Food Safety Monitoring System using IoT in the Poultry Slaughterhouse

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Abstract. Many actions are taken to improve the appropriate level of protection for biological and chemical hazards in the poultry slaughtering. Consumers’ concerns are increasing for food safety and health from their poultry consumption. Several measures are started by the government to improve food safety. We aim to develop a system to notify the slaughterhouse with regards food safety hazards. In this system, we will put a sensor on top of the poultry slaughtering conveyor system to detect the possible hazard based on the appropriate level of protection for biological and chemical hazards. When the garbage reaches the maximum level of the appropriate level of protection, a notification will be sent to the food safety officer, and then the officer will be able to take necessary actions to guarantee food safety. The system will improve the Hazard Analysis and Critical Control Point (HACCP) in the poultry slaughtering. By using this system, poultry slaughterhouses can guarantee their product safety.

Keywords: HACCP, food safety, IoT, slaughterhouse, real-time data, cost-efficiency

1. Introduction

Food quality and safety gain attentions after the consumers’ health risks are increasing. In several countries, many food unsafe incidents are caused by breaching the food standards. Therefore, there is an urgency to develop food safety technologies that can give assurance of safety in the food supply chains (FSCs) [1]. Internet of Things is one of many technologies that is used by food industry with foodborne illnesses on the rise [2]. Risk-based inspection in poultry slaughterhouse is a concept in scientific and regulatory to protect human health that needs cost-effectiveness methods [3]. By focusing on the Food Chain Information (FCI) approach, the risk level can be measured to detect the safety hazards on the poultry flock that will be slaughtered.

The intention of the IoT usage is to provide prediction of chemical or biological hazards that are fast and cost-effective. The food safety hazards are given by the predictions from wireless sensors that detect temperature, pathogen, chemical substance and possible metal or dangerous materials [3]. IoT technology provides real-time data to identify problems and immediately prevent the problem spread to consumers [1]. The systems along the production are locating contamination and ensuring the control at their prime response and action. The developed devices have the artificial intelligence
ability to analyses, communicate, and act based on real-time data in the connected network. This paper proposes the conceptual approach of food system monitoring development for the poultry slaughterhouse.

2. Methodology
This paper proposes a conceptual approach to describe the development of an initial food monitoring system in the poultry slaughtering based on IoT. Consequently, the food chain, slaughtering system, and Hazard Analysis and Critical Control Point (HACCP) need to be understood. The main framework uses a HACCP to establish food safety monitoring and develop the food chain information. The food chain information will structure the IoT model of food monitoring system and as a foundation for the system infrastructure.

3. Result and Discussion
The architecture of the food safety monitoring system was constructed based on HACCP in the poultry slaughterhouse system. The food safety system follows slaughtering process that triggers four food chain information tasks: analysis, ante mortem examination, post mortem examination, and bottom-up FCI (Figure 1). Then, the process is designed by monitoring the biological, chemical, temperature, smoke, lighting, and humidity in the slaughtering process that related to the power switches for emergency means. The sensor detection is performed by 3D scanning, image analysis, comparison and classification with regards to the food hazards database.

As illustrated by Figure 1, Food Chain Information (FCI) is used by slaughterhouses to assess any potential hazards presented by the poultry intended for slaughter as part of their HACCP-based food safety management systems. FCI is required for every animal intended for human consumption. Using a vast network of ‘intelligent’ and connected devices, sensors, software and connectivity, the IoT is already enabling end-to-end transparency of the food distribution chain. The intelligent package ensures quality and safety of foods by using monitoring devices such as temperature data loggers, time-temperature integrators (TTIs), smart radio frequency identification (smart-RFID), and other low-cost commercial devices [4].

The food safety monitoring system is based on a set of decision programs and graphical user interfaces (GUIs) that focus on food chain information. The program objectives are to ensure a data-taking configuration is being monitored and the raw data is able to be checked while the solid-state drive (SSD) performs as expected. At the same time, the debugging mode computes the pedestal, noise and signal of each strip to assess the performance of the detector. The data acquisition is designed to run in a specific stand-alone mode. The main idea is to ensure the data go to the monitoring system based on each type. The different types of data that the food safety monitoring system will have to deal with are as follows:
1. Raw-data with no zero-suppression
2. Raw-data with zero-suppression
3. Dst-data: results of the SSD reconstruction algorithm

The food safety monitoring system focused on the software that provides C++ classes compiled in the food monitoring framework. The software is expected to process histograms and runs GUIs features. Each software performs readout of the data from files, runs algorithms to compute, store the values and signals for each strip, and eventually stores the data and computation results to the file for GUI.
Fig 1. Monitoring system architecture

The monitoring for poultry slaughter gives the possibility to detect several things as follows:
1. Monitoring the activities of slaughtering to ensure optimum yields
2. Tracking food across the supply chain through inbuilt sensors that show the exact provenance of products.
3. Remote temperature/humidity monitoring.
4. The early warning system of foods that about to spoil
5. Avoiding potential food safety incidents
6. Frequently monitoring for microscopic nuisances to cut waste when storing carcasses
7. Ability to check temperatures through handheld IoT probes.
8. Instant data upload from sensors to the cloud in real-time.

The use of IoT provides new challenges and complexities in the food monitoring system design. It requires innovative solutions to enable technology to cope with food safety hazards that increase the possibility of food protection [1]. The Internet of Things, big data analytics, machine learning, artificial intelligence and blockchain are all technologies that will trigger the delivery of food safety monitoring system that is more efficient and effective for the poultry slaughterhouse [3]. It will be based on real-time information processing within the food supply chain. The IoT is one of the food industry’s best ways to improve efficiency on traceability standards and increase business intelligence for the future of food safety in human consumption [1]. It can protect the slaughterhouse from accepting and processing sick poultry that comes from unhealthy poultry market [3, 5]. Furthermore, it will decrease the possibility of consumers’ concern towards market channels and avoid consumers to switch market channel due to food unsafety incidents [6].
4. Conclusion
The Internet of Things has the capability of improving the prospects for automated monitoring and real-time control for food safety. Combined with other digital technology, it will push the food industry to quickly take preventive action and deliver a curative action if needed. This action will enhance food safety while developing efficiency for the slaughterhouse in the future.

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