Bilkent University

Department of Computer Engineering

Senior Design Project

Prelude

Project Specification Report

Group Members: Samet Özcan, Osman Orhan Uysal, Osman Burak İntişah, Mehmet Alper Karadağ, Ziya Erkoç

Supervisor: Uğur Güdükbay

Innovation Expert: Veysi İşler

Jury Members: Hamdi Dibeklioğlu, Shervin Rahimzadeh Arashloo

Progress/Specification Report

February 24, 2020

This report is submitted to the Department of Computer Engineering of Bilkent University in partial fulfillment of the requirements of the Senior Design Project course CS491/1.

Table of Contents

1. Introduction

In the textile industry, the clothes produced in some factories are manually examined in a cloth inspection machine to detect anomalies. When an anomaly occurs, the personnel operating that machine is responsible for either fixing the error right away or marking the improper section so that it can be replaced later. Yet, since people need to scan the cloth flowing continuously, they might miss some anomalies which leads to faulty cloths due to fatigue and the limitations of human nature, therefore, decrease in the companies' product prices and loss in their reputation [1, 2, 3].

Some automated cloth inspection machines are developed to speed up and enhance the quality control process. They require small human intervention since anomaly detection is done by the machine itself. These machines use methods such as Fuzzy Logic, Artificial Neural Network (Uster Fabricscan) and sometimes deterministic methods [4]. Yet, these machines cost too much money since the machine are sold as a whole instead of just the automation part as an add-on. Because some companies - including *the* Company A (anonymized) - do not want to purchase new machines but improve theirs, they request an automated fabric anomaly detection product that is compatible with every cloth inspection machine [3].

1.1. Description

We are going to develop a software that will detect anomalies in the fabric using a special Deep Learning algorithm called Convolutional Neural Network (CNN). Our software is also going to ease the image labeling process by providing textile experts with a user-friendly interface. It will also allow continuous improvement of CNN by providing a way to do periodical training so that CNN can improve itself even during the product is live. Our solution will only require a computer and cameras as much as the number of cloth inspection machines and thus no new inspection machines are needed. As a result, our software will solve the problem more accurately with more recent technology, with continuous improvement mechanism and cheaper.

1.2. Constraints

1.2.1. Implementation Constraints

- GitHub will be used for version controlling of the project and collaboration among the team members.
- To be able to get the textile images, at least one camera will be placed on top of the machine.
- A Python application will be developed to be used by textile experts to label the images containing anomalies.
- Another Python application will be developed for training the system and detecting the anomalies of the textile.
- At first labeled photos will be stored in local storage, then while training the system the data will be used in Google Cloud and/or Amazon AWS.
- Open source libraries and frameworks such as Tensorflow will be used.
- Different libraries and frameworks can be added during the development process.
- Object Oriented Programming (OOP) principles will be followed while designing the applications.

1.2.2. Economic Constraints

The details related to the technical specifications of the system such as the resolution of the cameras, required computers or electronic devices etc. are not determined yet and they will be detailed after we investigate the possible solutions and understand the dependency of the success rate of the system to such technical specifications. The installation and all other costs related to the project will be paid by the Company A and at this stage, the Company A is ready to make payment considering the approximate upper bound for the totals cost.

1.2.3. Language Constraints

At least most of the workers in the Company A have only a single native language: Turkish. Therefore, the communication with them must be in Turkish. Furthermore, all of the workers in the company can speak Turkish meaning that communication in Turkish will be appropriate for all of the workers and Turkish is a native language of all the members in our team. The interface of the application aiming to be used by the workers during the data collection stage and for labels must be in Turkish as well. .

1.2.4. Ethical Constraints

After the successful implementation of the project and installation of the system, the number of workers for fabric fault inspection and recovery is estimated to decrease since the checking part will be maintained by the system continuously. A warning and navigation system for the responsible workers in case of fault detection is planned to be implemented at further stages of the project. By this way, relatively less worker is estimated to be needed since the amount of total work is going to be decreased dramatically, that is, the continuous following of the fabric flowing for fault detection will not be the responsibility of the workers anymore. Only the number of workers sufficient to recover the fabric faults, which are to be determined by the system and sent to the navigation device, will be enough for the target stages of the workflow in the company: fault detection and fault recovery. In other words, cloth inspector -currently responsible for fault detection & recovery- will be able to meet the recovery tasks of more than 2 -the current number- inspection machine on average. After the installation, not our team but the company will make a decision between dismissing any supernumerary and assigning them to other stages of workflow, and will be responsible for such a decision and its any legal and ethical consequences [3].

1.2.5. Privacy and Security Constraints

Any information taken from the company to be used in the project -e.g the width and height information of inspection machines and fabrics, daily production, production capacity etc.- or related to the organization, structure, workers etc. of the company must not be shared with any third party for any purposes.

1.2.6. Confidentiality Constraints

The statistics and any data related to the faults in the fabrics must be shared only with company when needed. Otherwise, they can be shared with the third party only if the company gives permission.

1.2.7. Maintenance Constraints

CNN will be continuously improved as more data is labeled to increase accuracy.

1.2.8. Time Constraints

Development of our project and its documentation will be done according to the following schedule [5].

- Project Specifications: **Monday, Feb. 24, 2020**
- Analysis Report: **Monday, Mar. 23, 2020**
- High-Level Design Report: **Monday, May 15, 2020**
- Conduct first round of tests in a factory: **June - September, 2020**
- Low-Level Design Report: **Monday, Oct. 5, 2020**
- Final Report: **Thursday Dec. 17, 2020**
- Conduct second round of tests in a factory: **Dec - Jan, 2020**
- Presentations & Demonstrations: **Dec. 21 - 24, 2020**
- Fully integrate into a factory: **Dec - Jan, 2020**

1.3. Professional and Ethical Issues

- During the implementation and deployment of our project, we will follow the Code of Ethics proposed by National Society of Professional Engineers [6].
- Since our project involves the data which will be taken from the company, data will be secured in local storage or the database but it may be moved securely to a cloud server for training. We will not benefit from the data by selling it to third parties or organizations.

2. Requirements

2.1. Functional Requirements

- Users can label data for training through a user interface.
- The system should stop the cloth inspection machine and signal warning when it encounters an anomaly.
- Users can view in which cloth inspection machine the anomaly has occurred and the exact location of the error on the cloth.
- Users can see which type of anomaly has occurred.
- Users can generate a report for frequently occurring anomalies per beam and also across all beams processed so far.

2.2. Non-functional Requirements

2.2.1. Performance

Software must be able to detect anomalies within at most 1 seconds to match the speed of the fabric inspection machine [3].

2.2.2. Accuracy

Software must be able to detect anomalies with at least 70% of accuracy which is the rate of accuracy for a human [4].

2.2.3. Reliability

Software should not let any fabric to pass uninspected in case of an anomaly such as slow down in the computer or a software error.

2.2.4. Compatibility

Software will run on Windows operating system. Video cameras which can record in high definition will be used to capture the flow of the fabric.

2.2.5. Scalability

Software should be able to handle the input from at least the number of cloth inspection machines.

2.2.6. Maintainability

Operating system, frameworks, python language get updates in a while. Therefore, our software should be up-to-date as well.

References

[1] M. S. Biradar, B. G. Sheeparmatti, P. M. Patil and S. Ganapati Naik, "Patterned Fabric Defect Detection Using Regular Band and Distance Matching Function," 2017 International Conference on Computing, Communication, Control and Automation (ICCUBEA), Pune, 2017, pp. 1-6.

[2] K. Srinivasan, P. H. Dastor, P. Radhakrishnaihan, S. Jayaraman, "FDAS: A knowledge-based frame detection work for analysis of defects in woven textile structures", *J. Text. Inst.*, vol. 83, no. 3, pp. 431-44 7, 1992.

[3] CEO of Textile Company A, Interview, Nov 2019

[4] Ö. Kısaoğlu. (2006). Kumaş kalite kontrol sistemleri. *Pamukkale Üniversitesi Mühendislik Bilimleri Dergisi*, 12(2), 233-241.

[5] Project Report Schedule, Bilkent University. Available http://www.cs.bilkent.edu.tr/CS491-2/current/. [Accessed: 15-Feb-2020].

[6] "Code of Ethics," Code of Ethics | National Society of Professional Engineers. [Online]. Available: https://www.nspe.org/resources/ethics/code-ethics. [Accessed: 15-Feb-2020].