Dialog Styles: Pen & Gesture and Speech & Natural Language

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Agenda

• Pen & gesture
  – PDA overview
  – Pen input styles
  – Issues

• Speech & natural language
  – What is speech?
  – When to use speech
  – Speech output
  – Speech input
  – Designing the speech interaction
Dialog Design

- 1. Command language
- 2. WIMP
- 3. Direct manipulation
- 4. Pen, gesture
- 5. Speech, audio

How to use a PDA

DILBERT / SCOTT ADAMS, scottadams@aol.com

I FOUND THE ULTIMATE TOOL FOR THE MOBILE PROFESSIONAL.

IT'S A COMBINATION PDA, PHONE, PAGER, DIGITAL CAMERA, FAX, E-MAIL, LAPTOP AND SHREDDER.

IT CLIPS RIGHT TO MY BELT!
Personal Digital Asst. (PDA)

PDAs

- Becoming more common and widely used
- Smaller display (160x160), (320x240)
- Few buttons, interact through pen
- Estimate: 14 million shipped by 2004
- Improvements
  - Wireless, color, more memory, better CPU, better OS
- Palmtop versus Handheld
Alas, No Shredder...

Input

- Pen is dominant form
- Main techniques
  - Free-form ink
  - Soft keyboards (tapping)
  - Numeric keyboard => text
  - Stroke recognition – strokes not in shape of characters
  - Hand printing/writing recognition
- Sometimes can connect keyboard
Free-form Ink

- Ink is the data, take as is
- Human is responsible for understanding and interpretation
- Like a sketch pad

Example

- Digital Ink - CMU
  - video, CHI '98
- Flatland - Xerox PARC
  - video, CHI '99
Soft Keyboards

- Common on PDAs and mobile devices
- Many varieties
  - Tapping interface
  - Stroking interface

Tapping Interface

- Presents a small diagram of keyboard
- You click on buttons/keys with pen
- QWERTY vs. alphabetical
  - Tradeoffs?
  - Alternatives?
Tegic Communications-T9

- Tapping interface that uses phone pad
- Press out letters of your word, it matches the most likely word, then gives optional choices
- Used in mobile phones
  - www.tegic.com/t9

Cirrin

- Developed by Jen Mankoff (GT->CMU)
- Word-level unistroke technique
Stroke Recognition - Quikwriting

- Developed by Ken Perlin
- UIST ’98 paper

Quikwriting Example

Said to be as fast as graffiti, but have to learn more

http://mrl.nyu.edu/projects/quikwriting/
Recognition Systems

- Recognizing letters and numbers
- Special symbols

Handwriting Recognition

- Lots of systems (commercial too)
- English, kanji, etc.
- Not perfect, but people aren’t either!
  - People - 96% handprinted single characters
  - Computer - >97% is really good

- OCR (Optical Character Recognition)
Recognition Issues

- Off-line vs. On-line
  - Off-line: After all writing is done, speed not an issue, only quality
  - On-line: Must respond in real-time but have richer set of features such as acceleration, velocity, pressure

- Bitmapped vs. Vectorized
  - Bitmapped: Usually off-line, like OCR
  - Vectorized: On-line, uses angle, direction, speed, pressure, acceleration, etc.

More Issues

- Boxed vs. Free-Form input
  - Sometimes encounter boxes on forms

- Printed vs. Cursive
  - Cursive is much more difficult

- Letters vs. Words
  - Cursive is easier to do words
More Issues

• Using context & words can help
  – Usually requires existence of a dictionary
  – Check to see if word exists
  – Consider 1/I/l

• Training - Many systems improve a lot with training data

Special Alphabets

• Graffiti - Unistroke alphabet on Palm PDA
  – Experience?

• Other alphabets or purposes
  – Gestures for commands
Pen Gesture Commands

- Might mean delete

Define a series of (hopefully) simple drawing gestures that mean different commands in a system

Pen Use Modes

• Often, want a mix of free-form drawing and special commands

• How does user switch modes?
  – Might use visible mode switch on screen
  – Might have pen action buttons/switches
Error Correction

- Having to correct errors can slow input tremendously

- Strategies
  - Erase and try again
  - When uncertain system shows list of best guesses
  - ...

Interesting Applications

- Signature verification
- Note-taking
  - Academic course
  - Corporate meeting
- Sketching systems
  - Designers’ aids
Dialog Design

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A Voice Interface

_Dilbert_ By Scott Adams

*It took me three days to enter all of my appointments into this PDA.*

*I'll enter our next meeting._

_Tuesday... Two o'clock._

*Is it voice-controlled?*

*I sure hope so.*
When to Use Speech

- Hands busy
- Mobility required
- Eyes occupied
- Conditions preclude use of keyboard
  - Vibration, cold, water, hygiene, public use
- Visual impairment
- Physical limitation

Speech

- What is speech?
  - Vibrations of vocal cords creates sound “ahh”
  - Mouth, throat, tongue, lips shape sound

- English speech
  - 40 phonemes; 24 consonants, 16 vowels

- Sounds transmit “language”
Waveform & Spectrogram

- Speech does not equal written language

Parsing Sentences

"I told him to go back where he came from, but he wouldn't listen."
Speech Input

- Speaker recognition
- Speech recognition
- Natural language understanding

Speaker Recognition

- Tell which person it is (voice print)
- Could also be important for monitoring meetings, determining speaker
Speech Recognition

- Primarily identifying words (not meaning)
- Improving all the time
- Commercial systems:
  - IBM ViaVoice, Naturally Speaking, ...

Recognition Dimensions

- Discrete vs. Continuous speech

  - Discrete
    - Say one word at a time

  - Continuous
    - Say all the words run together
    - Computer calculates where one word ends and the next starts - much harder than discrete
Recognition Dimensions

- Speaker dependent/independent
  - Parametric patterns are sensitive to speaker
  - With training (dependent) can get better

- Speaker-independent
  - Are mostly discrete word-oriented
  - Must work with male, female & accented voices
  - Typically used with phone-based systems
    - Banking, Airline reservations
  - Keys to success
    - Limited set of choices at each step
      - "Would you like to make domestic or international reservations?"
      - "Speak your frequent flyer number"
    - Frequent feedback and error-correction opportunities
      - “Did you say 434568432?”

Recognition Dimensions

- Speaker dependent systems require initial training
  - User reads text (several pages) known to system
  - Continues to get better after initial training
    - Partly by learning from mistakes/corrections
    - Partly by training user :)

- Vocabulary
  - Some have 50,000+ words
Recognition Systems

- **Typical system has 5 components:**
  - Speech capture device - Analog -> digital converter
  - Digital Signal Processor - Gets word boundaries, scales, filters, cuts out extra stuff
  - Preprocessed signal storage - Processed speech buffered for recognition algorithm
  - Reference speech patterns - Stored templates or generative speech models for comparisons
  - Pattern matching algorithm - Goodness of fit from templates/model to user's speech
    - Make heavy use of probabilities and large finite state machines

Errors

- **Systems make four types of errors:**
  - Substitution - one for another
  - Rejection - detected, but not recognized
  - Insertion - added
  - Deletion - not detected

- Which is more common, dangerous?
- MUST HAVE means for user recovery from system errors!
Natural Language Understanding

- Giving *meaning* to the words
- Input might be spoken or typed
- Holy grail of Artificial Intelligence problems

Eliza - a “Faked” Understanding

- **Person**: Men are all alike.
  - **ELIZA**: In what way?
- **Person**: They're always bugging us about something or other.
  - **ELIZA**: Can you think of a specific example?
- **Person**: Well, my boyfriend made me come here.
  - **ELIZA**: Your boyfriend made you come here?
- **Person**: He says I'm depressed much of the time.
  - **ELIZA**: I am sorry to hear that you are depressed.
- **Person**: It's true. I am unhappy.
  - **ELIZA**: Do you think coming here will help you not to be unhappy?
- **Person**: I need some help, that much seems certain.
  - **ELIZA**: What would it mean to you if you got some help?
- **Person**: Perhaps I could learn to get along with my mother.
  - **ELIZA**: Tell me more about your family

- [http://www.ai.ijs.si/eliza/eliza.html](http://www.ai.ijs.si/eliza/eliza.html)
NL Factors/Terms

- Syntactic
  - Grammar or structure
- Prosodic
  - Inflection, stress, pitch, timing
- Pragmatic
  - Situated context of utterance, location, time
- Semantic
  - Meaning of words

SR/NLU Advantages

- Easy to learn and remember
- Less transfer problems
- Powerful
- Fast, efficient (not always)
- Little screen real estate
- Enormous potential
SR/NLU Disadvantages

- Doesn’t work good enough yet
- Assumes knowledge of problem domain
  - Not prompted, like menus
- Requires confirmation/clarification
- Requires typing skill (if keyboard)
- Enhancements are invisible
- Unrealistic expectations

Speech Output

- Male or female voice?
  - Technical issues (freq. response of phone)
  - User preference (depends on the application)
- Rate of speech
  - Technically up to 550 wpm!
  - Depends on listener (blind: 150-300 wpm)
- Synthesized or Pre-recorded?
  - Synthesized: Better coverage, flexibility
  - Recorded: Better quality, acceptance
Speech Output

- Synthesis
  - Quality depends on software ($$)
  - Influence of vocabulary and phrase choices
- Recorded segments
  - Store tones, then put them together
  - The transitions are difficult (e.g., numbers)
- Numbers
  - Record three versions (rise, flat, fall)
  - Logic to determine which version to play

Designing the Interaction

- Constrain vocabulary
  - Limit valid commands
  - Structure questions wisely (Yes/No)
  - Manage the interaction
  - Examples from the airline systems?
- Slow speech rate, but concise phrases
- Design for failsafe error recovery
- Process preview & progress indicator
Speech Tools/Toolkits

- Java Speech SDK
  - “For 3/4 or 75% of his time, Dr. Walker practices for $90 a visit on Dr. Dr., next to King Philip X of St. Lameer St. in Nashua NH.”
- Cepstral TTS (probably the best, right now)
- Microsoft Speech SDK
- IBM JavaBeans for speech
- Visual/Real Basic speech SDK
- OS capabilities (speech recognition and synthesis built in to OS) (TextEdit)
- VoiceXML

Notes to Remember

- A natural language interface need not be speech
  - Pen and typing are also natural
- A speech interface need not use natural language (might be more command language-like)
- Wizard of Oz evaluations are particularly useful in this area
HW 3

- Speech interfaces
  - Try out two airline reservation systems that use speech
  - Brief evaluation per assignment
  - A short one
  - Due Tuesday

Upcoming

- Predictive Models
- Cognitive Models