Biometric Authentication through Advanced Voice Recognition

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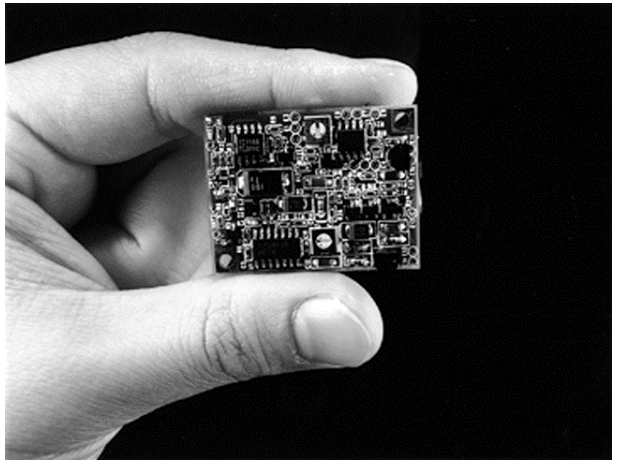
Outline

- **Introduction—need for improved biometric devices**

- **MicroPower EM sensors**
  - **— The sensor system**
  - **— Sample data**

- **Use of the MicroPower sensors for speaker validation**

- **Other applications**



Biometric devices automatically verify identity using one or more physical feature or repeatable actions

Examples currently in use include:

- **Hand Geometry**
- **Retina Scanner**
- **Finger print**
- **Handwriting**

- **Acoustic voice recognition system**

For a biometrics system to be useful for safety and security applications it must provide

- Unique identification
- Repeatable results
- A low false alarm rate
- Insensitivity to variations (e.g., common colds, illness, etc.)
- Resistance to tampering and falsification (voice imitations)
- An audit trail for alarm/incident resolution
- Performance and cost advantages over manual procedures

The MicroPower EM sensor system can satisfy these requirements

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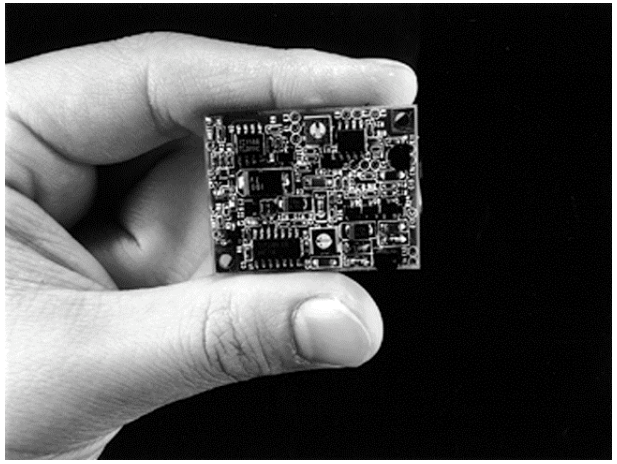
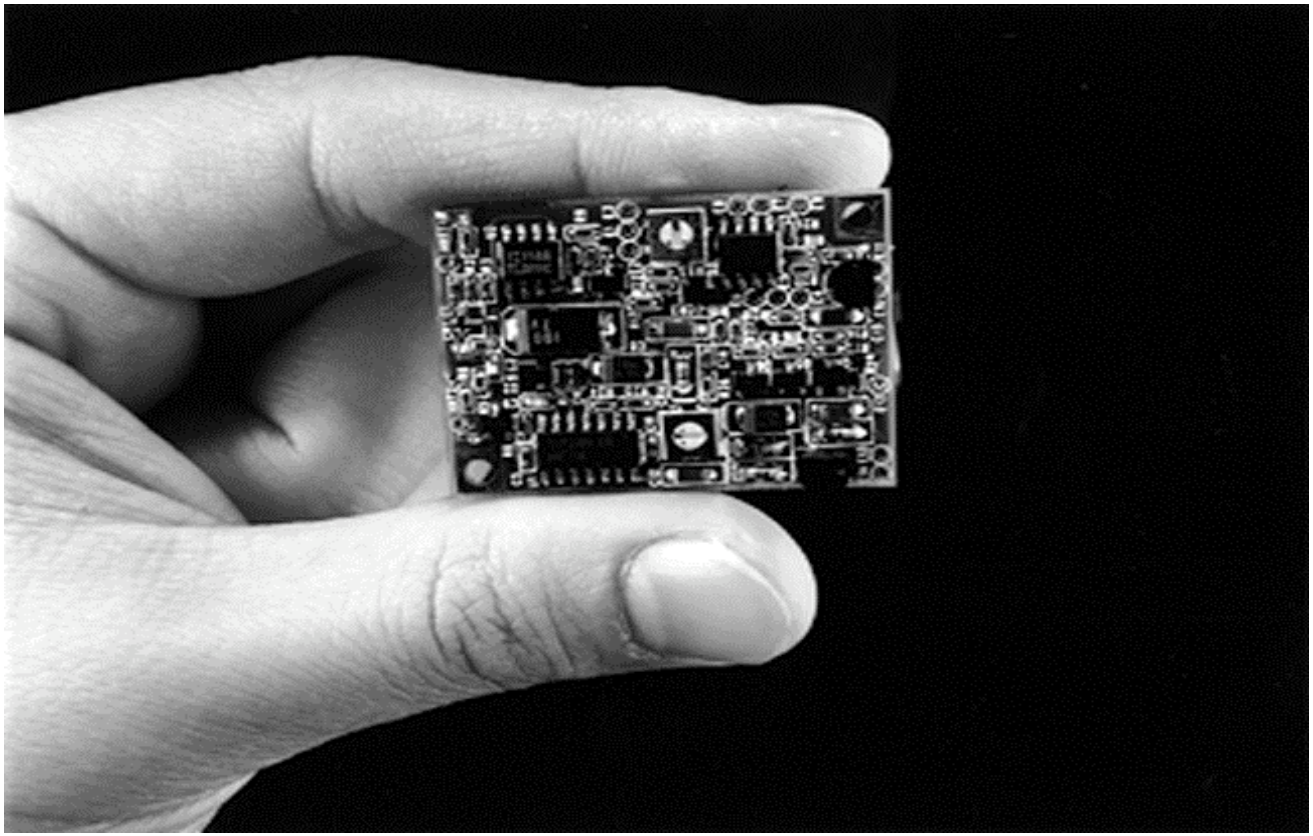
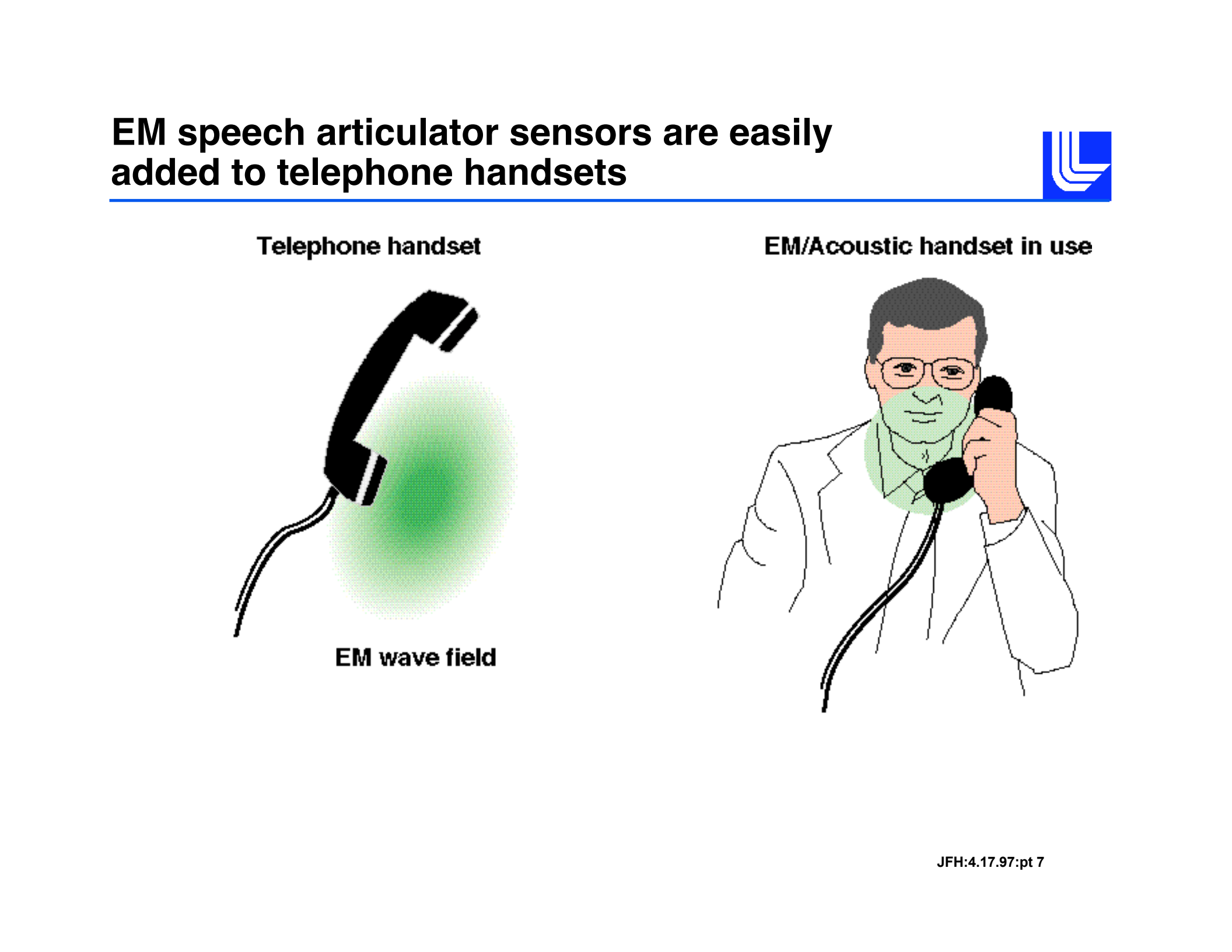


We are exploring a new biometric device using one or more miniature micropower radar units

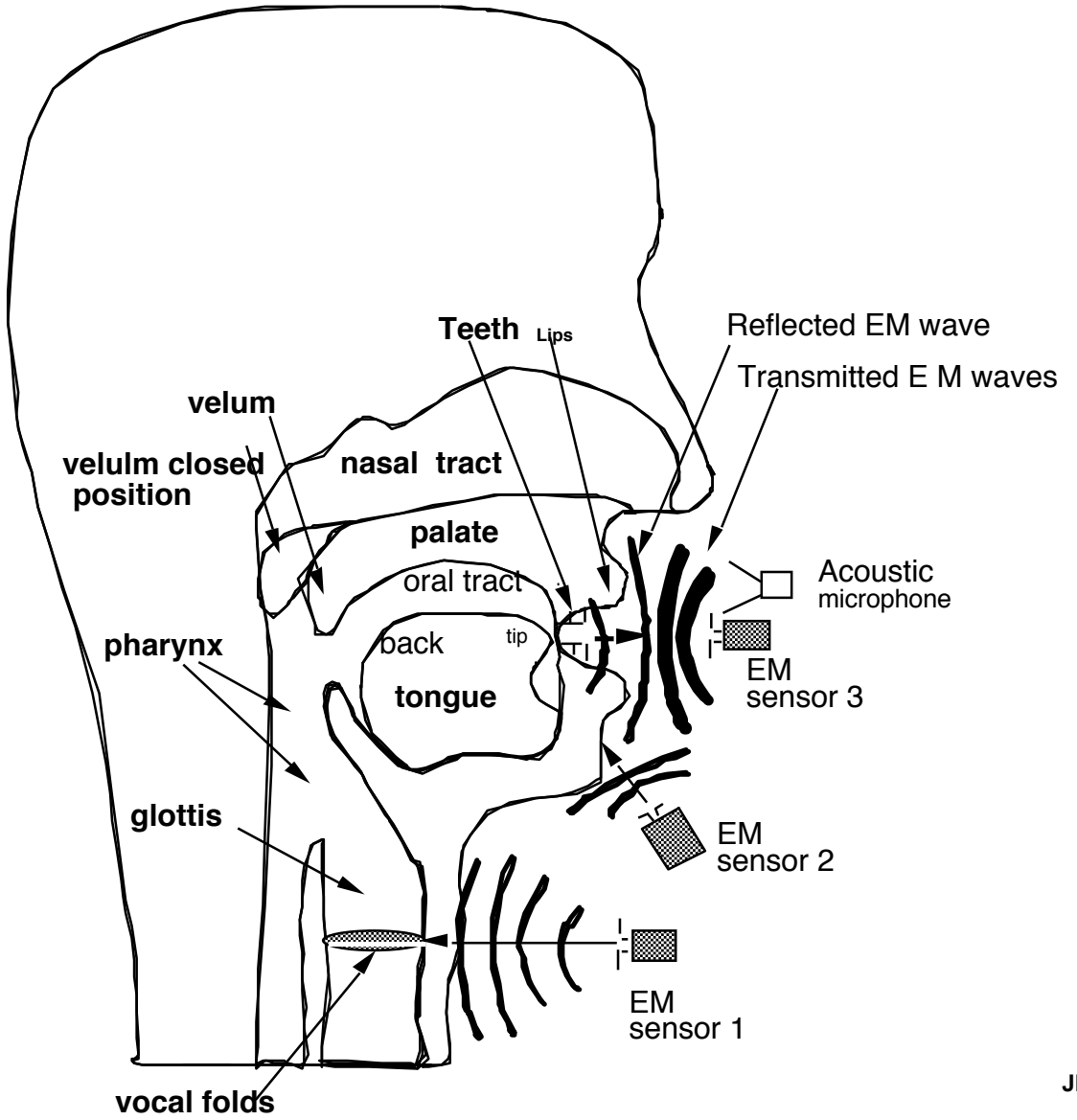
- The unit can be used to measure many speech articulator conditions



EM speech articulator sensors are easily added to telephone handsets



Miniature micropower radars can measure articulator positions and motions



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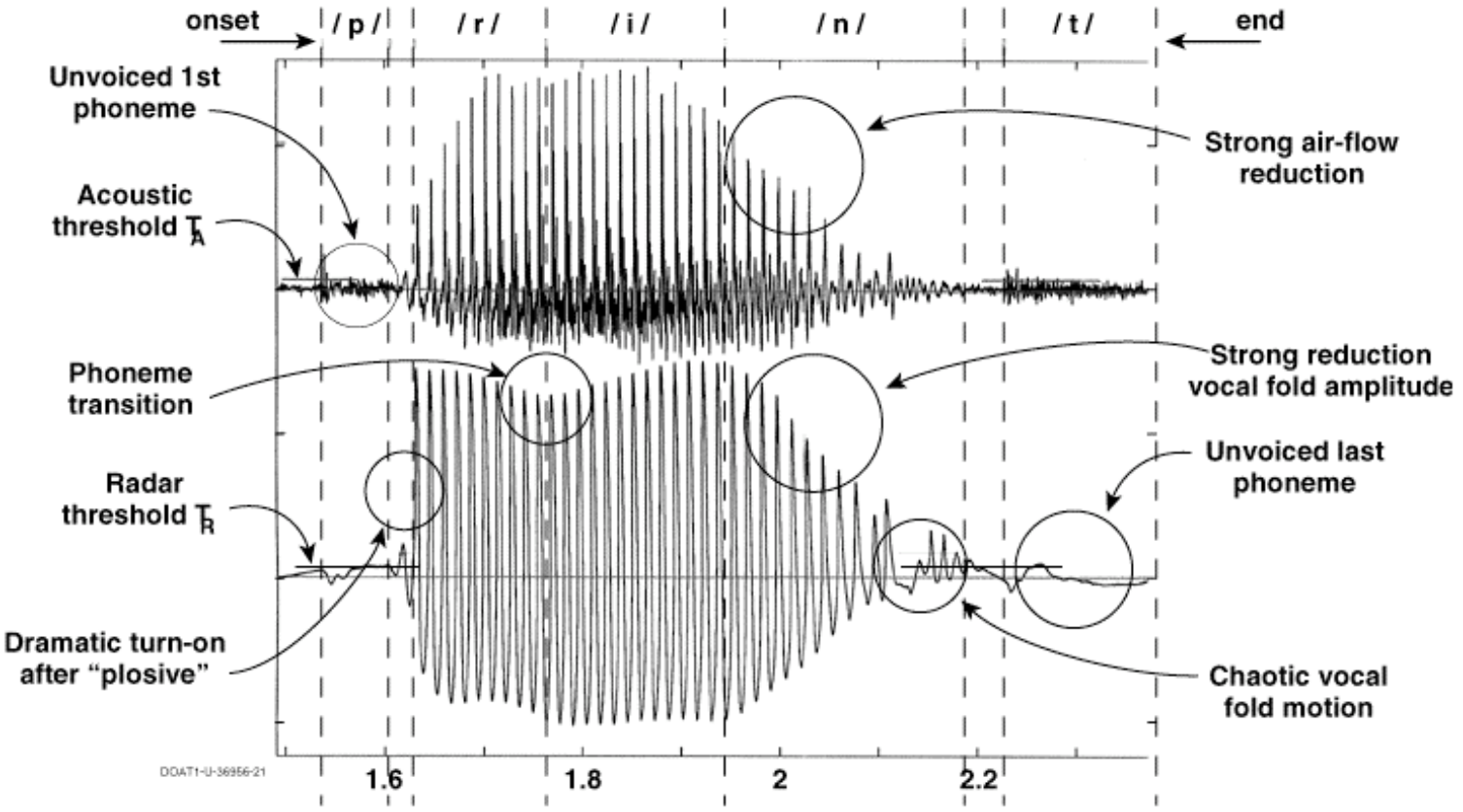
Simultaneous acoustic and glottal-radar signals for isolated word “print”



MicroPower EM sensors vastly increase an individual's characteristic speech related information

- Provides locations of vocal articulator interfaces during human speech at up to 1 kHz rates
  - Measures vocal folds, tongue, lips, jaw, velum
  - Measures articulators not influencing the acoustics

- Enables the measurement of the vocal fold motions and their excitation of speech for each cycle up to rates > 10kHz

- Obtains physiological values of each individual's speech organs and their EM wave reflection coefficients

- Provides accurate timing of articulator interface motions to acoustic speech output signal

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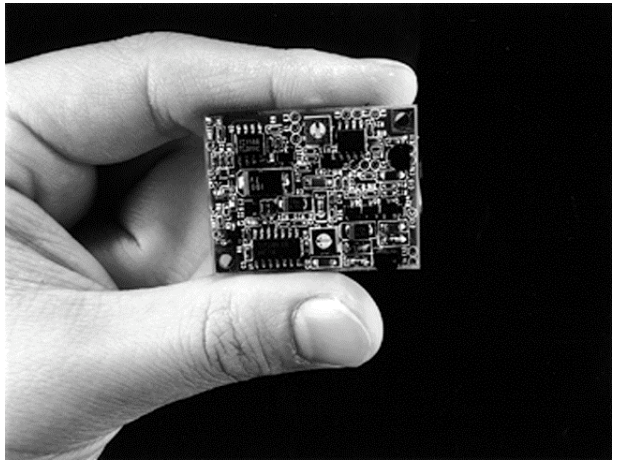
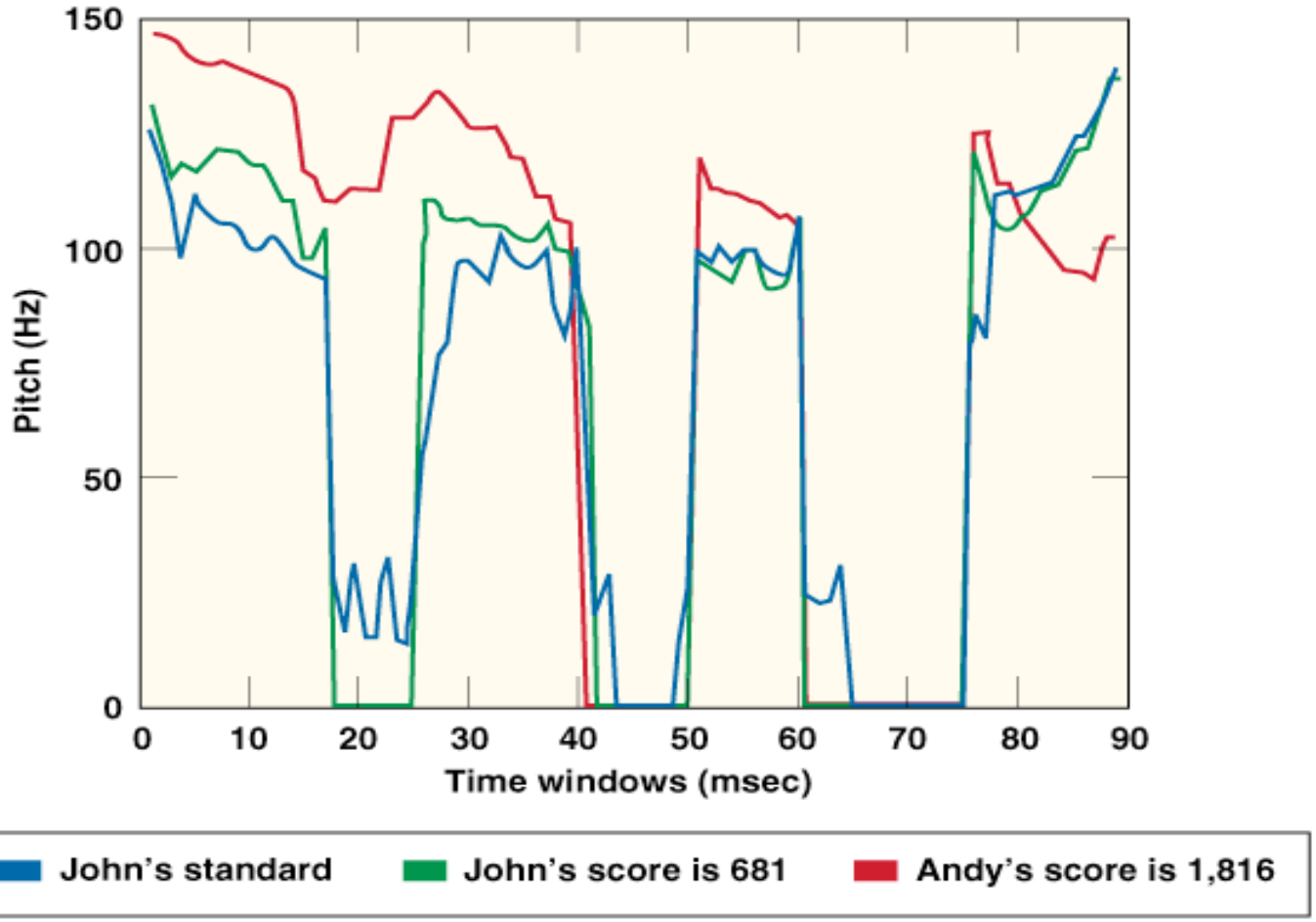


Measurements have validated many specific speaker identification characteristics

- Pitch tracking versus fixed word sets
- Physiological dimensions: vocal tract length, vocal fold vibration rates
- Vocal tract transfer functions for all voiced sound units
- Individual organ motion rates and signal amplitudes versus time

A preliminary experiment used EM sensed pitch tracking to validate the speaker “John”



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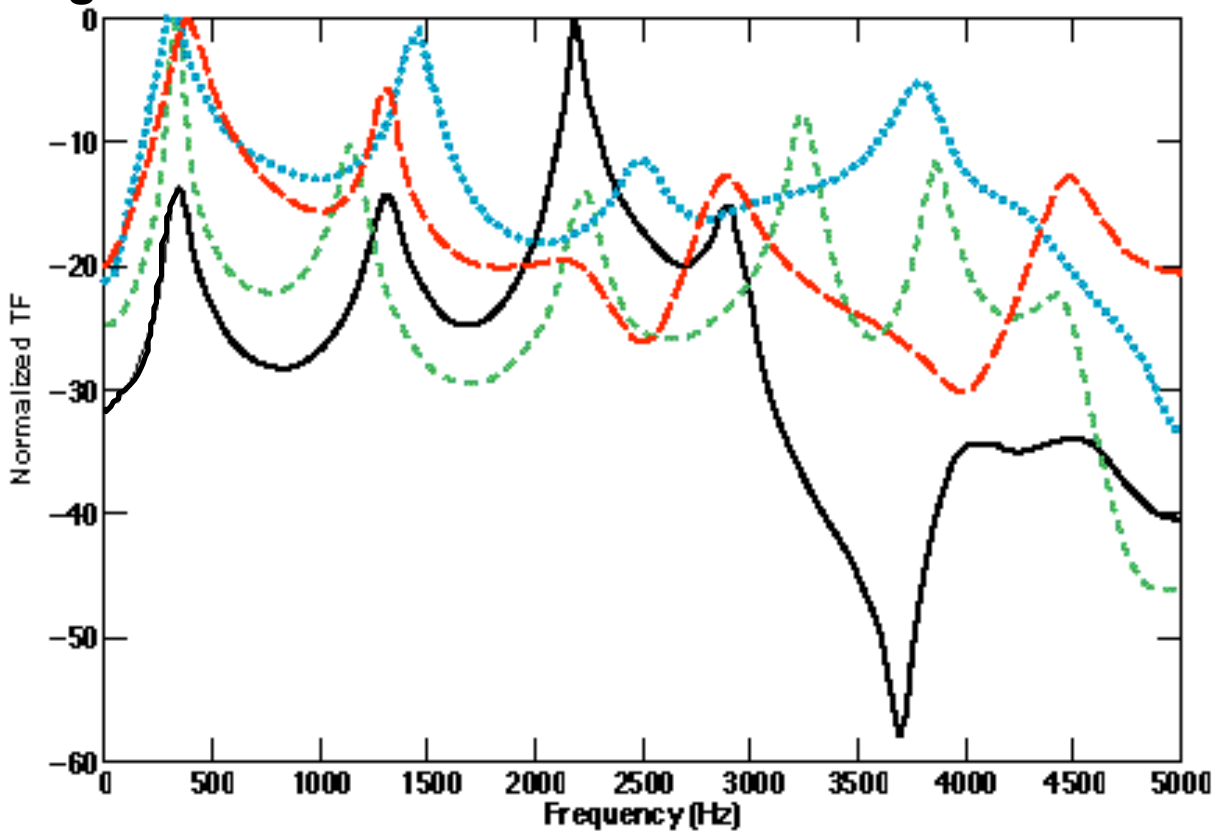
Measurements have validated four speaker-specific vocal transfer-function characteristics

Single sound unit /u/



The EM sensor/acoustic speaker verification system uses a large number of templates

- The speaker is “templated” using 10 minutes of continuous speech into an EM validation microphone
  - In response to many questions
  - At a site where his identify is initially validated

- The data includes a large number of word patterns and corresponding speech articulator motions
  - Compressed into a large number of templates
  - Stored at Federal Headquarters

The EM sensor/acoustic speaker verification system is very difficult to deceive

- From any site with an EM/acoustic validation microphone, the user may call the federal agency center
  - A large number of questions are posed to the user
  - The federal center chooses the templates it wishes at random to test the user
  - A score is obtained by matching recognized patterns to the templates

- Deception is difficult because
  - Random questions and templates can be used
  - The questions must be recognized, answers formulated, and responses given in second(s)
  - Even with microphone and speaker data, the question/answer cycle is not possible to simulate in such short time periods.

R&D is required in order to validate the degree of usefulness of this new biometric concept

- Validate on a statistically significant number of subjects
- Determine the types of vocabularies needed for optimum template libraries
- Analyse against security metrics
- Determine template stability of individuals over useful periods of time

In addition to speaker validation, EM sensors have other important speech applications

- Higher quality speech recognition because of increased speed and accuracy of sound characterization
- Personalized speech synthesis
- Speech coding for telephony, compression, encryption, and other applications is possible
- It should enhance speech correction, language learning, and aid the speech/hearing impaired

EM sensor/acoustic voice recognition systems should have advantages over other systems

- More accurate biometric analysis
- Remote application
- Difficult/impossible to imitate w/random questions
- Audit trail
- Lower data storage requirements for templates
- No health and safety concerns (noncontact)
- Ease of use
- Continuous verification
- No time for “man in middle”