

New Labs for Control Courses using Vision Systems – Cognex

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Abstract:

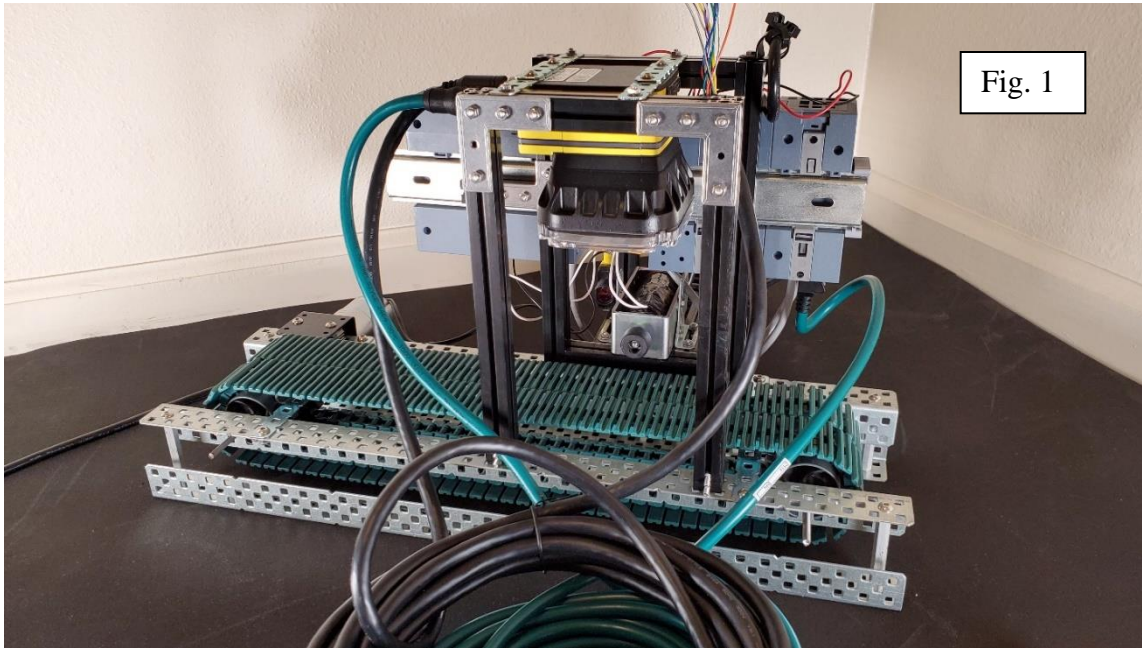
An exciting series of labs have been discovered that greatly enhance a course in automation controls for Engineering Technology students as well as for Electrical Engineering students. The Cognex company furnishes these labs with accompanying text and lab material that introduce the student to the concepts of vision part inspection using simple programming techniques. They include videos as well for a very complete course in this subject.

This paper shows the steps to introducing this material and how it can be used in an advanced course for students preparing for a career in automation.

Introduction

The Cognex equipment was purchased through the Rapids Grants from the State of Ohio. A request for a vision system was made and the Cognex name was given as a potential source of a complete vision system. Nothing was known about Cognex at the time, just the name. They had been good at advertising their brand in trade journals and other automation magazines.

The cameras were purchased and delivered in late 2019. They sat in their delivery boxes for quite some time. There was no time do anything at the time they were delivered and then Covid hit. As Covid slowly gave way to ‘normal’, a student asked to do an independent project so he was asked if he would like to explore the PLC/Cognex interface and provide a report with a project. He did, a wonderful report with a fully operational system. His project included a conveyor, a Siemens S7-1200 PLC and a Cognex 7802 Camera system. They were interfaced and provided a detection system that would inspect and kick out a bad part. The part inspected was a terminal block. The project can be seen in the figure below (fig. 1).



A second group the succeeding semester made a similar inquiry. This group, however, added a robot. Again, there was much concern about integrating all these systems together. This group was a Mechanical Engineering group, not electrical as was the first, but seemed to handle the problems of integration of the various pieces very well. Their main need was understanding of the PLC programming portion. The instructor was able to assist in this portion of the project.

By this time, the Cognex equipment had been used twice with great success. The students seemed to ‘get’ the programming themselves in the Cognex system easily and move through the setting up of equipment, programming of the PLC and robot and commissioning of the system. Both groups just needed a little encouragement and were successful with their project.

Integration into the Classroom

This led the instructor to explore the Cognex system more thoroughly to see if the equipment could be used on a more general basis, not just in special projects.

In Fall 2022, a first attempt to integrate the Cognex cameras into the teaching material of various courses occurred. There was great success in this endeavor. Students were challenged but successful across the board in implementing applications using the equipment.

What was found was a great number of helpful videos and labs for two different programming platforms. EZB (Easy Builder) and SS (Spreadsheet) were the two platforms. After examining the first videos, it was determined that all effort should concentrate on SS instead of EZB.

Course Description for the In-Sight (Cognex) Spreadsheet first course is given here:

“In-Sight Spreadsheets Standard (TRN-IS-CGNX-STD) gives new or potential In-Sight users a 2 day overview of the hardware and software used by In-Sight vision systems. With the focus on getting the most from the In-Sight Explorer Spreadsheets interface, users learn how to walk through the process of setting up a vision application using spreadsheet programming best practices.

Expected Outcomes:

At the end of this course, participants will be able to:

–Identify In-Sight hardware and software interface components

–Demonstrate skillful use of the:

- Spreadsheet interface
- Tools to solve vision inspections
- Communication options of the system

–Build starter operator interfaces

–Explain the fundamentals of Lighting and Optics”

Videos accompanied the chapters were able to give a good understanding of the software and hardware. The software can be run in the emulate mode but with a student body mostly of hands-on students, the actual cameras furnished the incentive to use the actual versus simulated system software. There was no substitution for actually finding the part under the camera and honing in on the view being sought. The Cognex system relies on actual parts or pictures of parts. Either is acceptable. What was used in this first semester was pictures but actual parts are being built for use in the classes for next semester. Students will be able to inspect actual parts with or without flaws or other dimensional differences.

Additions by Instructor

If manuals, lab manuals, camera and video were provided by the Cognex company, what is left for the instructor?

First it was found was that there was need for a mounting system for the cameras. It was not enough to just hand a camera to the student. The camera needed to be mounted properly. The mounting found to best address the issue was a small tripod with a cantilever weight to support the camera and provide some adjustment for viewing. See Fig. 3 below.

Also, the software from Cognex needed to be loaded and a communication path from the Cognex software to the camera established. This includes an ethernet port. The ethernet port was

provided by a USB-Ethernet dongle. With correct configuring, this communications path works well.

Also, it was noted that the Cognex camera needed a 24 V DC power supply. The first attempt was to have students wire to existing power supplies. It was later found that most of the students were opposed to this technique so a separate 24 V DC power supply was provided, just for the Cognex equipment. It was pre-wired to the Cognex cable so there was no need for additional wiring.

Cognex provides a very complete wiring cable capable of using 24 V DC inputs and outputs. None have been used to date although the possibility is there to include this logic in future labs.

Also, the Cognex help line was used many times in the initial start-up stages in order to ‘see’ the part and establish the Spreadsheet platform correctly. This help line was extremely supportive.

The Cognex Package

What can be expected from the systems from Cognex? The Spread Sheet Programming method was decided early as the best and adopted. The SpreadSheet Standard manual provides a 14 chapter text and a 10 chapter lab manual. These accompany the school addressed in Append I.

The school includes the patented PatMax pattern recognition program, Extract Histogram and Calibration program, a Blob detection program as well as sections on error handling, network communication and operator interface. At present, the labs for coursework in EET courses ended with the blob programming. Additional labs are available that complete the Spreadsheet course and provide additional lab experiences. In the future these labs may be included but for the present, the labs included are just through the blob (chapter 5 of the Spreadsheet course).

There will be effort in the future to expanded into other areas as outlined in the school in Appendix I. Eventually, students will be willing to advance through more of the school and complete the entire Spreadsheet school during the semester.

Cognex initially proposed a 10 camera system. Each system was purchased for approximately \$6K. Five systems were purchased and five donated. This package was proposed by Cognex and this pricing can be expected by other schools wishing to begin a lab using the Cognex vision system. For \$30K, a vision system lab was established using state of Ohio grant funding. Others wishing to begin by using the emulate mode can do so for no cost.

Gains from Project

The importance of the course taught inside another course is important as well. It brings up areas of interest such as character recognition, neural network design and bar-code recognition. All these areas are of extreme interest to most engineering and engineering technology students.

Two courses used the Cognex hardware and course material. One was the EET 4450 course – Automatic Controls. In this course, EET and MET senior students were given five lectures from the videos covering the first five chapters of the SpreadSheet book. They were then required to complete through Lab 5.2, almost the end of the first day of the Cognex school outlined in the appendix. Their success rate was 30 of 31 students achieved this lab complete.

The second course was a Electrical Engineering elective – EECS 4220. In this course, no lectures were devoted to the Cognex material other than to point the students to the appropriate videos and lab material. They were given sufficient credit for these labs to influence their grade and they were successful as well. Forty one of forty eight students finished this lab sequence, a very high rate considering that this lab was voluntary.

This was the first time either group had been exposed to Cognex but the enthusiasm for understanding the hardware and the programming in SpreadSheet was of interest enough that they thoroughly enjoyed the experience. It will be valuable to them all in the future and they are aware of the value of this experience.

Cognex Vision System - 7802M-363-50



Fig. 2

The Camera/Computer system pictured here is from Cognex. It is used to inspect parts for a number of different functions outlined later in this section. Here the camera inspects these parts proceeding down the conveyor for defect and length.

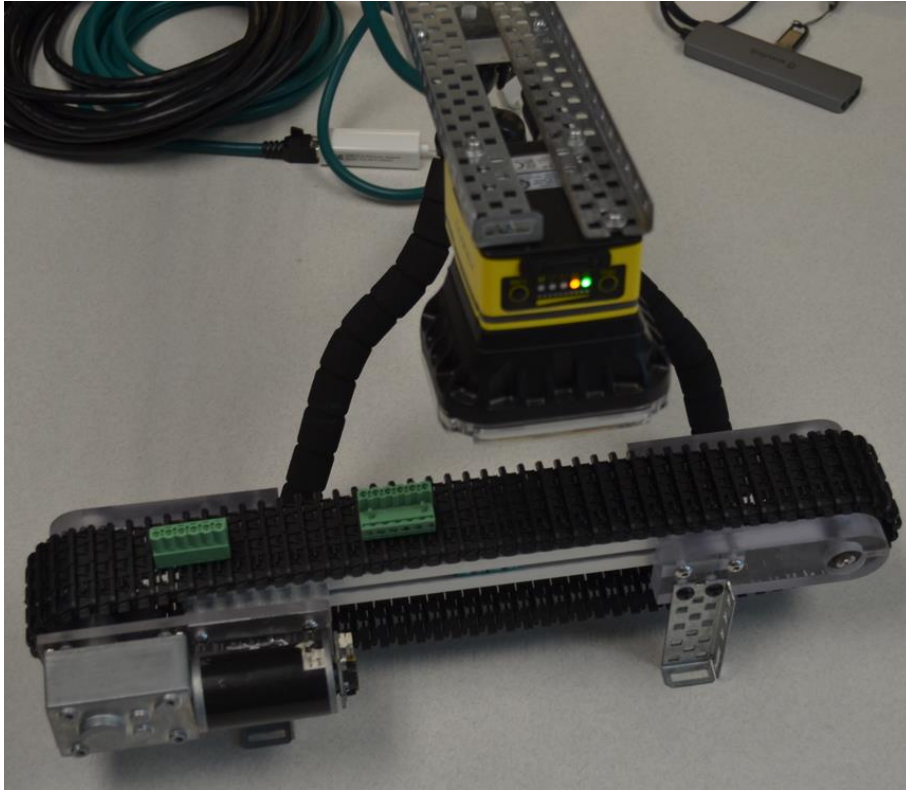


Fig. 3

The Camera Shown
Mounted to Tripod
and Counterweight

The Spread Sheet Course for Cognex is found as a download in Appendix I. Videos as well as PowerPoints and Labs are included. Appendix II gives examples of types of inspections available using these cameras. Appendix III gives information concerning the use of Emulator software.

Future labs in addition to completion of the Spreadsheet course include communication with the PLC and eventually the robot. The PLC portion is relatively simple and will be added next semester. Regarding the robot, there is only one robot available for use so its inclusion will be only as a special project.

Summary

The Cognex equipment is state-of-the-art. It includes all that one needs to successfully implement a complete vision inspection station. The experience on these small units give a very good experience in how to set up and program more sophisticated industrial systems. Cognex is the leader in vision systems world-wide and knowledge of set-up of their systems is highly desired. Their labs are encouraged for anyone entering the automation field.

Appendix I

“Spreadsheet Standard Course

01 HW Connections

[In-Sight Explorer - Hardware and Connections](#)

You will learn about different In-Sight product offerings, including the 7000 Series, the Micro Series, the 5000 Series, VisionView Operator Interface, and In-Sight...

02 Spreadsheets Image Acquisition

[In-Sight Explorer - Software and Image Acquisition](#)

You will learn how to manage multiple networked In-Sight systems from a single PC, save job files, and load job files. You will also learn the properties of the In-Sight camera,...

03 PatMax Logic

[In-Sight Explorer - PatMax](#)

You will learn how to effectively utilize PatMax - Cognex's patented feature-based pattern matching tool. PatMax allows you to train a model of a feature, and then it looks for...

04 ExtractHistogram Edges

[In-Sight Explorer - Histogram and Edges](#)

You will learn how to correctly describe and apply Property Sheet parameters and auto-inserted information for ExtractHistogram and Edge functions to a sample image, how to...

05 Blob Image

[In-Sight Explorer - Blobs and Image Processing](#)

You will learn how to correctly describe and apply Property Sheet parameters and auto-inserted information for ExtractBlobs to a sample image, and how to correctly apply to a...

06 Calibration

[In-Sight Explorer - Calibration](#)

You will learn how to correctly implement in a job a non-linear Calibration using the calibration wizard, cell state dependencies, and error handling functions, how to...

07 Discrete I/O

[In-Sight Explorer - Serial and Discrete Communications](#)

You will learn how to correctly identify which functions to use to read from and write to discrete channels, and which functions to use to read from a write to a serial port, how to...

08 Network Communications

[In-Sight Explorer - Network Communications](#)

You will learn how to describe different forms of communication, including PLC protocols, FTP, and TCP/IP, and how to communicate between In-Sight and a PC using TCP/IP device...

09 Operator Interface

Cognex School

Day 1

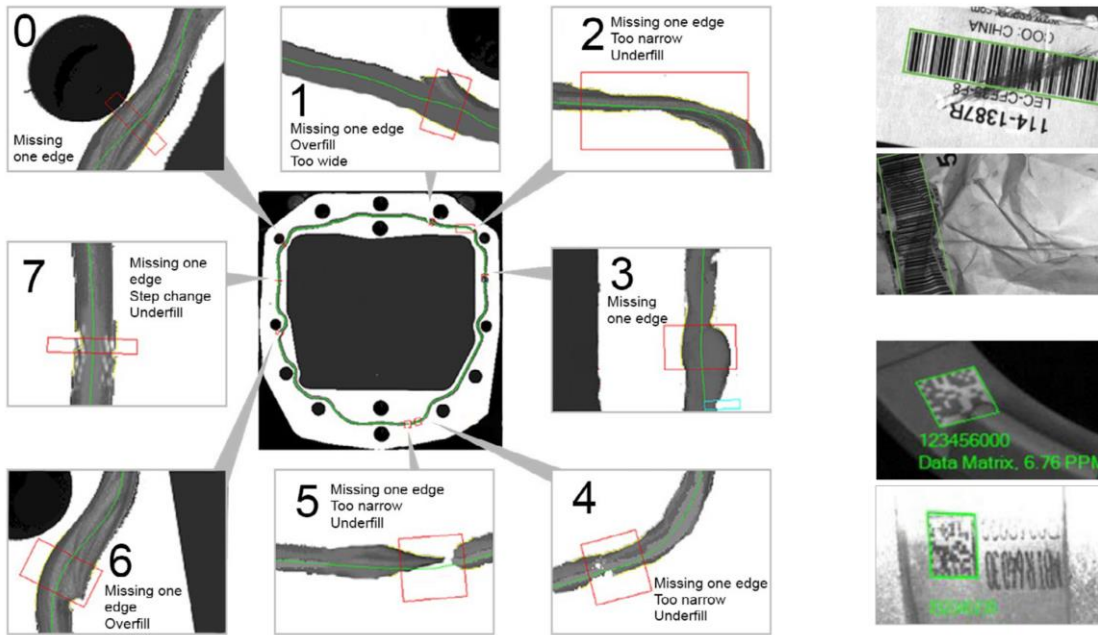
8:45 am	9:30 am	Hardware and Connections	45 min
9:30 am	10:00 am	Lab Exercise	30 min
10:00 am	10:45 am	Spreadsheets and Image Acquisition	45 min
10:45 am	11:00 am	Break	15 min
11:00 am	11:15 am	Lab Exercise	15 min
11:15 am	12:00 pm	Pattern Matching and Logic	45 min
12:00 pm	1:00 pm	Lunch	60 min
1:00 pm	1:30 pm	Lab Exercise	30 min
1:30 pm	2:15 pm	Extract Histogram and Edges	45 min
2:15 pm	2:45 pm	Lab Exercise	30 min
2:45 pm	3:00 pm	Break	15 min
3:00 pm	3:45 pm	Blobs and Image Tools	45 min
3:45 pm	4:15 pm	Lab Exercise	30 min
4:15 pm	4:45 pm	Calibration	30 min
4:45 pm	5:00 pm	Wrap-up	15 min

Day 2

8:30am	8:45 am	Review of Day One	15 min
8:45 am	9:15 am	Calibration Lab Exercise	30 min
9:15 am	9:30 am	Discrete I/O	15 min
9:30 am	10:00 am	Lab Exercise	30 min
10:00 am	10:15 am	Break	15 min
10:15 am	11:00 am	Network Communications	45 min
11:00 am	11:30 am	Lab Exercise	30 min
11:30 am	12:00 pm	Building Operator Interfaces	30 min
12:00 pm	1:00 pm	Lunch	60 min
1:00 pm	1:30 pm	Building Operator Interfaces (continued)	30 min
1:30 pm	2:00 pm	Lab Exercise	30 min
2:00 pm	2:30 pm	Maintenance and Deployment	30 min
2:30 pm	2:45 pm	Lab Exercise	15 min
2:45 pm	3:00 pm	Break	15 min
3:00 pm	4:15 pm	Lighting and Optics	75 min
4:15 pm	5:00 pm	Final Project	45 min"

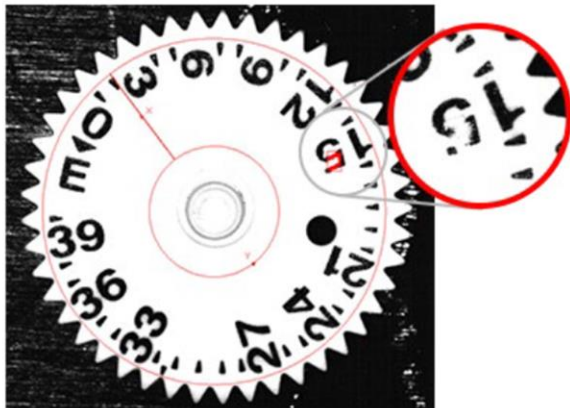
Appendix II

Features of this inspection system include:



Bead Inspection

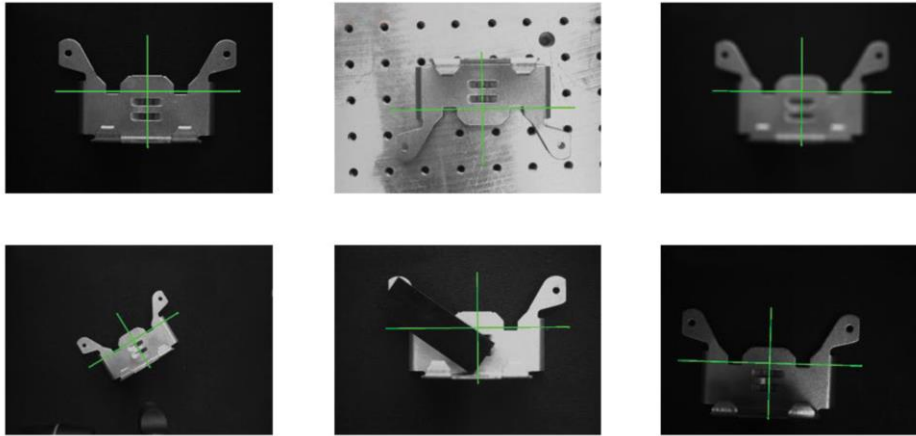
Read Codes, Characters



Flexible Flaw Detection



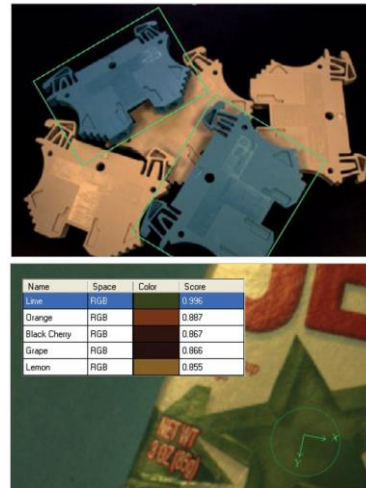
Difficult to Read Characters (OCR)



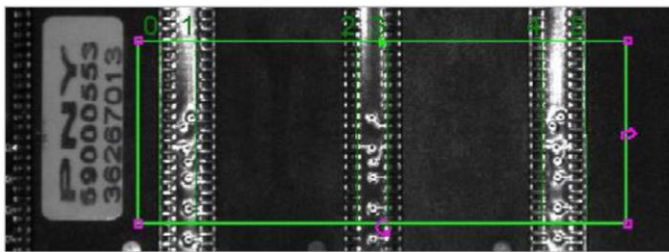
Object Location using PatMax:



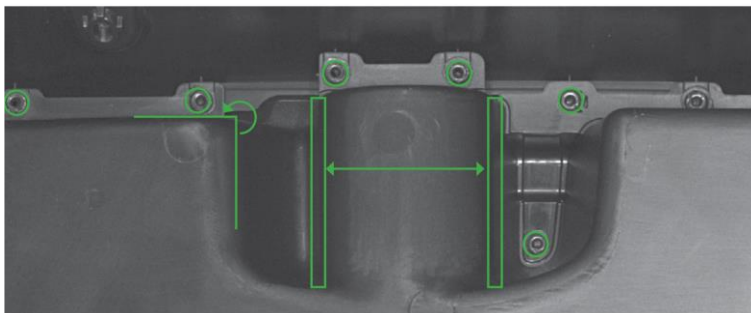
SearchMax Feature Location Technology



Color, Color Match



Edge Detection



Measurement

Appendix III

Emulator Setup in InSight Explorer Software

<https://support.cognex.com/en/downloads/detail/in-sight/4113/1033>

“Note: All Cognex programs can be executed using the emulator instead of live equipment except the actual set-up of the camera. The pictures supplied with the downloads include all you need to execute the programs in the Spread Sheet Course without a camera present.

Three Common Software Pkgs for Cognex:

1. DataMan Setup Tool – Barcode Readers
2. InSight Explorer – InSight Systems
3. InSight Vision Suite – InSight Deep Learning Systems & InSight 3D (Program 3D inspections in Spreadsheet)”

AUTHOR INFORMATION

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