

## **Proposal on : Post-vaccination Trajectory Assessment on Speech Features Validated by Rapid Diagnostic Test**

**Name of the institute:** Indian Institute of Technology Jammu

**Incubator:** IIT Jammu in collaboration with AIIMS Rishikesh

**Faculty:** Dr. Karan Nathwani (IIT Jammu), Dr. Dharitri Rath (IIT Jammu), and Dr. Minakshi Dhar (AIIMS Rishikesh)

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**Objective:** Post Vaccination Studies

**Type of Intervention: (Choose one):** 4) Post Vaccination studies.

**Details of intervention:** See Appendix A

(Should cover details about the product/ technology, methodology, milestones, timeline, Line-item wise financials along with tentative cost of transportation, annual maintenance etc.)

**Do you have State Government connection, or will you require support from CSR –** Need Support from CSR

**States that you can provide technology to –** J&K, Punjab and Delhi

**Please answer following questions depending on the intervention you choose and if applicable to you:**

**Can you do the Community engagement yourselves or will need help by CSR-** Need help from CSR

**If you have a Market ready technology available,**

- **How do you plan to deploy:** Using App Development
- **Number of units available:** Under Development Stage

**Do you wish to partner with an NGO? If yes, name the NGO and provide details on how u will partner? (Item wise costing should include cost to NGO for their scope of work) -** NO

### **Appendix A**

**Abstract:** The world's biggest vaccination drive against novel coronavirus has already rolled out in India. Our study is going to focus on the effect of vaccination on human speech that is, how our voice production, speech samples, glottal features and other characteristics are going to change from the normal scenario and its impact after vaccination. This would be the first attempt to evaluate the changes in human voice production mechanism post vaccination. To achieve this, we will be exploiting several speech features to analyze these abnormalities in comparison to normal voice samples. Further, we would also focus on how long it is taking for these abnormalities to return back to normalcy. By this, we can comment on the efficacy of the various vaccines using several speech processing features, which is the need of the hour. To deploy this, we would like to develop a Mobile Application for the same.

**Methodology: A. Pseudo Algorithm:** The pseudo algorithmic steps involved in evaluating human voice production post vaccination are as follows: **Step 1:** Framing: Compute Short Segments (around 20 ms) of normal, during Corona and post-vaccination (on continuation for a few days) speech signals. **Step 2:** Feature extraction from Short Segments: Several speech features like Pitch, Short-Time Energy, Zero crossing rate and MFCC (See section B for more details). **Step 3:** Comparison of normal, corona positive patients and post-vaccinated samples for the aforementioned speech features. **Step 4:** Analyzing the trajectory of post-vaccination speech features to attain normalcy (see Section C more details). **Step 5:** Verification of each of the predictions from the proposed speech features for their validation (See Section D) and deploying on Mobile Application.

Note: We would require to acquire voice samples from CORONA patients at various stages, which would be provided by Dr. Minakshi from AIIMS Rishikesh.

**B. Preliminary Results:** We have got satisfactory results using the aforementioned features in COVID-19 detection as shown in Fig. 1. We have successfully distinguished the speech sample of a COVID-19 patient to that of a Normal one using these features. We have implemented these features on several normal and COVID data and successfully detected COVID-19 positive samples. Some of these results are illustrated in Fig. 1.

1. **Short time Energy:** It is the frame wise energy computation of a speech. The mean short-time energy and variance is significantly higher during COVID-19. This could be because more pressure is exerted on the vocal tract due to the throat infection and this requires more energy for the speech utterance.

2. **Zero Crossing Count (ZCC):** It is the number of times the signal crosses the zero, or the time axis. The mean ZCC is lower during COVID compared to normal voice...

3. **Average Power:** It is seen that the average power of COVID-19 positive speech is comparatively higher than Normal Speech. This is again due to extra pressure exerted on the vocal tract during Covid-19.

4. **Pitch:** It is the relative highness or lowness of a tone as perceived by the ear, which depends on the number of vibrations per second by the vocal cords. It is the fundamental period of the speech signal. There is a significant decrease in pitch frequency when a patient is infected with the Covid-19 disease.

5. **Mel-frequency cepstral coefficients (MFCCs):** They approximate the human auditory system's response (vocal tract). We have seen that the mean MFCCs and variance for Normal Speech are -1.32953 and 21.79806695 respectively and the same for COVID-19 positive patients are -1.16356 and 12.06242361 respectively.

**C. Analysis of Post-Vaccination on Speech Features:** It can be concluded from Section B that speech features change significantly from Normal to that of a COVID infected person's voice samples. So, we believe that these speech features are going to be very helpful for our post vaccination study on human speech. We may be able to comment on the impact of vaccination on human voice and also human health. Therefore, we can extend our analysis to estimate various things such as the recovery rate, which vaccine is working faster, which one is better and has no side effects, etc. In this way, our work can contribute to the successful implementation of the world's largest vaccination drive. For instance, if the pitch computed (on every day basis after post-vaccination) is not going to increase i.e., remains flat (or in other words does not get to normalcy), it would be a clear indication of the efficiency of vaccination on human voice reaching towards normalcy.

**D. Biological Sample Analysis of Post-Vaccination:** Prediction of the above speech features will be validated using the commercially available antigen kits in order to check for the presence of viral elements. This would help us in real time validation and cross verification of the prediction of Covid-19 patients to normalcy post-vaccination. In Parallel, we would deploy our validation on Mobile Application. The required clinical data would be obtained from AIIMS Rishikesh.

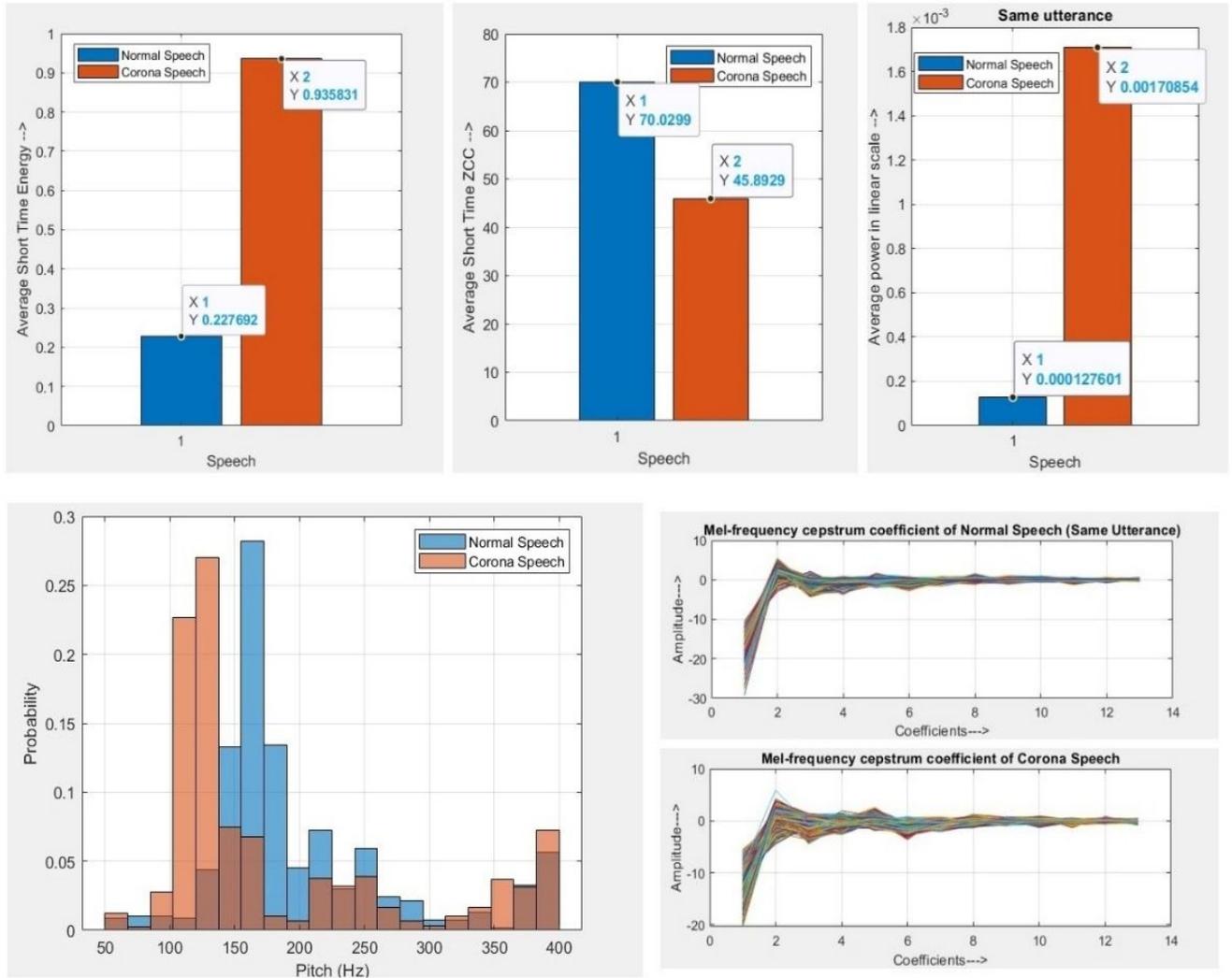


Fig.1: Classification of Several Speech Features of Normal vs. COVID-19 positive patients.

**Tentative Budget:**

Sr. No.	Items	Budget			
		12months	12months	18 months	Total
1.	Salary : 1 Manpower	4,31,520	4,31,520	4,31,520	12,94,560
2.	Equipment	6,00,000	0	0	6,00,000

3.	Consumables	50,000	50,000	50,000	1,50,000
4.	Travel	50,000	50,000	1,00,000	2,00,000
5.	Contingencies	50,000	50,000	50,000	1,50,000
	Total	11,81,520	5,81,520	6,31,520	23,94,560
6.	Overhead expenses* (20)	2,36,304	1,16,304	1,26,304	4,78,912
	Total	14,17,824	6,97,824	7,57,824	28,73,472

### Estimated Timelines:

Activities	0-6 months	6-18months	18-24 months	
Collection of voice samples of patients (Normal, Corona and Post-Vaccination).				
Purchase of equipment and set-up of lab				
Data Acquisition and Pre-processing				
Speech Feature extraction, classification and Mobile Application Development				
Post-Vaccination Trajectory of Covid-19 patients to normalcy through speech processing features				
Validation of the Speech algorithm for quick recovery with commercially available with antigen kits				
Report writing and IPR filing				

### Justification for Equipment proposed

Workstation will be used for high end processing and running deep neural network algorithm. Smart-phones will be used for app development, validation and COVID-patient recordings. Printer for taking print-outs of the data analysis. Audio recorders will be used for recording the voice samples of patients which will be collected and stored in the cloud.

Sr. No.	Equipment / Accessories	Make & Model	Imported / Indigenous	Estimated Cost
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1	Workstation (1)	Indian	NA	4.5 lakhs INR
2	Smart Phone	Samsung	NA	50,000 INR
3	Printer	Indian	NA	50,000 INR
4	Audio Recorder(2)	Indian	NA	50,000 INR
TOTAL				6 lakhs

**Justification for BUDGET FOR TRAVEL:**

There will be 4-5 visits per year between IIT Jammu and AIIMS Rishikesh for data collection and analysis and technical discussions. Additionally, there will be visits to the local hospitals and medical colleges per collection of samples.

**Justification for consumable materials giving estimated requirement of consumable for each prototype.**

S.No.	Items	Budget (Rs. Lakhs)			
		1 <sup>st</sup> Yr	2 <sup>nd</sup> Yr	3 <sup>rd</sup> Yr	TOTAL
1	Stationery items for rapid assay	10,000	10000	10000	30,000
2	COVID-19 kits	40 000 INR	40 000 INR	40 000 INR	1,20,000
	<b>Total</b>	<b>50,000</b>	<b>50,000</b>	<b>50,000</b>	<b>1.5 lakh INR</b>