

Design Issues

Smart Camera to Measure Coil Diameter

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Team 5

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Introduction

When it comes to starting a design project, many issues come up from equipment issues to design issues. Issues are not seen in full or clearly until the project starts to develop after the early stages of development. Design issues can cover a wide range of areas from picking what devices to use all the way to reliability. The two design issues that we have ran into are product lifecycle management, product reliability, and product vision. The subcategories of these issues are as follows, production, distribution, consumption, retirement, lighting changes, obstructions, camera position, and GigE Vision. These issues came into view once the project came into motion. This paper will address all the issues stated above and will go into further detail on how these issues were met and the outcome of each.

Product Lifecycle Management

Production

The target product for this project is a single system as opposed to a part meant for large scale manufacturing so all of the costs are one-time costs to build the system and put it in place. There are three main elements to the system, the Axis P1355 camera, the dedicated pc used for processing, and the software on the pc. The axis camera costs \$900, the dedicated computer costs approximately \$600, the software developed by the team will incur no additional cost as it is written entirely by the group.

The production time is composed completely of the software development over three months and installing/calibrating the system, approximately one day. After the first system is installed assembling an identical system will only take as long as the lead time of the components and a one day installation/calibration.

The quality of the system will be controlled by its initial calibration done by the developing team and a periodic check of this calibration by the team utilizing the system. This calibration will be done by measuring the diameter of the coil with a physical measurement device, measuring tape, wood ruler, laser measure, etc., and comparing that to the systems measurement and making adjustments as necessary.

The system will have a very little environmental impact. The only environmental factor will be the power consumption of the camera which is 25.5W and is negligible compared to the power consumed by the other control systems already in place.

Distribution

All of the components of the system except the software are already at the target location; this only leaves electronic transmission of the written software.

Consumption

There is no customer training required for utilizing the system once it is installed as the system will operate independently and will interact with the existing control systems.

There is customer training required for maintenance and calibration adjustment. The customer will need to be made aware of the functionality of the software and what values affect its performance so that it can be re-calibrated if necessary.

Retirement

The system will continue to be useful as long as the dedicated pc is able to interact with the line control systems. If the control systems running the line are changed or upgraded, the programming on the dedicated pc or possibly the pc itself will have to be changed/upgraded so that communication between the two can still exist.

After the initial installation and calibration, customer support of the system will cease in any formal nature.

Product Reliability

Not maintaining the calibration of the software for the purpose of measuring the coil diameter is the largest threat to a continuously reliable system. The calibration of our software is crucial to the success of our product and its ability to provide ArcelorMittal with accurate information. There are three events that could potentially occur within the environment around the camera to interfere with the calibration of our software. Changes in the lighting of the environment, obstructions between the camera and the coil, and the position or orientation of the Axis camera.

Lighting Changes

Our method of edge detection relies upon the ability to segment the desired object from the background. In our case, the desired object is the side of the coil being wound on the tension

reel. Segmentation is accomplished by setting a threshold in which to convert the loaded frame into a binary image. If the difference in the intensity of the background compared to the intensity of the coil is not large enough (i.e. not enough contrast), segmentation will fail to pick up the desired border and thus object.

Obstructions

Undesired objects within the frame can produce two undesired scenarios. The first is that the object could very well “touch” the coil to the edge of the frame. One of our methods to reducing the “noise” or undesired blobs within the frame is to use a function called *imclearborder* if this object “touches” the coil with the border (edge of the frame) the function will remove that blob from the binary image. As a result, the software will no longer have a blob to analyze because it will have been removed. A “blob” in this document is any collection of white pixels that touch to create a cohesive and distinct object. Another result of obstructions within the frame could be another object being measured for its diameter. We desire for only one blob to be analyzed and only one diameter be output. There are ways to suppress more than one output, by size (we are assuming the coil will be the biggest blob in the frame), however the obstruction could produce a blob larger than the coil.

Camera Position

Changing the position of the camera could potentially produce the previous two scenarios in that the angle which the camera is pointed could produce different contrasts or significant movement could introduce an unwanted image into the frame.

Product Improvement/GigE Vision

As previously stated, our design solution consists of an Axis P1355E Power over Ethernet Internet Protocol Camera. This camera is being used to monitor the coiling process of steel production plant. The camera is feeding the live stream of that process into software that detects the edge of the coil and measure the growing diameter. The diameter value solution is done in real-time by measuring the number of pixels from one edge of the coil image to the opposite edge, multiplying that by the calibrated scaling factor, and then reporting that value for verification to the production controller. There is a design standards issue worth talking about in this applied solution because of the brand of camera the solution team has been instructed to use. Accurate real-time video analysis is a function of latency. Latency is the intrinsic delay that

exists between reality and displayed reality. The processor of the camera, the method of communication (Ethernet cable vs USB vs FireWire etc.), and the resolution of the video are all factors that determine the amount of latency. The camera provided for us is the Axis P1355-E. This device complies with the industry standards for security cameras, but lacks performance characteristics comparable to industry standard video processing cameras. Our camera transmits power and data on one cable. While this is convenient, as only one cable needs to be installed, it causes significant problems in allowing real time analysis of the video feed. Fortunately we have been able to circumvent this problem. Instead of streaming a live video into the software, we grab individual frames at a fixed delay and present them in succession to recreate an analogous video signal. Additionally, the measured latency of our solution has been tested and is sufficient to provide an accurate diameter measurement solution; however, our accuracy could be improved and the software development required to link the camera to the code would be much simpler if the camera complied with the GigE Vision standard. GigE Vision is an interface standard introduced in 2006 for high-performance industrial cameras. It provides a framework for transmitting high-speed video and related control data over Ethernet networks. GigE Vision is based on the Internet Protocol standard. In order to set up a GigE Vision network, a GigE Vision compatible camera, network switch, and Ethernet cable are required. If we were to switch cameras to the Point Grey Zebra2, power and data could still be transmitted on just one cable, but the maximum bit would be increased to theoretically 10 gigabits per second. In addition to a faster data stream, our software development program, MATLAB, has built in support for GigE Vision feeds. This would eliminate the need for frame grabbing and allow true video streaming into the software for the highest accuracy of diameter measurement and reporting.

Conclusion

These design issues stated could have put an end to the project if they were not seen and taken care of. As seen throughout the paper, the design issues are real world problems and many of them cannot be dealt with fully due to changes in the working environment due to workers and materials being moved in front of the camera. The product lifecycle management will be taken care of by going through instructions on how to keep the camera and pc in working condition and testing to see how much power the devices are consuming if needed by Arcelor-

Mittal . These were minor issues that could turn into bigger issues if the directions are not followed. The design issues stated regarding capturing the coil were taken care to the best extent possible with matlab and simulink coding to help the camera distinguish between the coil being wound and obstructions in the way. All the design issues that came up have been and are taken care of in order to fulfill the project requirements.