New Project Proposal to NCSS  I/UCRC

Audio Analysis of Cough and Breathing Patterns for COVID-19 Detection

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**Project Leads:** Andreas Spanias (PI) and Greg Raupp

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ASU 2020-12-1
Problem Statement

› Why is this research needed?
  › Low cost, Non invasive COVID-19 detection will be fast efficient and accomplished via cell phone
  › Leveraging prior research in audio compression and recognition for COVID-19 sound analysis
    Potential to elevate the field of encryption
  › Machine learning, has been demonstrated to work well in sound recognition.

› What is the specific problem to be solved?
  › Develop and investigate unique audio features for COVID-19 detection
  › Develop customized machine learning algorithm for classification and COVID-19 detection via cellphone

› Challenges
  › Databases with COVID-19 audio data
  › Robustness of the classification process
Project Description

› How will this project approach the problem?
› Characterize performance and complexity.
› Develop specific features for Covid-19 audio features
› Develop customized neural nets for COVID-19 detection
› Create the software needed to eventually port on cell phone (2nd year)

› Preliminary results from this or previous projects:
› Some preliminary results created in our REU project [1]
Images from researchers at Cambridge University show how algorithms look for signs of COVID-19 in audio samples of coughs. (Courtesy of Dimitris Spathis)

ASU Study

Spectrogram from Cambridge University, UK

ASU Study
Project Differentiators

› What results does this project seek that are different (better) than others?
  › Customized Features.
  › Pruned NN Algorithms.

› What specific innovations or insights are sought by this research that distinguish it from related work?
  › Potential for high percentage of success in non-intrusive testing
  › Efficient Implementation on cell phone
  › Extension to other areas of breathing abnormality detection
### Connection to NCSS Competencies/Capabilities

<table>
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<tr>
<th>Competencies</th>
<th>Capabilities</th>
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<tr>
<td>Net-Centric Solutions</td>
<td>Web Services</td>
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<td>Next Gen HW and Tools</td>
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<td>Software Engineering</td>
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<td>Information Assurance</td>
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<td>Big Data</td>
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<td>Next Generation Network</td>
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#### Sensors & ML
- Audio Analytics

### Levels of Competence

- **Primary** (1)
- **Secondary** (2)
- **Tertiary** (3)

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1 = Primary, 2 = Secondary, 3 = Tertiary
Statement of Work:

Briefly describe the work to be performed, task budgets, and deliverables for the 5 most important tasks planned for this project.

<table>
<thead>
<tr>
<th>Task#</th>
<th>Description</th>
<th>Budget</th>
<th>Deliverable</th>
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<tbody>
<tr>
<td>Task-1</td>
<td>Develop unique features for COVID-19 breathing</td>
<td>3 MOS</td>
<td>Performance and complexity profile, Software</td>
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<td>Task-2</td>
<td>Develop customized NN algorithms using pruning approaches.</td>
<td>3 MOS</td>
<td>Presentation of results. Confusion matrix</td>
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<td>Task-3</td>
<td>Improve results by training with additional data</td>
<td>3 MOS</td>
<td>Presentation and software</td>
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<td>Task-4</td>
<td>Compare algorithms with prior work and establish final results.</td>
<td>3MOS</td>
<td>Software, Final Report. Prepare IEEE paper.</td>
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Potential Member Company Benefits

Important for diagnostics on breathing and cough

Extensions to other pathologies: Apnea, Dyspnea, Tachypnea

Assessment of basic algorithms and architectures and tech transfer.
Sponsorship and Collaboration

Efforts to involve multiple companies in project sponsorship:

- Resonea
- Lighsense
- Qualcomm

Multi-university Collaboration:

Describe efforts to involve multiple universities in sponsorship of the proposed research (whether or not they were successful).

This will likely mostly be performed at ASU.
## Project Quality Attributes
PI’s assessment of extent to which project demonstrates each QA.

### Project Quality Attribute Self-Assessment:
- **Alignment with Center Competencies**: 4
  - Machine learning, signal processing, sensors
- **Sponsor-acknowledged Leverage to R&D**: 5
  - Resonae, Qualcomm,
- **Multi-company Sponsorship**: 3
- **Multi-university Collaboration**: 2
- **Compliance with NSF Operations Requirements**: 5
- **Objective Deliverables**: 4
- **Innovation & Technology Evolution**: 3
  - AI/ML for Audio
- **Potential for Derivative Services**: 4
- **Commercialization Opportunities**: 3
  - It will need significant additional resources.
- **Past Performance**: 4
  - Publications in Audio & ML
References

