# Mehta daryush phd thesis proposal final

Technology

Dimmitt D. Delivery, PhD, University of South Carolina, whose areas of expertise are in the acoustic analysis of voice and the development of laryngeal high-speed videophones. The proposal, which is enclosed, was favorably received by the Committee, and we approved the scientific content and proposed work as being suitable for a PhD thesis. All of the above members of the Committee have agreed to serve on the Thesis Committee. Sincerely, Joseph S. Propeller Thesis Committee Chair Robert E. Hillman, PhD Thesis Co-Supervisor Once: Thesis Proposal Supervisor Agreements Reader Agreement Thomas F.

Squattier, Sad PhD Thesis Committee Members 1 . Joseph S. Propeller, PhD (Chair) a. Title: Senior Research Scientist, SpeechCommunicationGroup, Research Laboratory of Electronics, Massachusetts Institute ofTechnologyb. Major Discipline: Sensory-motor control of speech production c. Justification: Dry. Propeller fills the role of Chair as a non-supervisor and senior researcher at MIT. Dry. Per keel offers a wide knowledge range from voice and speech production to speech acoustics and motor involvement in pathological speakers. 2. Robert. E. Hillman, PhD (Co-Supervisor) a.

Title: Co-Director/Research Director, Center for Laryngeal Surgery and Voice Rehabilitation, Massachusetts General Hospital; Associate Professor, HarvardMedical School; Faculty of Harvard-MIT Program in Speech and Hearing Bioscience and Technology b. Major Discipline: Voice function assessment c. Justification: Dry. Hillman is co-adviser and supports the clinical aspects Of the thesis project. The proposed research calls for data collection in the voice clinic and assessment of the voice production

mechanisms and acoustic characteristics of human subjects. Subjects will be selected and evaluated under Dry.

Hillman supervision. 3. Thomas F. Squattier, Sad (Co-Supervisor) a. Title: Senior Member of Technical Staff, MIT Lincoln Laboratory; Faculty of Harvard Program in Speech and Hearing Bioscience and Technology b. Major Discipline: Speech signal processing c. Justification: Dry. Squattier is co-adviser and supports the signal processing aspects of the proposed research. Dry. Squatter's work includes the speech signal processing using multimode analysis, and this work especially relates to the proposed research on characterizing vocal fold vibratory asymmetries from multimode sensor measurements. 4.

Dimmitt D. Delivery, PhD (Reader) a. Title: Associate Professor, Department of Communication Sciences and Disorders, University of South Carolina; Director, USC Voice and Speech Laboratory b. Major Discipline: Voice acoustics and laryngeal high-speed videophones c. Justification: Dry. Delivery's areas of expertise are in the acoustic analysis of voice and laryngeal high-speed videophones. Dry. Delivery is a world-leader in the development of high-speed video camera technology for clinical voice assessment. Massachusetts Institute of Technology Harvard-MIT Division ofHealthSciences and Technology

Speech and Hearing Bioscience and Technology Program proposal for Thesis Research in Partial Fulfillment of the Requirements for the Degree ofDoctorofPhilosophyTitle: Investigating the impact of in vivo human vocal fold vibratory asymmetries: Co-variations among measures from laryngeal

high-speed videophones, acoustic voice analysis, and auditory-perceptual voice assessment of sustained vowel phonated Submitted by: Darkish Meat 70 pacific street, Apt 516 Cambridge, MA 02139 Signature: Subtract: Signal Processing Date of Submission: Expected Date of Completion: November 25, 2008 July 2009

Thesis Co-supervisors: Location of Research: Center for Laryngeal Surgery and Voice Rehabilitation, Massachusetts General Hospital Abstract: Voice specialists make criticaldiagnostic, medical, therapeutic, and surgical decisions by coupling visual observations Of vocal fold tissue motion with auditory-perceptual assessments of voice quality. The details of the relationship between vocal fold tissue motion and the acoustic voice signal are not fully understood, and there is recent evidence that the acoustic impact of visual judgments of vibratory asymmetry may be overestimated during clinical voice assessment.

A series of three descriptive studies is proposed to systematically describe the co-variations among measures of vocal fold vibratory asymmetries and visual-perceptual judgments, acoustic voice properties, and therapeutically ratings. First, recent findings describing co-variations be; en subjective visual judgments and basic objective measures of vocal fold vibratory asymmetry in subjects with and without vocal pathologies will be validated with automated algorithms.

After replicating these results, image-based measures will be further refined to consider additional dimensions in the left-right and anterior-posterior planes f the images. Second, it is proposed to apply the developed objective

measures of asymmetry to voice data from a new subject population with vocal pathologies that will be evaluated using a state-of-the-art system for laryngeal high-speed videophones. The new system will enable the validation Of hypothesized relationships between vocal fold vibratory asymmetry measures and objective acoustic voice measures at unprecedented temporal resolution.

Preliminary work has revealed mild co-variations between average values of vocal fold vibratory asymmetry and traditional acoustic perturbation assure, and new acoustic correlates of vocal fold vibratory asymmetries will be explored using knowledge of their effects on voice production. Third, an initial study is proposed to characterize the influences of vocal fold vibratory asymmetry on the auditory perception of voice quality. This study more directly addresses the clinical reality that voices are assessed by relating vocal fold tissue vibratory patterns to the voice quality of a patient during a standard examination.

Voice specialists make critical diagnostic, medical, therapeutic, and surgical decisions based on coupling visual observations of vocal fold tissue motion With auditory-perceptual assessments of voice quality (Zestiest et al. , 2007). While clinical experiences indicate that this approach is generally valid, it is inherently limited to case-by-case observations, and the details of the relationship be; en vocal fold tissue action and the acoustic voice signal are not fully understood.

Recent evidence indicates that visual judgments of vocal fold vibratory patterns may not adequately reflect changes in objective measures of the

acoustic signal (Haven et al. , 2003). Furthermore, "[t]he anecdotal reports and stroboscopic findings of a prevalent typical amount of asymmetry cause a concern, in that it may indicate an increase in overreactions of laryngeal pathology' (Shaw and Delivery, 2008).

The overall goal of this project is to better understand the relationship between vocal fold tissue motion and the acoustic characteristics f the glottal voicing source so that clinical methods for assessing voice production can be improved. This work is made possible by recent advances in high-speed digital imaging, which provides adequate sampling for detailed intra- and inter-cycle comparisons between vocal fold tissue motion and the concomitant acoustic voice waveform.

A series of three descriptive studies is proposed to systematically describe the co-variations among traditional and more advanced measures of vocal fold vibratory asymmetry and their impact on visual judgments, acoustic voice properties, and auditory-perceptual tings. First, it is proposed to replicate and improve upon recent findings describing co-variations between subjective visual judgments and basic objective measures of left-right vocal fold vibratory asymmetry in subjects with and without vocal pathologies (Bonham et al. , AAA; Bonham et al. Bibb). After validating the baseline co-variations with more automatic algorithms for computing left-right asymmetry, the image-based measures will be further developed and optimized based on the visual judgments Of vocal fold vibratory asymmetry in both the left-right and anterior-posterior dimensions. Second, the developed objective measures of asymmetry will be applied to voice data from a new subject population exhibiting vocal pathologies who will be

evaluated using a state-of-the-art system for laryngeal high-speed videophones.

The new system will allow for the validation of hypothesized relationships between vocal fold vibratory asymmetry measures and objective acoustic voice measures at unprecedented temporal resolution. Preliminary work has revealed mild cavitations between overall values of vocal fold vibratory asymmetry measures and traditional acoustic perturbation measures. Acoustic correlates of vocal fold vibratory symmetries will be explored using knowledge of their effects on voice production. Third, an initial study is proposed to characterize the influences of vocal fold vibratory asymmetry on the auditory perception of voice quality.

This study more directly addresses the clinical reality that voices are assessed by relating vocal fold tissue vibratory patterns to the voice quality of a patient during a standard stroboscopic examination. 1. 2 Thesis proposal structure This thesis proposal is organized as follows. First, Section 2 outlines the three specific aims and associated hypotheses of the proposed investigation, along tit a timeline ofgoals. Section 3 continues with background information on voice production mechanisms and reviews relevant research studies characterizing vocal fold vibratory asymmetries and the acoustic voice signal.

Section 4 introduces work that investigated the co-variations between a preliminary measure of vocal fold vibratory asymmetry and traditional acoustic perturbation measures. Section 5 follows with the research design and methods for the three studies proposed. F-anally, Section 6 concludes

with information regarding the use of humans as subjects in these studies. 2 Specific Aims A series of three studies is proposed to investigate the influence of vocal fold vibratory asymmetries on the acoustic voice signal.

Specific aims and associated hypotheses of these studies are detailed below. 2. 1 Aim 1: Investigate co-variations between visual judgments of vocal fold vibratory' asymmetry and objective measures of vocal fold vibratory asymmetry in subjects with and without vocal pathologies Aim 1 proposes to validate and improve upon recent findings describing co- variations between subjective visual judgments and objective image-based measures of left-right vocal fold vibratory asymmetry in a subject population thou vocal pathologies.

The recent findings have documented moderate correlations between visual-perceptual ratings and a basic objective measure of vibratory asymmetry of the left and right vocal folds (Bonham et al. , AAA). Completely automated image-based measures of asymmetry will be developed to replicate the published co-variations with visual ratings on the same data. After validating the automated algorithms for computing asymmetry measures, the image-based measures will be refined and optimized withrespectto the peculiarities judgment data to improve pond the baseline co-variations in subject populations with and without vocal pathologies.

It is hypothesized that the new image-based measures of vocal fold vibratory asymmetry will co-vary with visual asymmetry judgments to a higher degree than previous image-based measure because of the ability to capture and integrate more temporal and spatial information from the image data.

Acoustic voice signal in subjects with vocal pathologies Aim 2 proposes to apply the developed objective measures of asymmetry to voice data collected from a new subject population with vocal pathologies hat will be evaluated using a statute-the-art system for laryngeal high-speed videophones.

The system will allow the validation of hypothesized relationships between vocal fold vibratory measures and objective acoustic voice 8 measures, on an average and frame-by-frame basis. Preliminary work has revealed mild co-variations between average values of vocal fold vibratory asymmetry and traditional acoustic perturbation measures (jitter, shimmer, and harmonics-to-noise ratio). As a result, these measures will be applied to a larger subject population and explore new acoustic correlates of vocal fold vibratory asymmetries using knowledge of voice production mechanisms.