Robot Assisted Ribbon Bender

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Abstract

This paper describes the integration of the Mitsubishi Robot and Cognex camera to create an autonomous process built at Fairfield University. Mitsubishis robot localizes itself and successfully fulfills the intended goal of bending small metallic ribbons, all while employing a visual recognition algorithm via the Cognex insight camera. This report describes the process and communication protocols for this automated process

Introduction

Automation in manufacturing is the use of various control systems for operating equipment with minimal or reduced human interaction. As technology has advanced over time, some processes have been completely automated at great benefit to production.

The process of the ribbon bending is currently done at Northeast Laser manually. To automate this process a few main components are included in the system. Key tools that are used to implement the procedure include a rotational bowl feeder, Cognex In-Sight 5000 camera and a Mitsubishi RV-3SDB robot.

The majority of the process is conducted using the Mitsubishi robot which is a very high tech, versatile, and robust machine within the realm of automation. It has led to many practical applications (bending ribbons in this case) and has a variety of features which can optimize the process even further. With an entire manual of distinct commands, the possibilities and projects are endless.

Mitsubishi's robots are unparalleled in the sense that there are not many companies which can deliver such quality equipment. Mitsubishi can accept commands that utilize all six of its dynamic axis to be maneuvered. Cognex is a coporation that designs cameras for industrial use that are high definition, high quality, and high performance to provide the best optical vision functionality possible.

Figure 1: Connection Box for Mitsubishi Robot

Figure 2 : Mitsubishi Robot Melfa RV-3SDB

Figure 3: Manual Controller for Mitsubishi Robot

Ribbon Bending Procedure

The fundamental goal of the process is to program the Mitsubishi robot to pick up a metallic ribbon, orient it correctly, place the ribbon into the bending apparatus, bend it, and finally place the bent ribbon into a tray to be manufactured. A sequence of steps for the entire process can be seen in Figure 1.

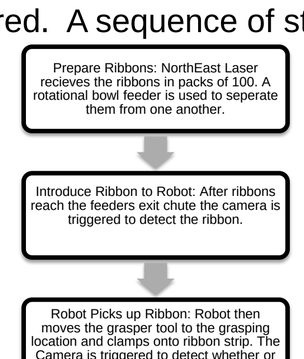


Figure 4: Ribbon Bending Process Sequence

Figure 5: Metallic Ribbon

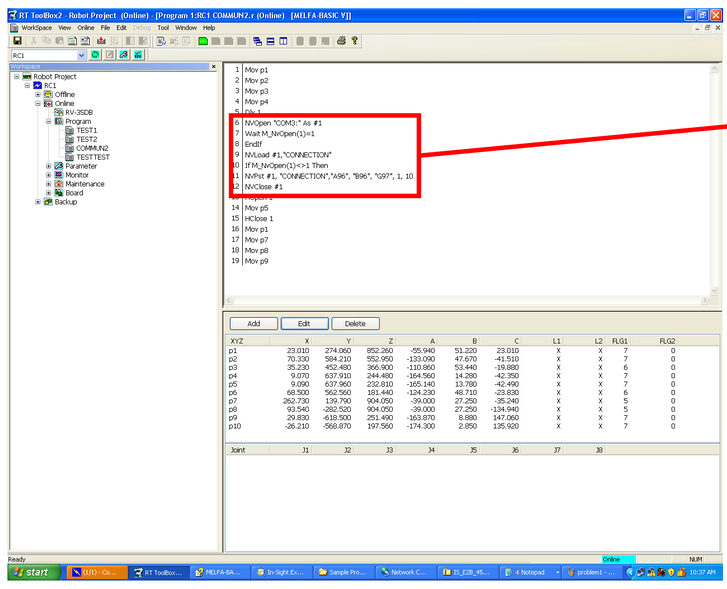
The ribbons must first be separated using a rotational bowl feeder. This feeder combines vibration and rotation to create a system that is able to separate the ribbons and place them in a position where they are easily accessible for the robot. The vision system via Cognex camera is used to detect the ribbons, and signal the robot to initiate its process. The communication between the equipment is essential in order to integrate these two processes. The Cognex and Mitsibushi must also communicate once the ribbon has been picked up. This is because the ribbon has two different sides and it is essential that the ribbon is placed into the bender in the correct manner.

In addition, a variable voltage potentiometer is used to control the speed of the rotational feeder. An Arduino Microshield will be used to turn the feeder on and off automatically to make the process much smoother, as well as be used for even more communication. Lastly, communication can be established and finalized via the X-10 receiving device along with the X-10 Arduino shield attachment.

Programs

The programs used in this project include Cognex easy builder, which allows users to take images which the Cognex camera can recognize to signal the Mitsubishi robot.

Also, RT ToolBox2, which is the main application that is used to program the robot commands. This string of commands are programmed in order to form a continuous flowing motion that can be repeated for as many ribbons that need bending.




```
6  NVOpen "COM3:" As #1
7  Wait M_NvOpen(1)=1
8  EndIf
9  NVLoad #1,"CONNECTION"
10 If M_NvOpen(1)<>1 Then
11 NVPst #1, "CONNECTION","A96", "B96", "G97", 1, 10
12 NVClose #1
```

Figure 7: RT Toolbox2 code for connecting Camera and Robot

Figure 6: RT Toolbox2 Robot Program for Ribbon Bending Process

Connection

The connection of all the components include the Cognex camera with its two slots that lead to a desktop computer and a power strip respectively. The camera requires a 24 V DC power supply and is connected through Ethernet on the computer. The robot is connected to a PLC box which is then connected to the desktop as well. Also, the robot requires a 240V wall outlet to power the device. Lastly, our X-10 device will allow us to link the Arduino with the ribbon feeder, and allow the Arduino to control the feeder wirelessly via X-10 Arduino shield attachment.

Mechanical Components

The main step in automating the ribbon bending process was to design a way to separate the ribbons and orient them correctly before they were introduced to the robot. To complete this task we designed a rotational bowl feeder. The feeder uses vibration and a rotational system to separate the ribbons. A ramp was added to the feeder to guide the ribbons to an exit chute from which the camera would be able to detect the ribbons and the robot would be able to grip easily. In addition a voltage controller is used to control the speed at which the feeder rotates.

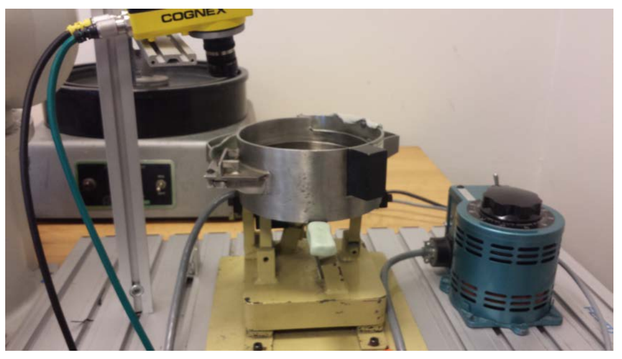


Figure 8: Ribbon Separating Process (Camera, Feeder, Voltage Controller)

Figure 9: Ramp to guide ribbons to exit chute

Figure 11: Rotational Bowl Feeder top view

Figure 10 V:oltage Controller for Rotational Feeder

Another mechanical system that is being utilized for this process is the bending apparatus. The bender uses a pneumatic system to trigger it turn on and off.

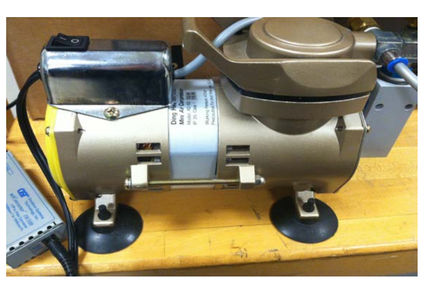


Figure 12: Pneumatic device

Figure 13: Ribbon bending device

Future Work

Final additions to the project include as follows:

- Building a final exit chute for the ribbon