Bluetooth Operation Verification via Monitoring the Transmission Pattern Using Machine Learning

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Bluetooth is a widely-used wireless communication protocol in small portable devices due to its low energy consumption and high transfer rates. Manufacturers normally buy their Bluetooth chips from third-party suppliers, which are then integrated into a complex hardware-software stack with a variety of potential vulnerabilities. Direct measurement of the output can help security functions prevent unauthorized data transmission. This work proposes a compact supervisory circuit to classify the operation of a Bluetooth chip at low frequencies by monitoring the radio frequency (RF) output of the Bluetooth chip through an envelope detector. The idea is that the envelope detector and classification algorithm can be inexpensively fabricated on a low-frequency integrated circuit in legacy technology and/or with minimal area. When the supervisory circuit detects abnormal behavior, it can be configured to shut down the Bluetooth chip. Using features extracted from the envelope of the RF output signal, we are able to train several machine learning (ML) algorithms to classify different Bluetooth operation modes and parameters such as operation profile, distance between the paired devices, and number of connected devices. In this work, we demonstrate ML models that can separate Bluetooth advertising and transmit/receive modes with ~ 100% accuracy and classify the operation profile of the Bluetooth chip with ~ 100% accuracy.

Detection and Verification of Periodontal Pathogens through Real Time PCR

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Abstract

The detection and verification of *Streptococcus gordonii*, *Fusobacterium nucleatum*, and other oral bacteria is crucial to scientific research involving periodontal diseases and can be done using a Quantitative Polymerase Chain Reaction (Q-PCR) experiment. Experimentation using Q-PCR provides fast and accurate bacterial strain detection over a span of two to six hours [1] compared to traditional microbiology techniques which may take up to 48 hours or more. This research project focuses on the detection and quantification of S. gordonii, F. nucleatum, and compound biofilms of both bacteria before and after the application of an experimental antimicrobial agent. The quantification of these bacteria through Q-PCR is important in detecting contamination of the experimental samples and in verifying the specific species of bacteria present in a sample. In order to confirm that the bacteria cultures have not been contaminated, a Q-PCR thermal cycler will be used for accurate testing conditions and analyses. Two gene-specific primers for both bacteria are required to amplify the bacteria to a detectable level. Results of the Q-PCR experiments will be determined through the analysis of the graph produced by the StepOnePlus Q-PCR machine and electrophoresis of the samples. Samples that are successfully amplified and confirmed to be either S. gordonii and/or F. nucleatum are expected to fluoresce and be detected during the reaction. Samples of bacteria, following verification through Q-PCR and electrophoresis, will be used for testing in further research in developing antimicrobial oral products.

Keywords: Q-PCR, PCR, primer, DNA template, DNA polymerase, amplicon, S. gordonii, F. Nucleatum, quencher, reporter dye

Mineralogy Controlled Dissolution of Uranium from Airborne Dust in Simulated Lung Fluids (SLFs) and Possible Health Implications

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Abstract (Word limit 250)

The recent increase in cardiovascular and metabolic disease in the Navajo population residing close to the Grants Mining District (GMD) in New Mexico is suggested to be due to exposure to environmental contaminants, in particular uranium in respirable dusts (fine dust small enough to reach gas exchanging/ alveolar region of lungs). However, the chemistry of uranium-containing-dust dissolution in lung fluids and the role of mineralogy are poorly understood, as is their impact on toxic effects. The current study is focused on the dissolution of respirable-sized U-containing-dust, collected from several sites near Jackpile and St. Anthony mines in the GMD, in two simulated lung fluids (SLFs): Gambel's solution (GS) and Artificial Lysosomal Fluid (ALF). We observe that the respirable dust includes uranium minerals that yield the uranyl cation, UO_2^{2+}, as the primary dissolved species in these fluids. Dust rich with minerals uraninite and carnotite is more soluble in GS, which mimics interstitial conditions of the lungs. In contrast, dust with low uraninite and high kaolinite is more soluble in ALF, which simulates the alveolar macrophage environment during phagocytosis. Moreover, geochemical modeling, performed using PHREEQC, is in good agreement with our experimental results. Thus, the current study highlights the importance of site-specific toxicological assessments across mining districts with the focus on their mineralogical differences.

Keywords: uranium, lung fluids, heavy metal inhalation