Augmented Reality and Automated Monitoring System to Enhance Food Safety Practices in Foodservice

I-Corps Team

EL: Heyao "Chandler" Yu; Doctoral Student

The EL, Heyao "Chandler Yu is a Ph.D. candidate at the University of Houston where he teaches food safety and sanitation. His research emphasis is behavioral food safety training and food safety culture. He is involved in several studies funded by the United States Department of Agriculture (USDA) as follows: USDA-NIFA (2014-68003-21656) to design task-specific, behavior-based training material for fresh and fresh-cut leafy green handling practices; and USDA-NIFA (2013-68003-21288) to design training material and improve food handling practices of small farmers' market vendors. He presented this research at the International Association for Food Protection in 2016. Mr. Yu has also designed an innovative soap dispenser to enhance handwashing frequency and has conducted studies to observe handwashing practices in a restaurant setting.

Mentor: Dr. John Bowen; Professor

Dr. John Bowen is a professor and former dean of the Conrad N. Hilton College of Hotel and Restaurant Management. Dr. Bowen has been recognized as one of the five most influential professors in hospitality management in an article published in the *Journal of Hospitality and Tourism Education*. He has been a three-time recipient of International CHRIE's annual award for the superior published research in the Hospitality Industry. He is co-author of *Marketing for Hospitality and Tourism*, the most widely used text on hospitality marketing. He has received over $1 million in grant monies. Dr. Bowen's foodservice experience includes managing restaurants, hotel food and beverage, university foodservice and hospital foodservice. His experience in the foodservice industry coupled with his knowledge of marketing will help the team identify and understand how to create a value proposition for the target markets. He holds a BS in Hotel Administration from Cornell University, a M.S. and MBA from Corpus Christi State University and a PhD in Marketing from Texas A&M University.

PI: Dr. Sujata Sirsat; Assistant Professor

Dr. Sujata Sirsat has published more than 20 peer-reviewed journal articles and four book chapters. She has been awarded over $1.5 million in competitive grant funds from agencies such as the U.S. Department of Agriculture and the Texas Department of Agriculture to improve food safety practices in retail, restaurant, small farms and farmers' markets. She currently teaches undergraduate Safety and Sanitation in the Hospitality Industry and Grantsmanship at the doctorate level. She was the recipient of Hilton College's 2015 Stephen Rushmore/HVS Faculty Research Award. She is a proud member of the Institute of Food Technologists, the American Society of Microbiology, and the International Association of Food Protection.

Lineage of the Proposed Innovation (one page limit)

1. Previous awards with managing program officer

Dr. Sujata Sirsat		
Grant name	Amount	Year
Development of Effective Behavior Based Standard Operating Procedures for Fresh Cut Leafy Greens in Retail Foodservice Operations" Agriculture and Food Research Initiative Grant	$304,163	2014
Enhancing Farmers Market Food Safety Practices for Fresh Produce Handling" Agriculture and Food Research Initiative Grant	$425,000	2013
Food Safety Best Practices Videos and Workbook for Small Farmers in Texas" Texas Department of Agriculture Grant	$56,900	2012
Agriculture Out of Bounds" Hispanic Serving Institutions Education Grants Program Grant	$49,847	2012
Dr. John Bowen		
New Pathways in the Food Industry for Underrepresented Students, sub-contract through the Houston Community College	$70,000	2009
Customer behavior research for San Remo Hotel	$10,000	2000

2. Briefly describe how this research has led the Team to believe that a commercial opportunity exists for the effort moving forward

Because we are located in Houston, which is the fourth largest city in United States (U.S.) with a population of over two million, we have had the opportunity to collaborate with supermarkets, retail stores, and restaurants within the city and neighboring suburb. A assessment study was carried out as part of the USDA-NIFA grant (2013-68003-21288). To this end, we conducted food safety knowledge surveys and designed observation tools to measure food handlers' food safety practices while handling fresh and fresh cut produce in 34 restaurants and grocery stores in collaboration with these organizations. Based on the results, we identified key high-risk behaviors and simulated those through behavioral modeling and microbial sampling experiments in a mock retail setting. Results from the food safety knowledge survey indicated that employees lacked knowledge of handwashing and temperature recording. Through observation of the employees' fresh and fresh-cut leafy green handling practices, low compliance was observed for hand hygiene, use of thermometers, cleaning and sanitizing food contact surface and documentation. When these behaviors were simulated in the lab, it was determined that these practices led to contamination of fresh and fresh-cut produce. To conclude, if current high-risk practices and procedures continue, the risks of foodborne illness outbreaks could potentially increase. Therefore, we propose a task specific, behavior-based, and affordable educational tool-kit that includes novel monitoring systems and Augmented Reality (AR) technology that will be able to improve employees' fresh and fresh-cut produce handling practices significantly. The technology proposed will enhance the overall food safety practices of the organization. Using these tools will ensure that food safety is not only being learned, but that knowledge is transferred into practice, which in turn will have a positive effect on reducing the number of restaurant and retail related foodborne illnesses.

Description of the Potential Commercial Impact

1. Profile of typical customers: A typical customer for this technology would be foodservice operations. These include deli stores, grocery stores and restaurants where food is processed, handled and or served. A secondary target market will be associations which serve these customers, such as the National Restaurant Association and companies that supply our target market, such as Ecolab. Due to the reasonable cost of training and monitoring system, this innovation will be a perfect solution for small to medium size independent restaurants and retail operations.

2. Describe the customer need that you believe will be met by the proposed innovation: The results of our pre-assessment research demonstrate that owners and managers of retail stores and restaurants need, not just knowledge, but a solution package to effectively improve their employees' food safety handling practices. It will allow them to maintain a high compliance with food safety standards at a reasonable and affordable cost. In addition, the solution should not require extensive time commitment from managers' to observe and monitor employees.

3. Describe how the customer currently meets those needs: Based on previous studies (Egan, et al., 2007), owners and managers of restaurants and retail stores mainly rely on two traditional approaches to solve low compliance of employees' handling practices: knowledge-based training and food safety management system (i.e. HACCP). Typical knowledge-based training consists of a one-hour lesson that includes three "top learning" methods: filmstrip (videotape), lecture, and demonstration (simulation). Some programs conclude with a group discussion (interaction) on various food safety scenarios that could potentially increase the risk of foodborne illness (Frtiz et al. 1989). The problem with current food safety training programs is that they rely heavily on the delivery of information. However, knowledge gained from food safety training programs alone is insufficient towards enhancing food safety behaviors. Moreover, the results of our baseline observation research indicated that high risk behaviors were prevalently found in these 34 foodservice operations even though more than 70% of the employees have received some type of food safety training before. HACCP is widely recognized in the food industry as an effective approach to establishing good production, sanitation, and manufacturing practices that produces safe foods. However, the problem of HACCP management system is that it relies heavily on managers' monitoring. Moreover, it is not uncommon that managers and supervisors prioritize operation over maintaining food safety management system (Pragle, Harding, and Mack, 2007). Hence, the food safety management system may not effective.

4. Your approach : Observational and experimental data from our previous studies have highlighted key high-risk practices such as poor hand hygiene practices, improper thermometer use, and lack of documentation. The proposed toolkit will be designed to include innovative, common sense, and easy to use technology to enhance food safety related behaviors of foodservice (restaurant and retail) employees. The toolkit will include the following:

a. Educational materials delivered via AR:

AR will be used to demonstrate simulated pathogen cross-contamination through smartphones or tablet devices for education and training. In addition, AR will be used to conduct on-site behavior-based food safety training to demonstrate standard operation procedures (SOPs)

in the foodservice industry. Previous studies indicated that the use of AR technology increased training motivation and improved training effectiveness by providing on-site learning experiences and connecting virtual imagery information with real world (Lee, 2012). AR behavior-based training will improve employees' food handling practices significantly by improving employees' training motivation and training fidelity, which are the two extremely important factors can enhance transfer of knowledge to practice.

b. Automated monitoring systems:

The toolkit will include an automatic monitoring system that monitors holding temperatures (hot and cold) and handwashing frequency. The temperature monitoring device will consist of a temperature sensor and micro-computer that will continuously record and send the temperature of the coolers or refrigerators to a tablet or smartphone device. Managers and employees can check the temperatures on their cellphone or other mobile device . This will avoid the need for paper based temperature documentation, which was observed low compliance in our pre-assessment study. The handwashing frequency monitoring device will consist of a motion-detection sensor and signal sender. The device will be designed to count handwashing frequencies for each shift and the data will be available to the manager via a smart device application. The manager will not need to spend a lot of time tracking and monitoring the management system. Instead, they can acknowledge the employees' best practices by accessing the application. The task-specific monitoring devices will help managers monitor handwashing frequency, any occurrence of time and temperature abuse, and maintain robust documentation.

5. How much do you think a customer would pay for your solution?

Managers in foodservice industry need affordable and efficient food safety training and monitoring systems to enhance food safety. Based on our personal communication with potential customers, they may not be able to spend thousands of dollars on food safety monitoring systems. A low cost solution will reduce the price barrier may prevent the use of the current systems by many operators. We propose an affordable toolkit allowing customers to either purchase the whole toolkit or a single device from the toolkit based on their needs. The cost of the automated monitoring systems (handwashing and temperature), will no more than $200. The cost of AR food safety training per unit (organization) will be approximately $50. If the proposed devices are commercialized, their cost will even lower due to industrial production. From this perspective, our innovations provide a cost effective solution that will help enhance food safety practices and potentially reduce the risk of foodborne illness. In addition, it will reduce potential liability caused by foodborne illness outbreak incidences to foodservice operators.

Brief Description of the project plan

1.Current Status

Monitoring devices: We have completed the prototypes of temperature and handwashing monitoring devices (Figure 1 and 2 respectively). The prototypes have proven to work well within the University of Houston's network. These two devices will be installed in a 150-seat full-service student run restaurant in University of Houston to test if the monitoring system will work well in a live foodservice operation. Also, researchers will request feedback from the

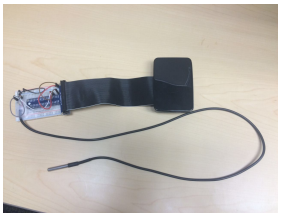

Figure 1. Temperature monitoring device

manager of this restaurant to further improve the performance of the monitoring devices.

Figure 2. Handwashing monitoring device

AR technology: The investigators are currently working on designing short videos and information-sheets that will be embedded with AR. The training materials will be behavior-based and demonstrate standard operation procedures (SOPs) of fresh and fresh-cut produce specifically. By using a smartphone application, users can scan the print material and view digital interactive content (video, message, and link) on the top.

2. Provide a brief description of the proof-of-concept or technology demonstration that will be provided at the end of the project.

Monitoring device: The handwashing frequency and temperature monitoring system will include a sensor that is connected to a micro-computer called raspberry pi. The sensor feeds the data to the raspberry pi which adds it to a database to monitor live feed and send out notifications in case it fluctuates. Hence, the manager will be able to track temperature of coolers, refrigerators, food holding devices, and handwashing frequency anytime by checking their cellphone or mobile device.

AR behavior-based training: AR technology allows computer-generated virtual imagery information to be overlaid onto a live direct or indirect real-world environment in real time. In AR, the environment is real, but extended with information and imagery from the system. We will use marker-based AR, which can be accessed through a tablet or smartphone and convert the information from markers to 3D-rendered information on the screen. Managers of foodservice units will be able to download the AR training application via smartphones or tablets, print the tags provided by the AR training application and paste them to specified places in the kitchen. When training starts, the employees could simply use their smartphone or tablet to open the application, scan the tags, and see the food safety training video on their screen.

References

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