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Review Article

Nonintrusive Inspection Using Predictive Big Data Analytics for Biological Pathogen Threats of Biofilms from ATP Bioluminescent Sensor Micrographs for Dairy Research and Technology

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Abstract

Non-Intrusive inspection (NII) using DJI Phantom 4 drones for video surveillance of dairy manufacturing plants operational activity and the utilization of computer vision, machine learning, NoSQL databases (e.g. MongoDB, HBase, and Cassandra) and the Hadoop Ecosystem with Spark Directed Acyclic Graph Execution Engine (DAG) to analyze ATP bioluminescent sensor micrographs from biofilms on a dairy manufacturing assembly lines is a powerful threat detection technique. The detection of "bacteria in milk typically adhere and aggregate on stainless steel surfaces, resulting in biofilm formation in milk storage tanks and milk process lines. The exponential growth of biofilms in milk processing environments incorporates more opportunities for microbial contamination of the processed dairy products. These biofilms may contain spoilage and pathogenic microorganisms, such as *Yersinia, enterocolitis*, and strains of *Escherichia coli* which can survive on different surfaces for periods ranging from several hours to days. In addition, even within biofilms the most deleterious spoilage bacteria originating from raw milk is pseudomonads. The detection and predictive tracking of pseudomonads originating from raw milk and pathogenic microorganisms captured by ATP bioluminescent micrograph sensors are ingested into the Nephilim Base Unit Architecture, authentication server that can be configured on the (Access Point) AP or on an external server. We also incorporate image anomaly detection to classify micrograph biofilm images which are considered outliers (e.g. ATP biofilm sensor yielding a totally black image). Micrograph images detected as outliers are filtered, flagged, and ranked using Spark filter and window functions before encrypted data propagation.

Keywords: *Non-Intrusive Inspection (NII); DJI Phantom 4 Drones; Hadoop Ecosystem; Directed Acyclic Graph Execution Engine (DAG)*

Executive Summary

Non-intrusive inspection (NII) using DJI Phantom 4 drones for video surveillance of dairy manufacturing plants operational activity and the utilization of computer vision, machine learning, NoSQL databases (e.g. MongoDB, HBase, and Cassandra) and the Hadoop Ecosystem with Spark Directed Acyclic Graph Execution Engine (DAG) to analyze ATP bioluminescent sensor micrographs from biofilms on a dairy manufacturing assembly lines is a powerful threat detection technique [1,14]. The detection of "bacteria in milk typically adhere and aggregate on stainless steel surfaces, resulting in biofilm formation in milk storage tanks and milk process lines. The exponential growth of biofilms in milk processing environments incorporates more opportunities for microbial contamination of the processed dairy products. These biofilms may contain spoilage and pathogenic microorganisms [1], such as *Yersinia*, *Enterocolitis*, and strains of *Escherichia coli* which can survive on different surfaces for periods ranging from several hours to days [7-9]. In addition, even within biofilms the most deleterious spoilage bacteria originating from raw milk is pseudomonads. The detection and predictive tracking of pseudomonads originating from raw milk and pathogenic microorganisms captured by ATP bioluminescent micrograph sensors are shown below in figure 1.

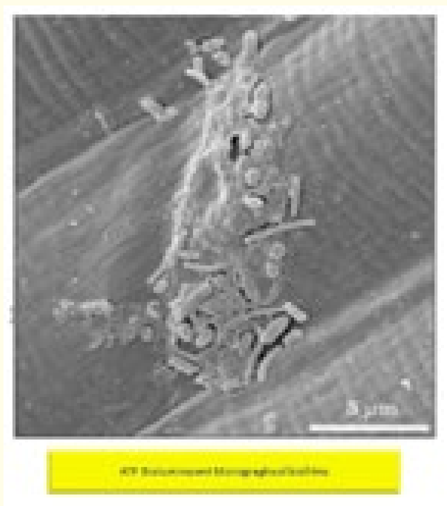

Figure 1: *ATP bioluminescent sensor micrographs from biofilms.*

We propose here the Nephilim automated-food safety and security system for dairy manufacturing plants [12,14,15] that would assist dairy manufacturing operators using computer vision and intelligent nonlinear control with big data analytics for future food safety and security inspection systems, shown in figure 2 below.

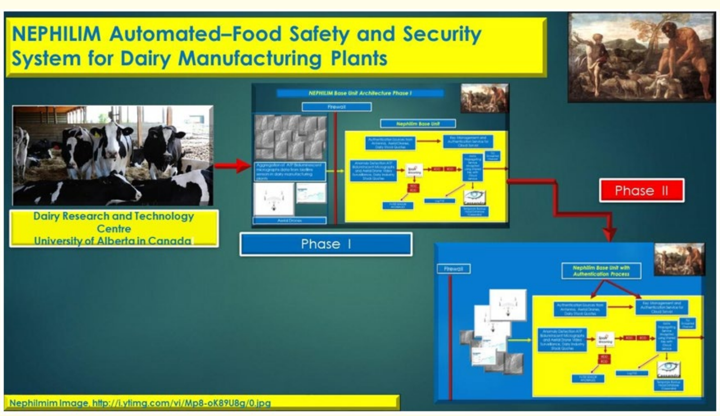

Figure 2: *Nephilim automated-food safety and security system.*

Our proposed Nephilim automated-food safety and security system for dairy manufacturing plants would use computer vision and machine learning algorithms for feature extraction and detection to classify key parameters of pathogens identified within ATP bioluminescent micrographs from biofilms which advocate the initiatives and objectives of the Dairy Research and Technology Centre (DRTC) at the University of Alberta in Canada in collaboration with Brandeis University. Additionally, we capture historical dairy stock market quote data for analysis when a major or predictive outbreak; which may cause a biological outbreak.

Technical approach

Concept description

We propose to develop a new tool to assist dairy manufacturing operators in the analysis of non-intrusive inspection (NII) ATP bioluminescent micrographs in biofilms analyzed in the Nephilim automated-food safety and security system for dairy manufacturing plants. A wide variety of features will be extracted from measured ATP bioluminescent micrographs of biofilms, and from measured micrographs with computer vision and machine learning algorithms to classify and detect pathogens. These features will train machine learning algorithms to provide dairy manufacturing operators with a valuable analysis tool that complements their own inspection and assists to classify and identify pathogens, anomalies in micrographs, and regions of the micrographs where pathogens and microorganisms maybe hidden and otherwise undetectable.

Novel approach

Phase I: Acquisition of ATP bioluminescent sensors and drone video surveillance to the Nephilim base unit

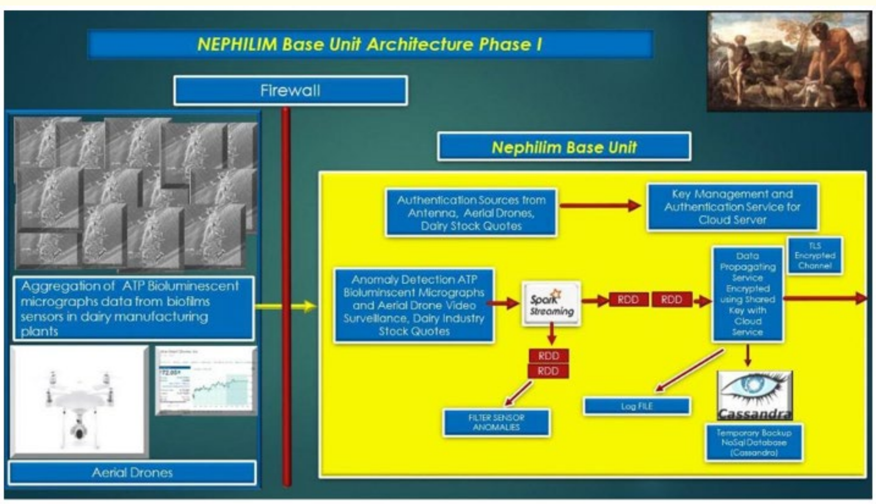

Figure 3: *Nephilim base unit architecture.*

In phase I of the Nephilim base unit architecture, authentication server can be configured on the (Access Point) AP or on an external server. We incorporate image anomaly detection to classify micrograph biofilm images which are considered outliers [16] (e.g. ATP biofilm sensor yielding a totally black image). Micrograph images detected as outliers are filtered, flagged, and ranked using Spark filter and window functions before encrypted data propagation.

The client authentication process is described below in figure 4 and 5, below respectively.

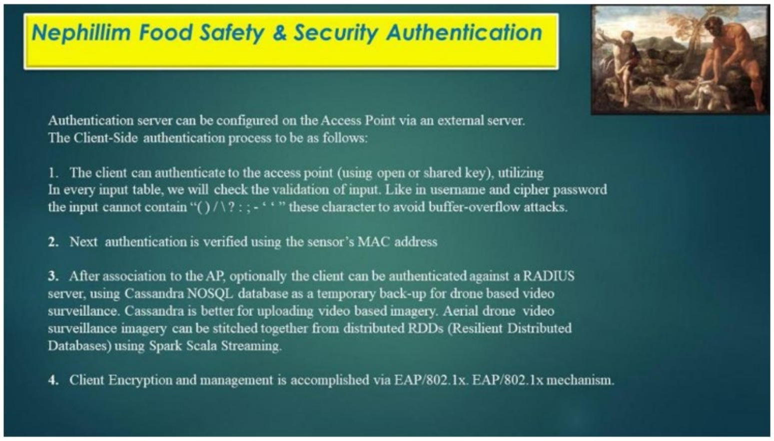

Figure 4: *Nephilim food safety and security authentication.*

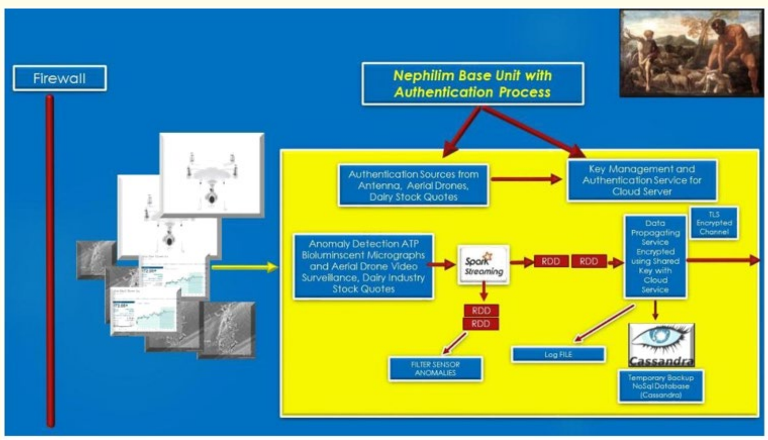

Figure 5: *Nephilim food safety and security base unit authentication process.*

Phase II Nephilim cloud security

The use of a web applications to connect to NoSQL databases (MongoDB, Apache HBase, and Apache Cassandra) send time stamped requests to the Nephilim computer vision and machine learning classifier utilizing Nephilim sliding mode observer control system for parameter values with differing Apache Spark window functions to yield quicker convergence and stability of the system [12,14], illustrated in figure 6.

The network dependence of the out-sourced private cloud is also equivalent to the out-sourced private cloud community, but the primary difference is the multiple protected communication links from the community members to the cloud service provider facility. However, the network dependency is equivalent to multi-tenant locations which are hidden from clients. In figure 6 (below), an out-sourced Nephilim cloud food safety and security service provider is referenced below for the multi-tenant network.

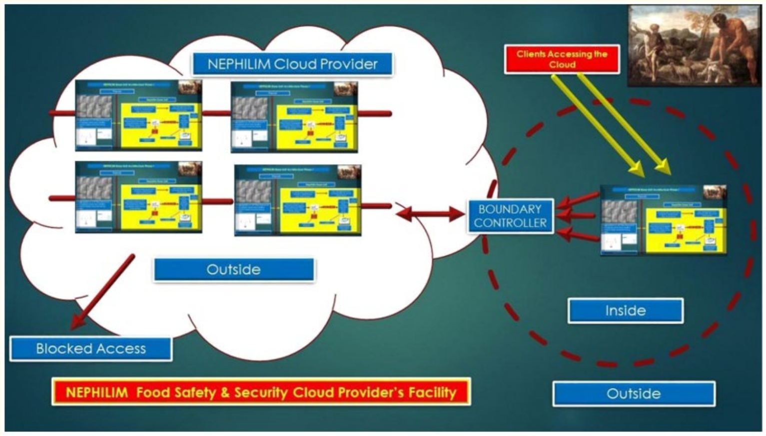

Figure 6: *Nephilim food safety and security cloud service provider.*

Enhanced security features of Nephilim automated-food safety and security system Security features in web UI design

- Nephilim automated-food safety and security system implements security enhancements to thwart malicious attacks (e.g. Port 80 (closed), penetration testing and packet sniffing software for testing (e.g. OWASP ZAP [13]) in figure 7, below.
- The Nephilim automated-food safety and security system website utilizes angularJS, PHP, and OpenSSL 1.0.2a with https protocol in figure 8, below.

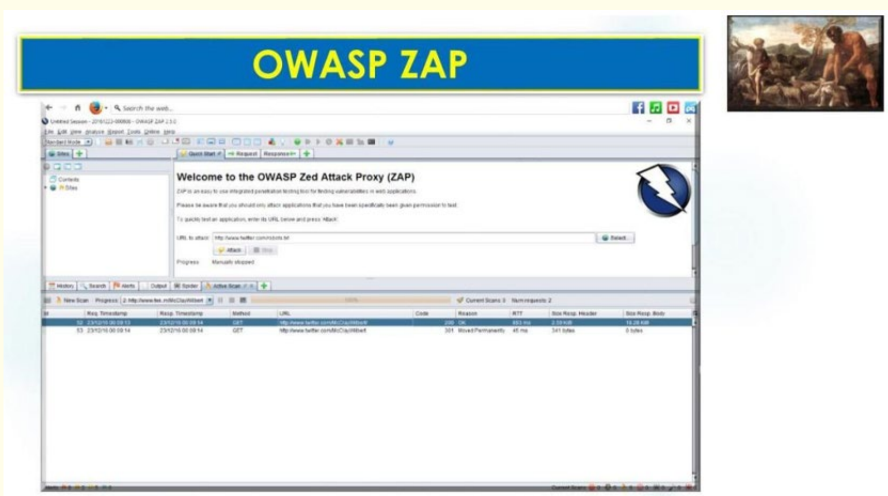

Figure 7: *OWASP ZAP penetration and vulnerability testing.*

Figure 8: *The Nephilim automated-food safety and security system website utilizes angularJS, PHP, and OpenSSL 1.0.2a with https protocol.*

Conclusion

Comprehensive ATP bioluminescent micrographs of biofilm datasets with tens of thousands of detected pathogens and microorganisms including measurements, meta-data, and manifest information are quintessential for big data analytics and the use of NoSQL databases (e.g. Apache Cassandra, Apache Hbase, MongoDB) with registered timestamps for data acquisition.

We have developed in the automated Nephilim food safety and security project to classify and detect ATP bioluminescent micrographs of biofilm datasets utilizing an out-sourced Nephilim cloud service provider with Cassandra as the NoSQl datastore; into various categories of micro-organisms and pathogens.

Bibliography

1. Marchand S., *et al*. "Biofilm formation in milk production and processing environments influence on milk quality and safety". *Comprehensive Reviews in Food Science and Food Safety* 11.2 (2012): 133-147.

2. Bredholt S., *et al*. "Microbial methods for assessment of cleaning and disinfection of food-processing surfaces cleaned in a low-pressure system". *European Food Research and Technology* 209 (1999): 145-152.

3. Bower CK and MA Daeschel. "Resistance responses of microorganisms in food environments". *International Journal of Food Microbiology* 50.1-2 (1999): 33-44.

4. Kumar C and SK Anand. "Significance of microbial biofilms in food industry: a review". *International Journal of Food Microbiology* 42.1-2 (1998): 9-27.

5. Flint SH., *et al*. "Biofilms in dairy manufacturing plant description, current concerns and methods of control". *Biofouling* 11.1 (1997): 81-97.

6. Storgards E., *et al*. "Hygiene of gasket materials used in food processing equipment part 2: aged materials". *Food and Bioproducts Processing* 77.2 (1999): 146-155.

7. Parkar SG., *et al*. "Factors influencing attachment of thermophilic bacilli to stainless steel". *Journal of Applied Microbiology* 90.6 (2001): 901-908.

8. Marshall K. "Biofilms: an overview of bacterial adhesion, activity, and control at surfaces". *ASM News* 58 (1992): 202-207.

9. Fett W. "Naturally occurring biofilms on alfalfa and other types of sprouts". *Journal of Food Protection* 63.5 (2000): 625-632.

10. Morris CE., *et al*. "Methods for observing microbial biofilms directly on leaf surfaces and recovering them for isolation of culturable microorganisms". *Applied and Environmental Microbiology* 63.4 (1997): 1570-1576.

11. Seo KH and JF Frank. "Attachment of *Escherichia coli* O157: H7 to lettuce leaf surface and bacterial viability in response to chlorine treatment as demonstrated by using confocal scanning laser microscopy". *Journal of Food Protection* 62.1 (1999): 3-9.

12. Wilbert McClay., *et al*. "A real-time magnetoencephalography brain-computer interface using interactive 3D visualization and the Hadoop ecosystem". *Journal of Brain Sciences* 5.4 (2015): 419-440.

13. Shi X and Zhu X. "Biofilm formation and food safety in food industries". *Trends in Food Science and Technology* 20.9 (2009): 407-413.

14. The Ancient Book of Giants was Discovered in Qumran, Thoughtful (2021).

15. Wilbert McClay. "A magnetoencephalographic/encephalographic (MEG/EEG) brain-computer interface driver for interactive iOS mobile videogame applications utilizing the Hadoop ecosystem, MongoDB, and Cassandra NoSQL databases". *Diseases* 6.4 (2018): 89.

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