NON-INVASIVE MONITORING OF HUMAN HYGIENE USING VIBRATION SENSOR AND CLASSIFIER

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INTRODUCTION

- Increase in life expectancy: the number of people over the age of 60 years will nearly double from 12% to 22% in the next 30 years.
- Aging causes accumulation of a wide variety of molecular and cellular damage over time which leads to a gradual decrease in physical and mental capacity, a growing risk of disease, and ultimately, death .
- The elderly population tend to have the highest disability rate and highest need for long-term care services and is also more likely to be widowed and without someone to provide assistance with daily activities.
- Given the current pandemic, daily habits such as washing hands or taking regular showers have taken major importance among people, especially for our elderly population living alone at home or in an assisted living facility.
- If there was a better way to monitor daily hygiene routine, it could truly help our healthcare professionals be proactive rather than reactive in identifying and controlling the spread of potential outbreaks within our community.

OBJECTIVES

- We propose to leverage the power of the sensor technology to help better understand the daily habits of the elderly population
- Our goal here is to raise awareness towards providing daily activities data to our healthcare workers, they can take proactive measures in remediating a potential health crisis.
- We utilize machine-learning based Support Vector Machine (SVM) model used for classification and regression problems using a hyperplane in an N-dimensional space (N is the number of features)

RELATED WORKS

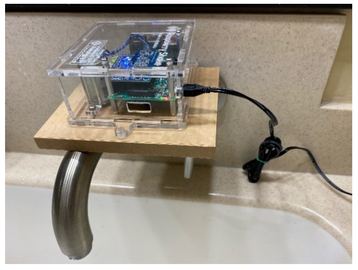
There are some previous studies done in the area of unintrusive monitoring using vibration sensors and classifiers but none have used the combination of the geophone, digitizer, and a computer board (raspberry pi) to measure multiple activities:

- Yiyuan Zhang proposed a Bathroom activity monitoring for older adults via wearable device makes use of a wearable accelerometer to monitor six types of bathroom activities: dressing, undressing, washing hands, washing face, brushing teeth, and toilet using 10-fold cross-validation.
- Jianfeg Chen proposed a system to recognize and classify different activities occurring within a bathroom based on the sound includes an infrared system which would detect entry into the bathroom, a microphone with a pre-amplifier circuit to record and classify the sound events in real-time using HMMs (Hidden Markov Models).
- Yingqi Hao focuses on creating a safety monitor that not only detects a safety hazard in the kitchen but will also respond to the threat and send out alerts or notifications. This system utilizes a single-chip microcomputer as the central core along with sensors to detect temperature, gas, and smoke concentration.

SYSTEM ARCHITECTURE

DATA COLLECTION → DATA VALIDATION → DATA EXTRACTION → DATA ANALYSIS

Figure 1: Present a four-stage approach to the experiment.



Raspberry Shake I/O
1 x Ethernet Port
1 x HDMI Port
4 x USB Ports
1 x 3.5MM jack
1 x MicroSD card slot

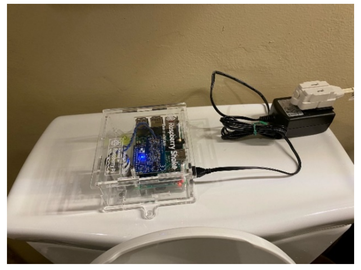
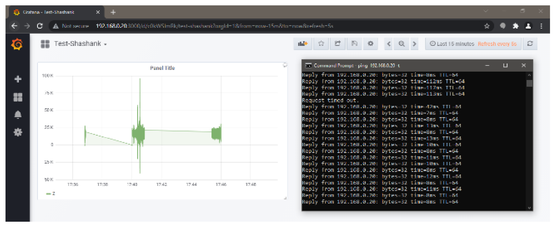


Figure 2 – Raspberry Bathroom Faucet Monitoring Setup (left), Raspberry Shake I/O Ports (middle), and Toilet Monitoring Setup (Right)



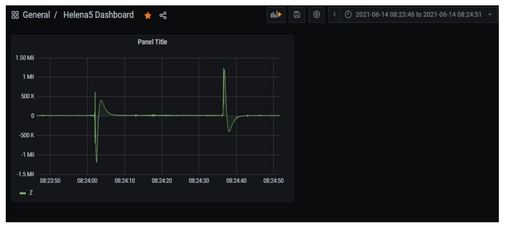
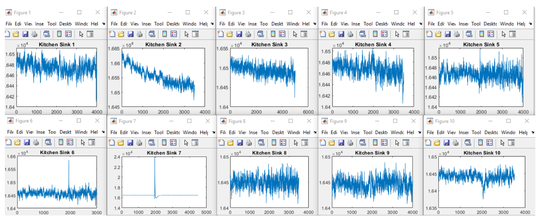


Figure 3 – Network Timeouts on Grafana (left), Data Captured in Grafana (right)

RESEARCH FINDINGS



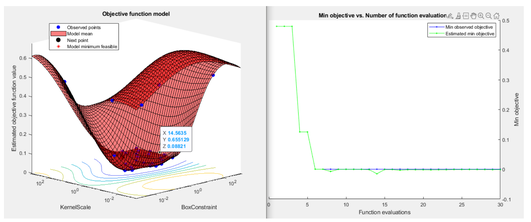


Figure 3 – Comparing Samples of the Same Event (left), Objective Function Model (right)

RESULT

- Feature extraction visa SVM is used, three separate files containing 60 events each where dataset devided (80:20) into training and test batches to measure accuracy of the classification from each batch.
- A cross-validation set was prepared with a K-5 fold to train using the entire dataset to improve accuracy by minimizing errors.
- Objective Function Model model was cycled 10 times, total of 120 events for each of the three classification scenarios.
- Training model provide very consistent and high accuracy each time, an overall accuracy of above 90% illustrates in fig. bellow.

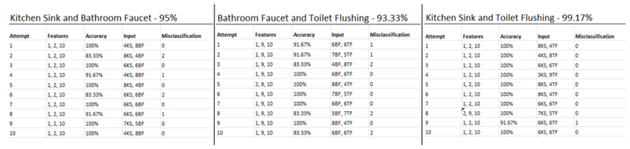


Figure 4 – Training Model Accuracy (above),

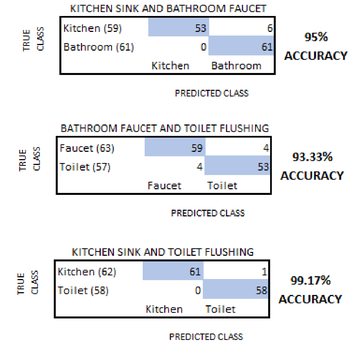


Figure 5: Confusion Matrix Accuracy (Right)

CONCLUSION

- Presents a concept and idea of a non-invasive monitoring system for human hygiene using vibration sensors.
- The approach is based on a combination of geophone sensor, a digitizer, and a cost-efficient computer board in a Raspberry Shake enclosure.
- Maintaining good hygiene practices not only reduce the chances of contracting a disease, but it could also reduce the risk of spreading illness within your community.

REFERENCES

1. "Ageing and Health." World Health Organization, World Health Organization, 4 Oct. 2021.
2. Public Information Office. (2016, March 28). U.S. population aging slower than other countries, Census Bureau reports. United States Census Bureau. Retrieved October 21, 2021