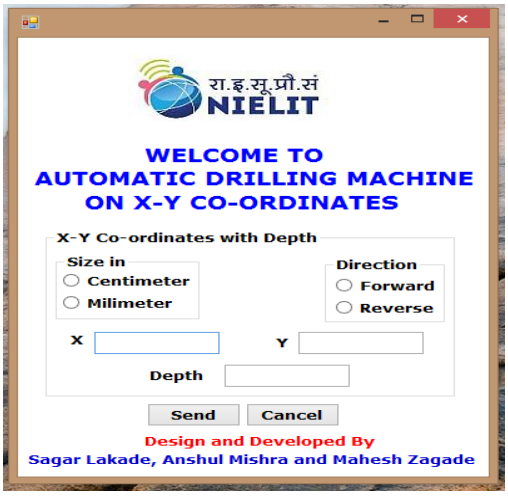


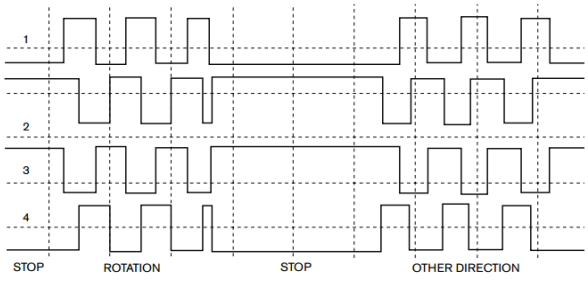
Figure. 2. GUI of drill head positioning system.

These coordinates are given positive, negative x and y directions considering centre of the drilling area as a origin. These coordinates are given serially to the microcontroller through the RS 232. Microcontroller calculates actual movement of drill head and number of rotations of motors required to position the drill head in x-y coordinates and accordingly operates both DC motors for calculated time duration. In this way drill head is positioned according to given coordinates.

3.3. Drilling mechanism

Drill head consist of two motors that are connected to the slider. One DC motor of 30 RPM is at upper end of slider which is just used to move the drill head in up-down position and to act the maximum torque on to the drill chuck. Stepper motor is connected to the drill chuck which operated bidirectional by giving specific controlled pulses through IC L293D motor driver. The driver circuit contains X-OR gates, D flip-flops and motor driver. The starts and stop pulses are as shown in figure.

Trace 1 to 4 is the control pulses obtained from output of L293D that controls the direction of stepper motor. After drilling work piece the drill head comes at its initial position by operating stepper motor in reverse direction and DC motor that controls the vertical movement of the drill head.



TRACE1: OUTPUT Q1 OF IC2B(IN1 OF IC1).
TRACE2: OUTPUT Q2 OF IC2A(IN3 OF IC1).
TRACE3: OUTPUT Q2 OF IC2B(IN2 OF IC1).
TRACE4: OUTPUT Q1 OF IC2A(IN4 OF IC1).

Figure 3. Control signals

3.3.1. Depth controlling

This mechanism is used to control the depth of work piece. It is done by controlling the delay time period of microcontroller. The digital signal is send by the microcontroller to the motor driver to rotate the motor in forward and reverse direction.

The depth is set directly from the GUI on computer.

3.4. Image processing to test accuracy.

Again conveyor starts and drilled work piece conveys by using this conveyor belt. After some distance again conveyor stops by using sensor 2
, this sensor sends the signal (ACK) to the microcontroller. Microcontroller again stops the conveyor belt and image capture and image processing done through the following steps.

- Image capture
- Image processing

3.4.1. Image capture Image capture is done through the web cam through steps given below using JavaCV.

- sense acknowledgement & capture live image
- save image as ".jpg"
- wait next acknowledgement.
- Repeat...

as soon as microcontroller receives the signal from sensor 2, it sends acknowledgement signal to the computer, which controls the web cam and capture image. this image is saved in our database in .jpg format. Again computer waits for the next acknowledgement signal and process is repeated.

3.4.2. Image processing JavaCV first provides wrappers to commonly used libraries by researchers in the field of computer vision. The classes found under the com.googlecode.JavaCV.cpp package namespace expose their complete APIs. Moreover, utility classes make their functionality easier to use on the Java platform. JavaCV also comes with hardware accelerated full-screen image display (CanvasFrame and GLCanvasFrame), easy-to-use methods to execute code in parallel on multiple cores (Parallel), user-friendly geometric and color calibration of cameras and projectors (GeometricCalibrator,ProCamGeometricCalibrator, ProCamColorCalibrator), detection and matching of feature points (Work piece Finder), a set of classes that implement direct image alignment of projector-camera systems

To use JavaCV, we used the following software:

- Java SE 6 or 7
- Open JDK
- Sun JDK
- IBM JDK
- Open CV
- Precompiled and prepackaged CPPJARs for Windows
- Eclipse (windows 7) project setup for JNA wrapper of OpenCV : JavaCV

JavaCV provides wrappers to commonly used libraries for OpenCV and few others. I stumbled upon a few libraries that enable us to put some artificial intelligence goodness right into our Java applications. One such library is OpenCV. OpenCV stands for Open Source Computer Vision and has a catalogue of functions that incorporate over 500 algorithms for real time computer vision and image processing. In Java, it is available through JavaCV, which is a wrapper that calls the native functions.

Stored image is then processed and coordinates of the drill position is verified if it violets the allowed tolerance. the work piece is declared as faulty and positive acknowledgement is send to the microcontroller.

3.5. Sorting mechanism

Ones the positive acknowledgement signal is received by the microcontroller, then it sends the signal to the actuator (DC motor) through L293D and it drives the DC motor and work piece is thrown from the conveyor.

If negative acknowledgement signal is received then motor doesn't starts and work piece goes for the further processing in next section.

4. Conclusion

In this machine, a cycle of drilling process is automated with the help of a micro controller and inaccuracy of drilled work piece also find out by the image processing using JavaCV. The microcontroller is interfaced with PC for the purpose of giving input parameters such as depth. Work pieces are queued on the conveyor, fixed the position of drilling, drills the work piece and then it verify the accuracy and position of drilling using image processing JavaCV. Here stepper motors and DC motors plays an important role in total automation.

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