머신 비전을 이용한 카 시트 쿠션 프레임 검사 시스템 개발

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Development of an Inspection System for Car Seat Bottom Cushion Frame Using Machine Vision

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Abstract

The increasing requirement for consistency and quality in the automotive industry started the development of a Machine Vision Inspection System (MVIS) for a car seat bottom cushion frame with the goal of providing a higher precision Inspection System with minimal components and less human intervention. The modifications made to an existing PC-based MVIS were shown to improve the accuracy and precision of the system. By using four monochrome cameras, the working distance was lowered and the image distortions were lessened without resorting to extensive image processing. The inspection scripts were evaluated if it could recognize good and bad products and were shown to be robust and able to reach an acceptable level of precision. It was also shown that the amount of human interaction was lessened.

1. Introduction

The use of Machine vision in the automotive industry is mostly toward a more automated inspection to ensure the right parts are installed, installation is correct and fit, and finish is acceptable[1]. In car seat frame manufacturing, machine vision became popular in quality control prior to the assembly section. To replace the eight to ten human inspectors needed to make sure that there are no defects to the frames[2]. Because it was observed that in manual inspection there is a high risk of inconsistencies in the inspection results, mainly dictated by the inspector's experience and physical, emotional, or mental state.[3]

2. Background

At the early stages of the project, a MVIS that utilized a color CCD camera was built. It has overhead lighting and uses National Instrument's Vision Builder AI (VBAI) software. The machine vision technique utilized was predominantly the Measure Intensity Method. Though it had been successful in verifying the presence or absence of the various parts of the car seat frame, it was limited only to presence verification[4]. The high working distance contributed to image distortions, limiting its capacity for high precision inspection.

For this paper, the general objective to develop a high precision MVIS for the car seat bottom cushion frame with minimal components and less human intervention that will be able to reach industry standards, was conceptualized. Specifically, it aims to: modify the existing hardware and develop a program that will integrate the whole system with minimal human interaction during the inspection process.

3. MVIS Development

3.1 Product Description

The product used for the development is a standard car seat bottom cushion frame which weighs about 2.5 kilograms and measures approximately 500 x 500 x 100 mm (Fig. 1). It is made from thin stainless and galvanized metal sheets that were cut, pressed and welded.

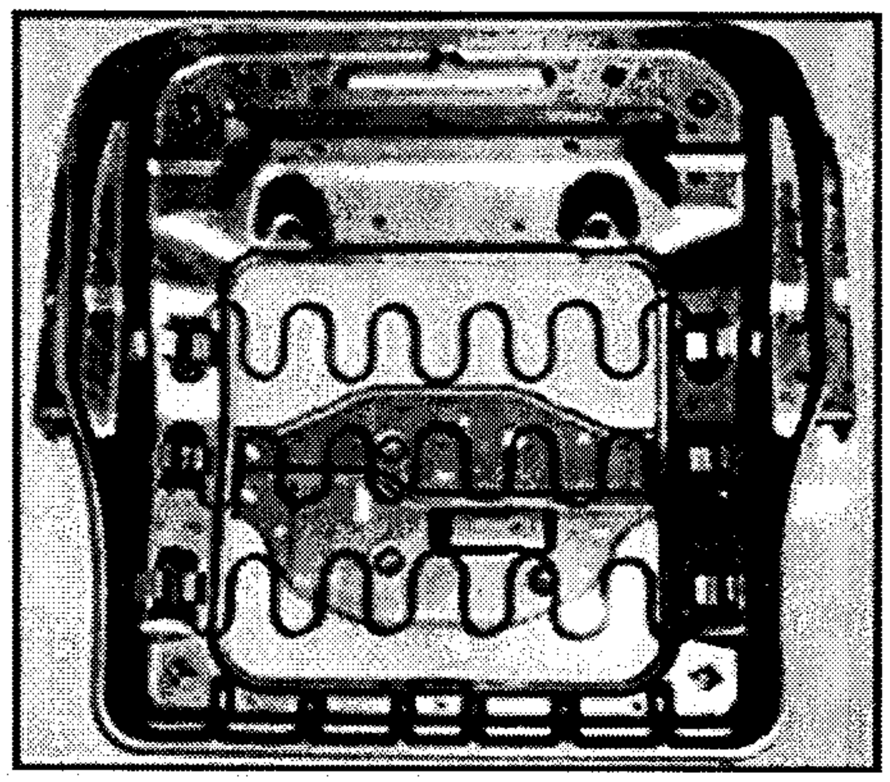

Figure 1. Car seat bottom cushion frame

Bored thru the seat frame are 17 holes, wherein nuts are welded on top of 8 of them. It has 3 springs fastened by packings at the ends. Brackets are welded on the sides and under the frame. Due to its curves, some holes that are supposed to be round appears to be elliptic, and the holes where nuts are welded over, are also a bit distorted if directly looked upon at the top.

Upon evaluation, the parts to be inspected were classified into two: the low precision parts and the high precision parts. The low precision parts are those that only need presence verification meaning the scripts should only be able to tell whether the parts are present or not and decide whether the part passed or failed the inspection. The high precision parts are the ones which presence verification is not enough. The scripts should also be able to determine if they are within the acceptable tolerance.

3.2 Inspection Booth Description

The inspection booth (Fig. 2) is basically a wooden closet which is 182 cm high, 86 cm wide and 72 cm thick. The ceiling made from aluminum profiles facilitated the easier attachments of the cameras with an added advantage of being less cumbersome when adjustments are to be made regarding camera positions. It has 4 fluorescent tubes at the side walls and one fluorescent bulb at the ceiling to provide better lighting.

The four XC-HR50 monochrome cameras were positioned to capture a quarter portion of the car seat frame. Channels 0 and 1 for the top portion while channels 2 and 3 for the lower portion of the car seat frame; hence the names Upper Left, Upper Right, Lower Right, and Lower Left, respectively.

To compensate for the potential problem regarding software recognition for the difference in the pixel intensities along boundaries, the contrast on the images were improved by providing a backlight.

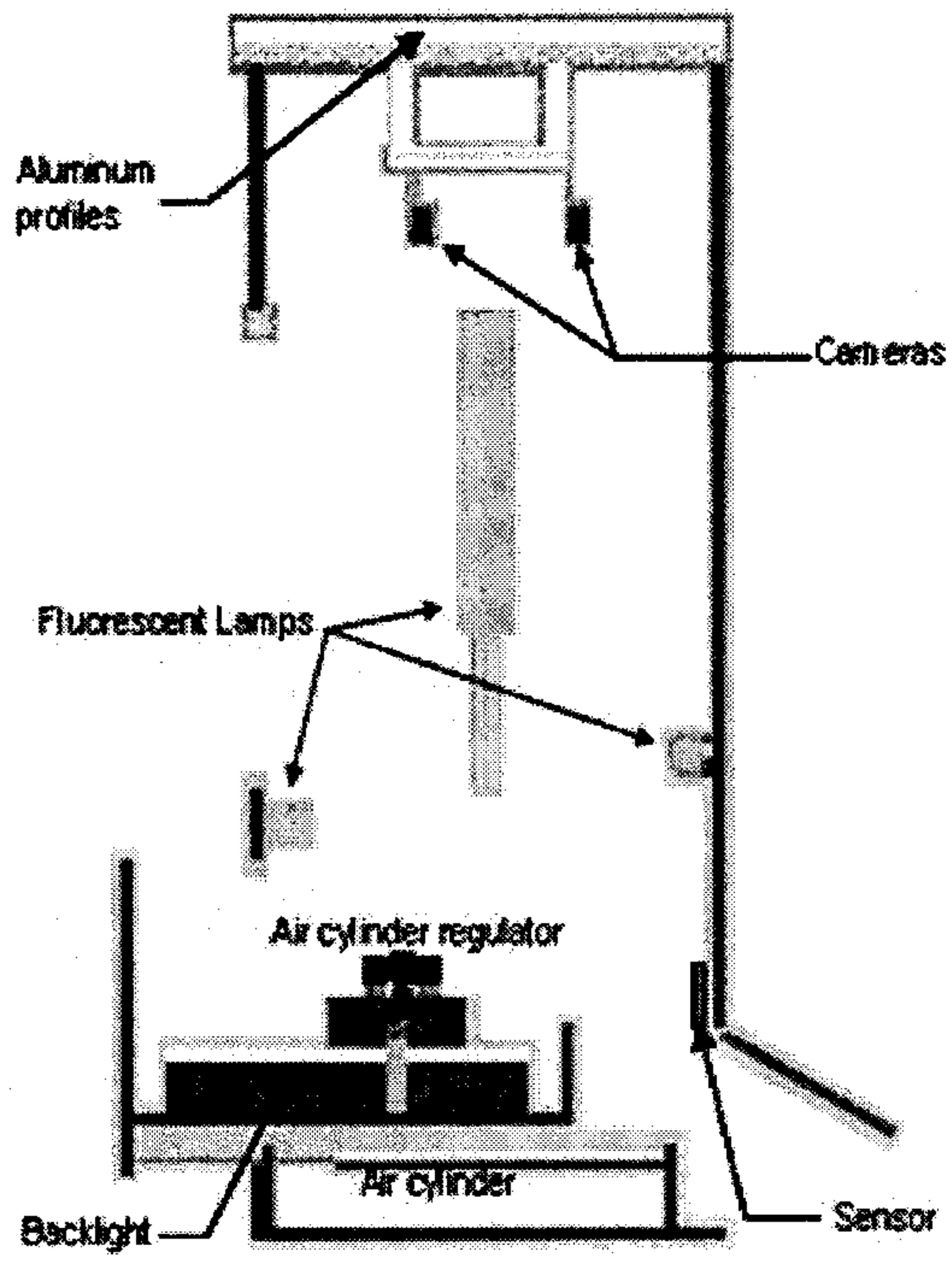

Figure 2. Inspection Booth

3.3 Inspection Script Generation

Vision Builder for Automated Inspection was used in the development of the inspection scripts. Using four cameras, four separate images were also acquired and an inspection script was written for each of the images. The 4 scripts have a combined 109 steps. The base templates for each of the image were chosen due to their uniqueness in the image captured. They are also the least probable to have any damage or defect. For the parts that need only presence verification, Pattern Matching steps were used. while for the higher precision parts, Detect Object steps were used.

To validate the effectiveness of the inspection scripts, they were each subjected to a series of tests. The first is by inspecting Good products in which the scripts must always return a decision of PASS. After this, the scripts were tested if it could identify defective products. The defects were simulated by covering the parts either completely or partially, or by removing them. The inspection scripts were then expected to recognize whether the part is missing or if it is not within allowable tolerance and return a decision of Fail. The test were run until such time that the results are deemed acceptable.

3.4 System Integration

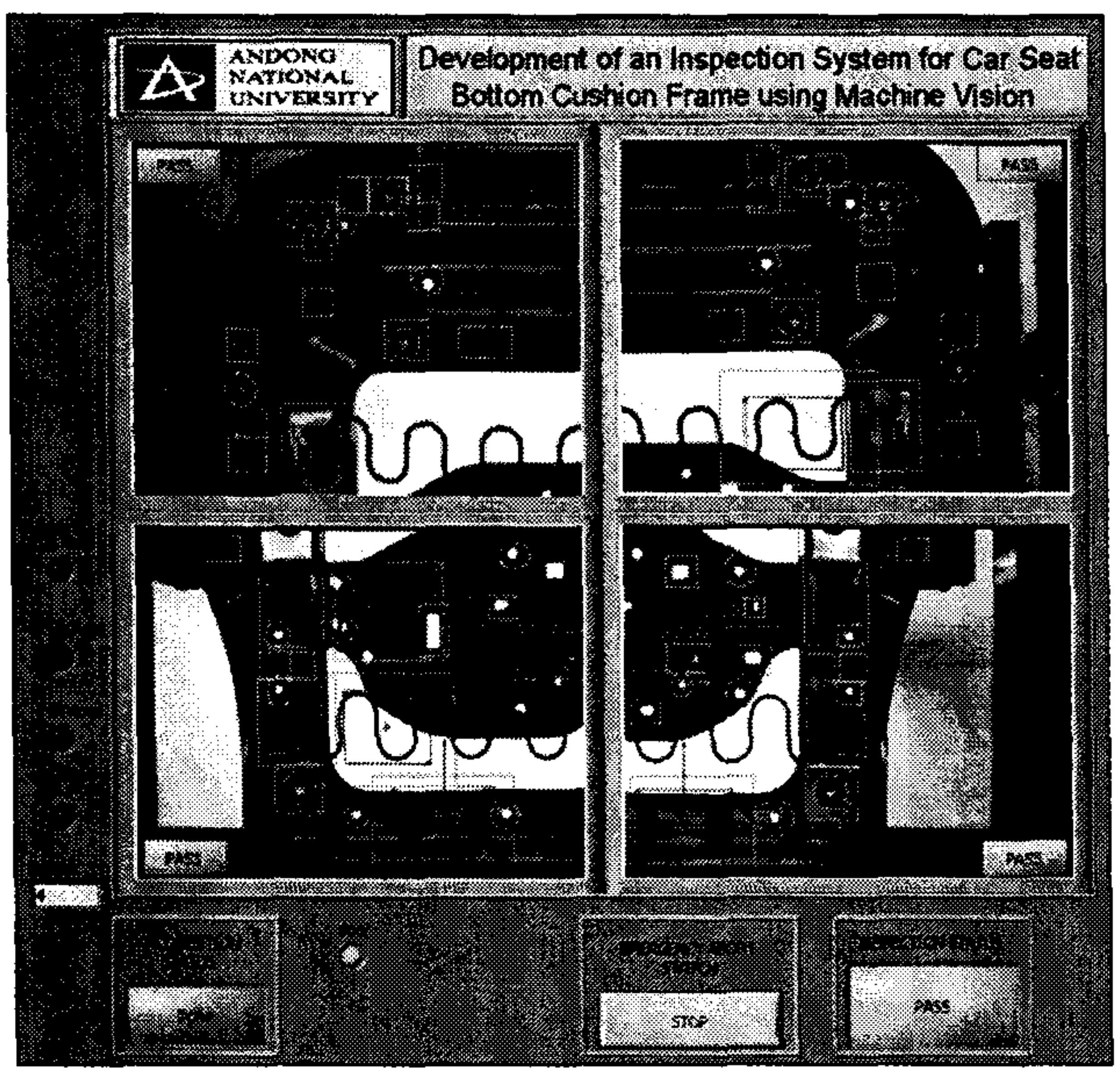

Figure 3. LabVIEW front panel

After all the scripts have been calibrated and tested they were migrated to LabVIEW. A program (Fig. 3) integrating all the inspection scripts and the hardware components was written. After which, the tests previously done on the VBAI scripts were also performed. Only this time the test for defective products were mostly done in combination not just to save time, but also to test the program's boolean capabilities. It can also be noted that the human interaction was limited only to pushing the switch to open and close the inspection chamber, and placing and removing the car seat frame on the fixture.

4. Conclusion

The modifications to the existing MVIS for car seat bottom cushion frame were proven to improve the accuracy and precision of the system. System integration leading to minimal human interaction was also established by limiting it to only the placing and removing of the car seat frame from the fixture and pushing the switch. Though there are still a few more improvements that can be carried out, the objective of developing a high precision MVIS with minimal components and less human intervention was successfully attained.

References

[1] Kelsey, R. and Forcinio, H. "Smarter Machine Vision Systems Proliferate in Automotive Industry," *Machine Vision Online*, 2006.

[2] Andres,N.S., Marimuthu R.P., Eom, Y. and Jang, B. "Development of a Machine Vision System for Automotive Part Frame Inspection", *Abstracts of the International Conference on Mechatronics and Information Technology*, p136, 2005

[3] Claude, E.J. and Carritte, R.M. "Increasing Product Yields with Automated Vision Systems,"*Medical Device & Diagnostic Industry Magazine*, 2006

[4] Andres, N.S. "Automated Car Seat Bottom Cushion Frame Inspection System using Machine Vision" Unpublished Master's Thesis, ANU, June 2006

[5] Tucit, J.D., Jung, H. and Jang, B. "Development of an Inspection System for Car Seat Bottom Cushion Frame Using Machine Vision," Proceedings of the 2006 Korean Society for Precision Engineering Autumn Annual Meeting. p.313-314, 2006