Milk Transport Security and Traceability System

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ABSTRACT

The United States Department of Homeland Security has targeted bulk food contamination as a focus for attention because it poses a high consequence health threat to our society. The current manual methods used for securing milk during transport are paper intensive and prone to errors. The objective of this project was to develop a Milk Transport Security System (MTSS) that would provide assurance that the milk, milk samples, and milk/security data are securely transported between the dairy farm and dairy processor. The project also required a demonstration of the security system at two dairy processors and multiple dairy farms, and delivery of the technology to the national community through collaborations, technical conferences, publications and standards. A milk transport security system was developed and consists of a Transport Monitoring System (TMS) located on the milk transport tank, a handheld device (mobile computer), and a remote data server. The TMS controls access to the milk during transport and automatically collects security data and transmits it to the data server. Both the milk and security data are transmitted by the handheld device using cell phone communication to a data server where access is only provided for authorized data users. The project resulted in the development of a prototype bulk milk transportation security system that will allow users to track milk from a farm to a dairy processor and ensure milk security and safety. The prototype demonstrated benefits including improved data accuracy, superior product traceability, improved efficiency of operations, increased productivity, and an increase in information available to the dairy industry. The system is comprehensive and addresses the food safety, food defense, and information gathering/management needs of the bulk milk transportation industry. The Milk Transport Security System, when fully developed, will add significantly to the United States’ security infrastructure for bulk food transport.

Keywords: milk; traceability; automation; security, transport

INTRODUCTION

The United States Department of Homeland Security has targeted bulk food contamination as a focus for attention because it poses a high consequence health threat to our society. The current manual methods used for securing milk during transport are labor and paper intensive and complications associated with handwritten records can occur. The bulk milk transportation sector stands to benefit greatly from a security enhancement that will reduce recording errors, enable normal transport activities while providing security against unauthorized access, and provide the ability to trace milk production back to the dairy farm.

In early 2006, DHS funded a $1.5 million project titled “A Wireless Electronic Monitoring System for Securing Milk from Farm to Processor” to develop a milk transport security system. The project was funded through the National Institute for Hometown Security and involved three universities: the University of Kentucky, the University of Louisville, and Western Kentucky University. The objectives of the that project were to develop a prototype system that would securely transport milk, milk samples, and security data between the dairy farm and dairy processor; demonstrate the security system at two milk plants and multiple dairy farms; and deliver the technology to the national community through collaborations, technical conferences, publications, and standards. That project ended successfully and it was then seen that a commercially robust system was needed to get the system closer to the commercial adoption by the dairy industry. In 2008, DHS funded a project titled “Technology Optimization of a Milk Transport Security System” to develop the prototype to a near-commercial state. The specific objectives for this project included: optimization of the hardware and electronics for the security monitoring system, development of commercial quality web-based software products, development of an enterprise quality data server system, and participation in meetings and demonstrations, all of which cumulate in a one month field demonstration of the system. The objective of the final demonstration was to show that the truck, handheld, and server
systems could operate in unison to provide the needs of the dairy plant, milk marketing agency, and milk transportation company. The projects had a broad cross-section of industry collaborators and met the needs of the dairy industry as reported by Thompson and Payne [1].

MATERIALS & METHODS

A Milk Transport Security System was designed and consisted of a Transport Monitoring System located on the milk transport tank; a handheld device (mobile computer); and a remote data server. The TMS controls access to the milk during transport and automatically collects security data and transmits it to the handheld device. The handheld device is used by the milk hauler/sampler to collect the milk data. Both the milk and security data are transmitted from the handheld device and TMS using cell phone communication to a data server where access is provided to authorized users via web-based software. An overview of the communication flow is shown in Figure 1.

![Figure 1. The communication system deployed in the milk transport security system.](image)

The successful prototype Transport Monitoring System was redesigned to optimize performance and included the addition of cell phone communication built into the TMS. This allowed direct communication between the TMS and the server and tracking of the TMS. The TMS electronics included electronic locks for the top dome and rear door, temperature sensors on the milk transport tank wall and milk sample container, a GPS receiver, Wi-Fi antenna, digital user interface, and a data storage unit.

The components used to develop the transport monitoring system are shown in Figure 2. A computer processor was located in the control module on top of the transport tank. It performed the task of monitoring and recording data on the status of the locks, GPS system, and temperature sensors on one minute intervals or upon an event (i.e. when a lock was opened). The temperature sensors monitored the milk in the transport tank and the sample bath. The tank temperature sensor could record the tank temperature during wash cycles thus verifying a proper wash.

The handheld device (Intermec Model CN3) had three different modes of communication (Bluetooth, WI-Fi, and Cellular); barcode reader; and touch screen in waterproof construction. The handheld used Bluetooth to communicate with the label printer. The label printer selected was the Zebra QL-220 with a 2” x 1” label. The barn receipt, sample bottle labels, and wash ticket were formatted to print on this label.
The data server contained the information attributes of the dairy farms; milk transportation companies and their transportation tanks and tractors; receiving stations at dairy processors, wash stations; and transfer stations. This information was stored in tables with associations as required. A database structure for storage and retrieval was developed as part of this system. The data server was built on two partitioned IBM System x Server platform, running Windows operating system, using IBM DB2 Database, and partitioned using VMWare software. The database was accessed through web pages that were formatted to perform various operations; including receiving updates for the handheld device from the central database and sending data on milk transportation activities from the handheld device to the central database.

The system secures milk during transport by electronically locking all access ports on the tank and allowing access to only authorized personnel. When an authorized person initiates an access, the TMS records the specific port accessed, the reason for the access, the geographic location using GPS, the position of the locks, and the time of the access.

**RESULTS & DISCUSSION**

The milk collection data and other information described above were stored in approximately 70 different tables in the database on the server. The MilkTrace™ software was developed to facilitate data entry, editing, reporting, and performing traces. An example of a “Processor to Farm Trace report” is shown in Figure 3. The Processor to Farm Trace Report requires input of processor, a date range, and optionally a bulk tank identification to list all milk deliveries with all information back to individual dairy farms.

The “Data Management System” is the combination of the handheld programming and the data server structure (without the TMS). It was evaluated in a test in New York state by the milk marketing agencies AgriMark and DMS Northeast and with a milk transportation company Richard Obreza Trucking Company, Mohawk, NY providing the drivers. The goal of the New York test was to show that the system could perform to meet the needs for automation and provide enhanced accountability to the milk transportation company, milk marketing agency, and dairy plant. The test had two main objectives: the successful utilization of the system by a milk transportation company for one month, and the reconciliation of the milk data provided by the system to the dairy plant and milk marketing agency with the existing data.
Figure 3. Processor to Farm Trace Report developed using the MilkTrace™ Software for Winchester Dairy Farms (processor) for a date range of between September 01 and September 24, 2008.

The New York Test was considered a strong success by the participants (Agri-Mark, DMS Northeast, and Richard Obreza Trucking Company). The handheld operation was accepted by the milk haulers, and the farm pickup programming was given high praise by the users. Noteworthy accomplishments were the successful operation and notable ease of use of the handheld device’s milk assembly program, and the successful performance of the data server, database, and server based software. Ten drivers tested the system. Commercialization will require altering the system configuration to remove the milk receiver functions from the handheld operation and adding a host of software features, some of which are specific to the milk marketing agencies. The milk marketing agencies highlighted traceability of the system and security and food safety improvement as advantages to implementing the system.

The Kentucky Test was conducted between November 16 and December 16, 2009. The purpose of the test was to demonstrate that the three main components in the Milk Transport Security System could perform their tasks in unison to secure the milk during transport, automate milk data collection, and provide a system for bulk milk traceability. The system met all of the goals, with the exception of transmitting some security data (lock status and one of the two temperature sensors) between the Transport Monitoring System and Data Server. The simultaneous operation of the technologies was considered successful. The operation of the Transport Monitoring System was successful and all the hardware interfaced perfectly. The handheld milk assembly software operated successfully. The server based software operated successfully with milk-tickets, lab sample reports, and traces performing well. The conclusions obtained from the experience of the Kentucky Test were that the technologies selected were appropriate to meet the goals established for the application and that the Milk Transport Security System has the potential to contribute significantly to the security infrastructure of the United States.

The system was presented to a national audience through meetings and papers. The developed system is comprehensive and addresses the food safety, food defense, and information gathering/management needs of the bulk milk transportation industry. Initial dairy industry evaluations of the system have been positive. The Milk Transport Security System, when fully developed, will add significantly to the United States’ security infrastructure for bulk food transport.

CONCLUSION

The prototype Milk Transport Security System developed with the initial grant in 2006 was optimized to enhance robustness of the system and minimize hardware costs. The developed MTSS fully addressed the need for milk transport security, automation of milk data collection, and provided traceability from the milk processor back to the dairy farms. The New York Test showed that the handheld’s milk assembly program,
the server software, and database performed and provided the intended functions. The Kentucky Test showed that the Milk Transport Security System would perform together as an entire system and that the technologies selected were appropriate for the dairy industry. The system has been presented to the dairy industry in multiple presentations across the United States.

The project personnel believe that the Milk Transport Security System developed is appropriate for complete automation of the milk and security data required to safely and securely transport milk from the dairy farms to the milk processors. It is also believed that future systems for collecting and transporting bulk milk will be in whole or part patterned around the set of technologies and methodologies used to in the MTSS. Consequently, it is concluded that this project has contributed to the security infrastructure of the United States.

REFERENCES


DISCLOSURE

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