Personal Experience Computing

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Research Interests

Pervasive (Ubiquitous) & Mobile Computing

- User Interfaces
- Cool Applications
- Middleware
- Systems
- Networking
- Security

Personal Experience Computing

- Imagine a wearable camera can record your entire life ….
  - Autobiography
  - Memory augmentation (google search your past)
  - Relive past memory (memory triggers)
  - Sharing personal experience
- Personal experience computing is about computing support for
  - Recording archiving, retrieving, searching, analyzing (annotating), editing, sharing, etc., of personal experiences.
- Largest database ever
- 4G+ Killer Applications

PE computing is a hot topic!

- Pervasive 2004
  - Workshop on Memory and Sharing of Experiences
- ACM Multimedia 2004
  - Keynote speech (Gordon Bell)
  - Workshop on Continuous Archival & Retrieval of Personal Experiences
- Microsoft Research: MyLifeBits
- DARPA LifeLog Initiative
- UK Grand Challenges in Computer Science: #3 Memories for Life
- Memex Device (V. Bush 60's)

Design & Evaluation of mProducer: a Mobile Authoring Tool for Personal Experience Computing

Chao-Ming Teng, Chon-In Wu, Yi-Chao Chen, Hao-hua Chu & Jane Yung-jen Hsu

Gadget & Lifestyle Trend

- Proliferation of camera-equipped phones, digital cameras, and camcorders
- Implication: Average consumers want to be content producers of their own personal experiences
  - Everyone can be a news reporter.
  - Record where they go, what they do, what they see, and hear
  - Share personal experience (edit before share)
  - Anywhere, anytime

Mobile Contents = Personal Experiences

Fundamental change in the type of contents!

	Type	**Producers**	**Tools**
PC Contents	Mass media contents	Professional Content Providers	PCs & Professional Content Creation Tools
Mobile Contents	Personal experience contents	Average consumers	Cell phones & mProducer

Why edit from mobile devices?

- PC Alternative:
  - Capture contents on mobile devices
  - Transfer them to PC
  - Use PC-based tools to edit & share them
- Reasons:
  - Reduce the amount of time between content capturing & content sharing
    - Share anytime, anywhere
  - Record important events as keepsakes
  - Use simple, intuitive user interfaces

Mobile Editing vs. Desktop Editing

- Desktop Authoring Tools:
  - Professional, skillful content creators
  - Focused attention
  - Resource-abundant desktop environment
- Mobile Authoring Tools:
  - Casual, unskillful consumers
  - Limited quick attention
  - Resource-poor mobile environment

Mobile Challenges

- Limited mobile storage
  - Toshiba T08 Mobile Phone with 8 MB Storage
  - Only 3 minutes of video: 5 FPS & 240x320
- Limited mobile computing resources
  - Image/video processing techniques are computational intensive
- Specialized user interfaces
  - Small screen, inconvenient input methods, limited user attention
  - Simplicity, ease-of-use, good learnability, reasonable quality of editing contents

mProducer's Solution

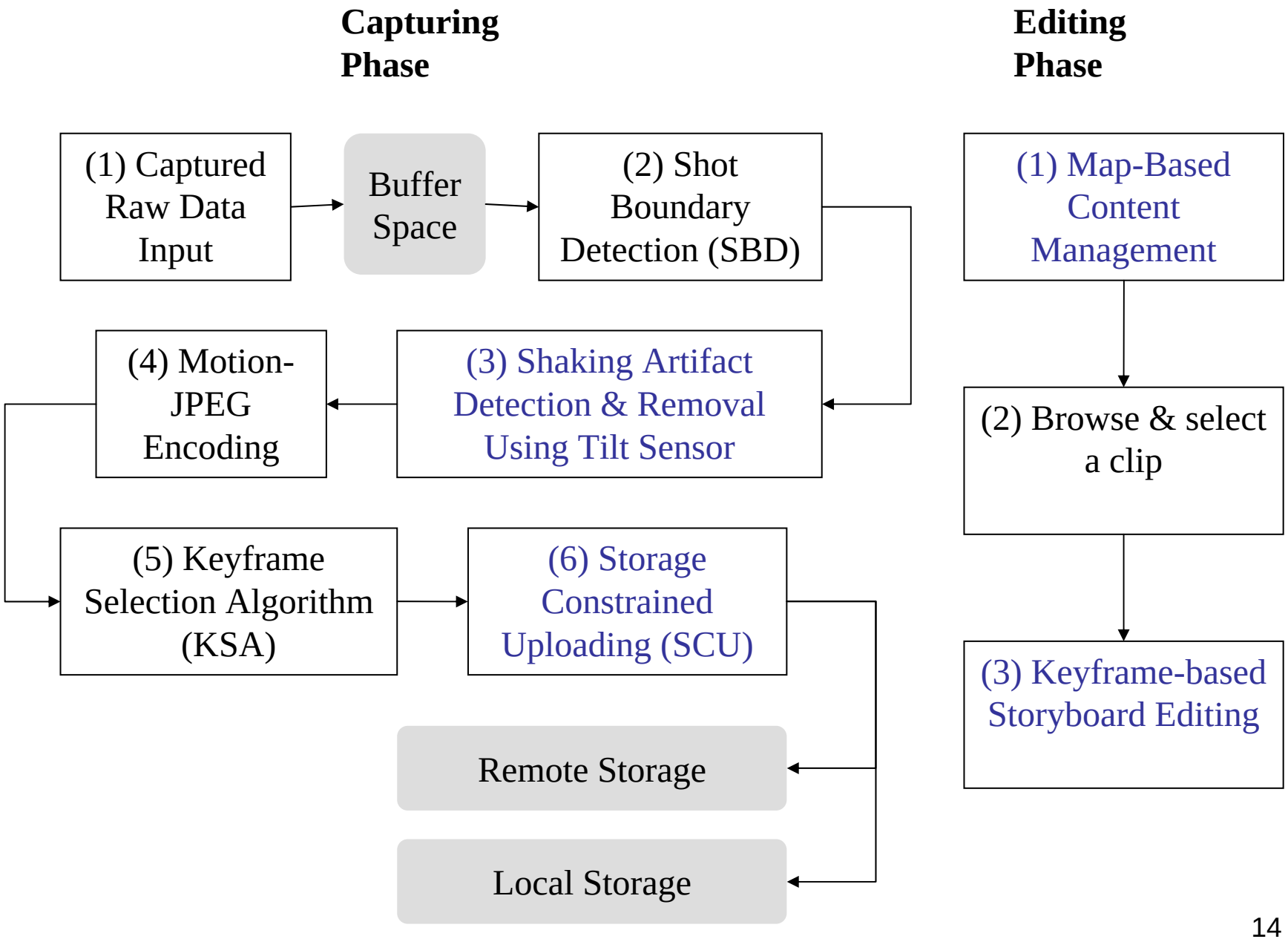
- Limited mobile storage
  - Storage constrained uploading
    - Do we need to download uploaded frames back during editing? No need to edit frame-by-frame (keyframe editing good enough)
- Limited mobile computing power
  - Sensor-assisted automated editing
    - Automated editing is computationally intensive
- Specialized UI
  - Location-based content management
    - Location-based mental model
  - Keyframe-based editing
    - Efficient & good enough quality

Outline

- Design & Architecture
- Storage constrained uploading
- Sensor-assisted automated editing (using tilt sensor)
- Specialized User Interface
- Related Work
- Conclusion & Future Work

Overall Design

- Camera Phone – Wireless Network – Server
  - Mobile storage uploading into server storage
- Capturing phase & editing phase
  - Typical usage: repeated patterns of capturing & editing
- Sharing phase (future work)


Capturing Phase
Editing Phase
(1) Captured Raw Data Input
Buffer Space
(2) Shot Boundary Detection (SBD)
(3) Shaking Artifact Detection & Removal Using Tilt Sensor
(4) Motion-JPEG Encoding
(5) Keyframe Selection Algorithm (KSA)
(6) Storage Constrained Uploading (SCU)
Remote Storage
Local Storage
(1) Map-Based Content Management
(2) Browse & select a clip
(3) Keyframe-based Storyboard Editing

Limited Mobile Storage
(Storage Constrained Uploading)

- When the mobile storage is full, offload all new contents to server
- Problems with naïve approach:
  - Download previously uploaded contents during editing phase
  - Transfer contents later be cut by a user
  - Slow content transfer over wireless network

Observation (Insight)

- User studies showed that editing at keyframe granularity is preferred over frame-by-frame granularity on mobile devices.
  - Consider user effort, attention, computing power, etc.
- Keep keyframes in mobile storage
- Offload non-keyframes
- Avoid downloading frames at editing phase

Storage Constrained Uploading

- Prioritize frames
  - 2 levels: Keyframe, non-keyframes
  - Multiple levels: keyframes, I, P, B (MPEG)
- Adjust editing granularity
  - Types of frames needed during editing phase
- One challenge: multiple clips
  - Keep all clips at the same editing granularity
  - Round-robin offloading across clips

Limited mobile computing power:
(Sensor-Assisted Automated Editing)

- Existing automated tools use image processing to extract meta-data information
  - Shaking detection (forget to hit stop button)
  - Lighting level detection
  - Group shot (scene) similarity
  - Computational expensive

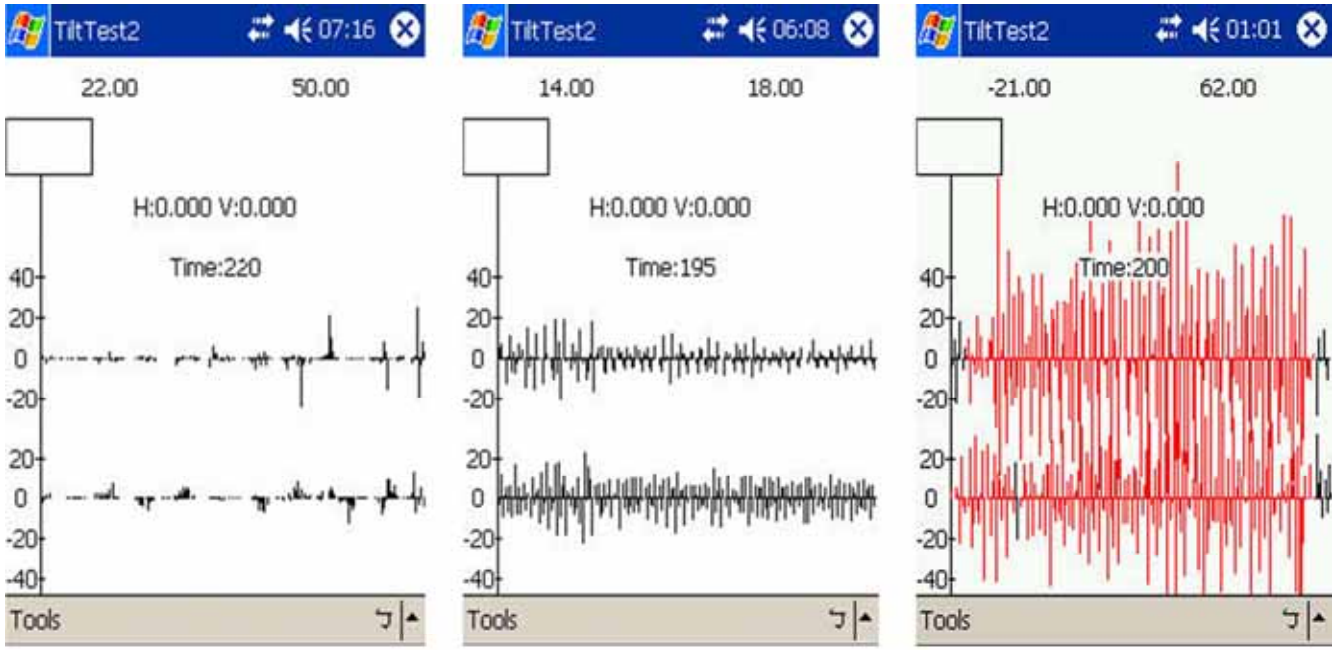
Observation (Insight)

- Sensors can achieve the same result as image processing
  - But use much less computation!
- Tilt sensor -> camera shaking
- Ideal for mobile devices

Tilt Sensor


TiltControl™ Sensor
Horizontal Axis
Horizontal Angle
Vertical Axis
Vertical Angle

Experiment to Identify Camera Shaking Pattern



Sitting

Walking

Shaking (Red lines)

User Interface Design

- Tradeoff between
  - Simplicity (ease-of-use, short learning curve, reduced user effort)
  - Quality of edited production
- Two parts in UI:
  - Location-based content management
  - Keyframe-based storyboard editing

Location-based Content Management

Material Pool

Storyboard

Location-based Content Management

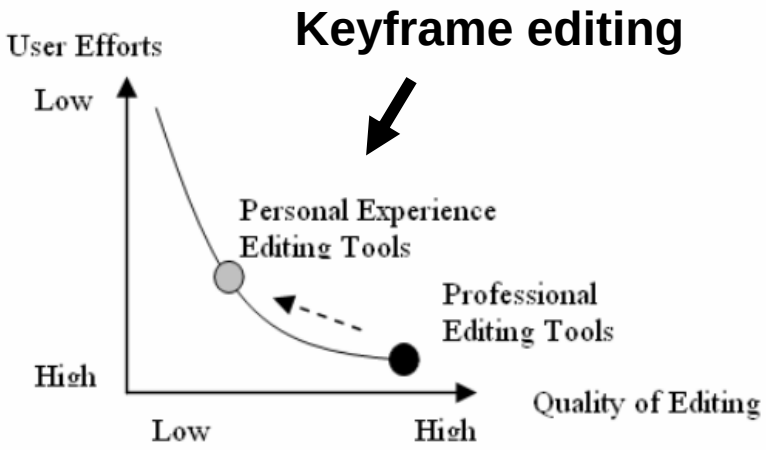
- Two ways people mentally group clips:
  - Recording time
  - Recording location
- Observation (Insight):
  - User studies showed that grouping by location is preferred.
  - Location information is more visual
  - Time information is more abstract
- Use GPS to annotate clips with location meta-data.

Keyframe-based Editing

- Previous work uses keyframes to expedite video browsing (video summary).
- Apply keyframe understanding to keyframe editing:
  - Concern #1: editing is more demanding than understanding
  - Concern #2: reduction of editing quality
- Understand the tradeoff between user efforts & editing quality.

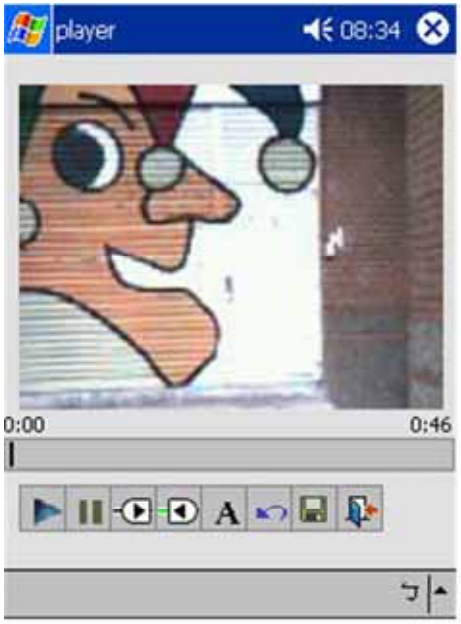
Tradeoff between User Efforts & Editing Quality

- User studies to understand this tradeoff
  - Reduction in user-perceived quality & produced contents acceptable to users
  - Reduction in user efforts or improvement in task completion time
  - Effectiveness when combining with slideshow player or storyboard player



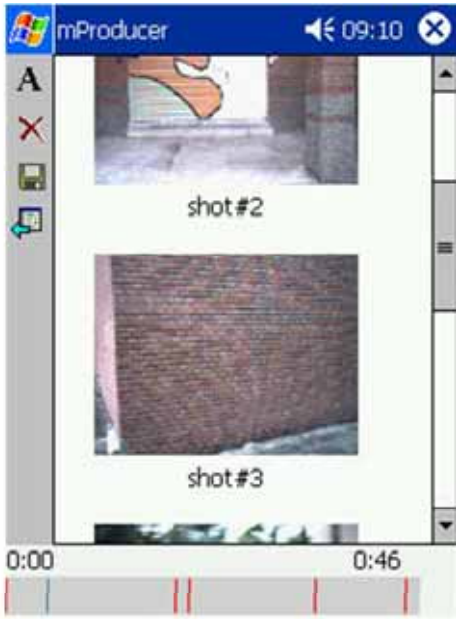
User Studies #1
(three editing interfaces)

- **(UI-A)**: Frame-by-frame editing with a video player (the scaled-down version of conventional desktop editing interface)
- **(UI-B)**: Keyframe-only editing with slideshow player
- **(UI-C)**: Keyframe-only editing with storyboard player



(a) Frame-by-frame Playback

(b) Keyframe-based Playback

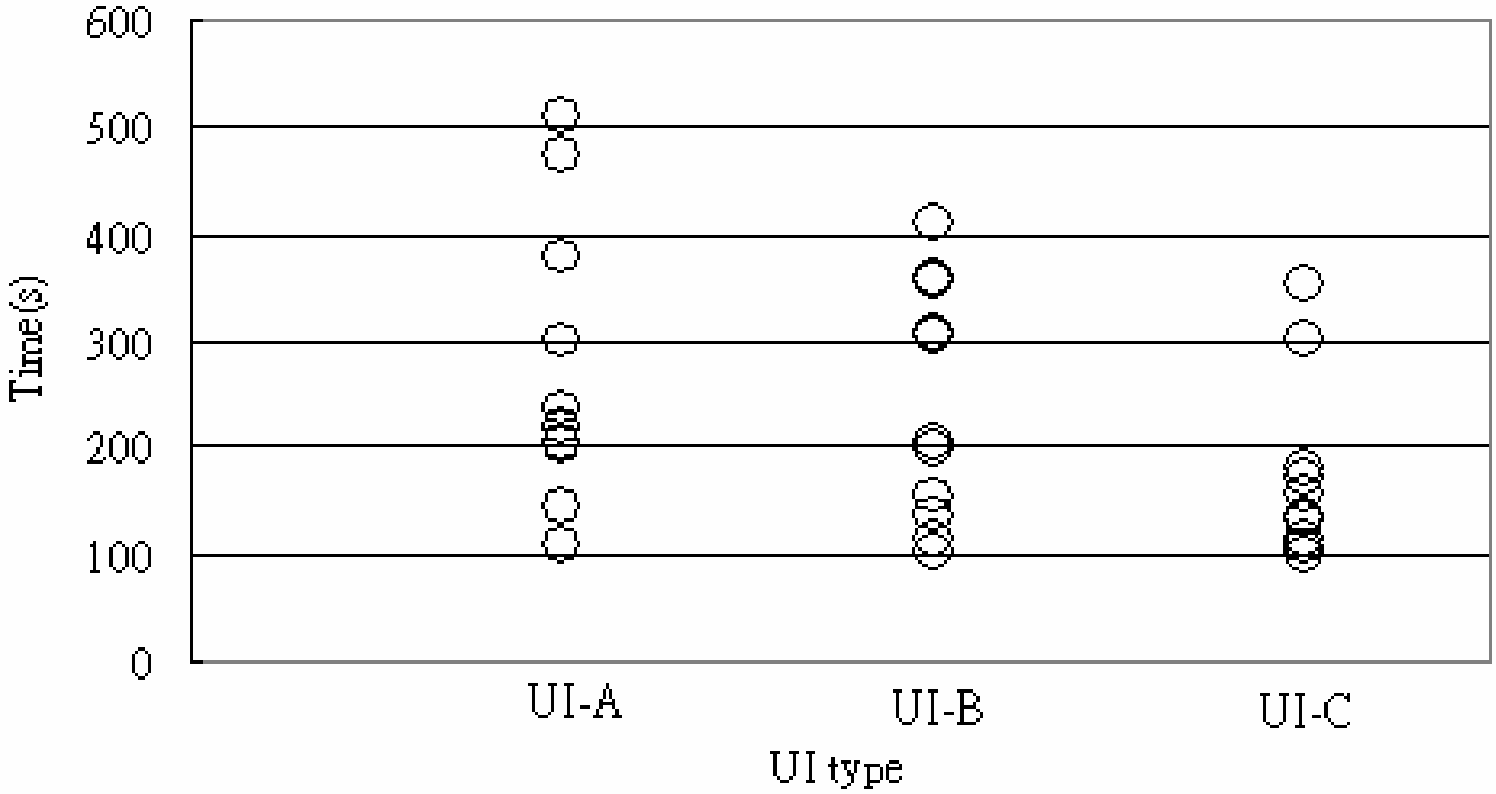


(c) Keyframe-based Storyboard

User Studies #1 Setup

- Participants:
  - 8 males & 3 females
  - 20 ~ 41 years (mean 24)
  - 3 males have experience with PDA
  - 5 have experience using PC-based video editing tool
- Procedures:
  - Brief them on software with demo
  - Each participant captures 6 minutes of video with 3 2-minutes clips on campus
  - Edit 3 clips using each of 3 interfaces
  - Task completion time is measured
  - At the end, each participant fills questionnaire scoring 3 interfaces.
  - Interview participants

User Studies #1 Result: Task Completion Time



Frame-by-frame

Keyframe + slideshow

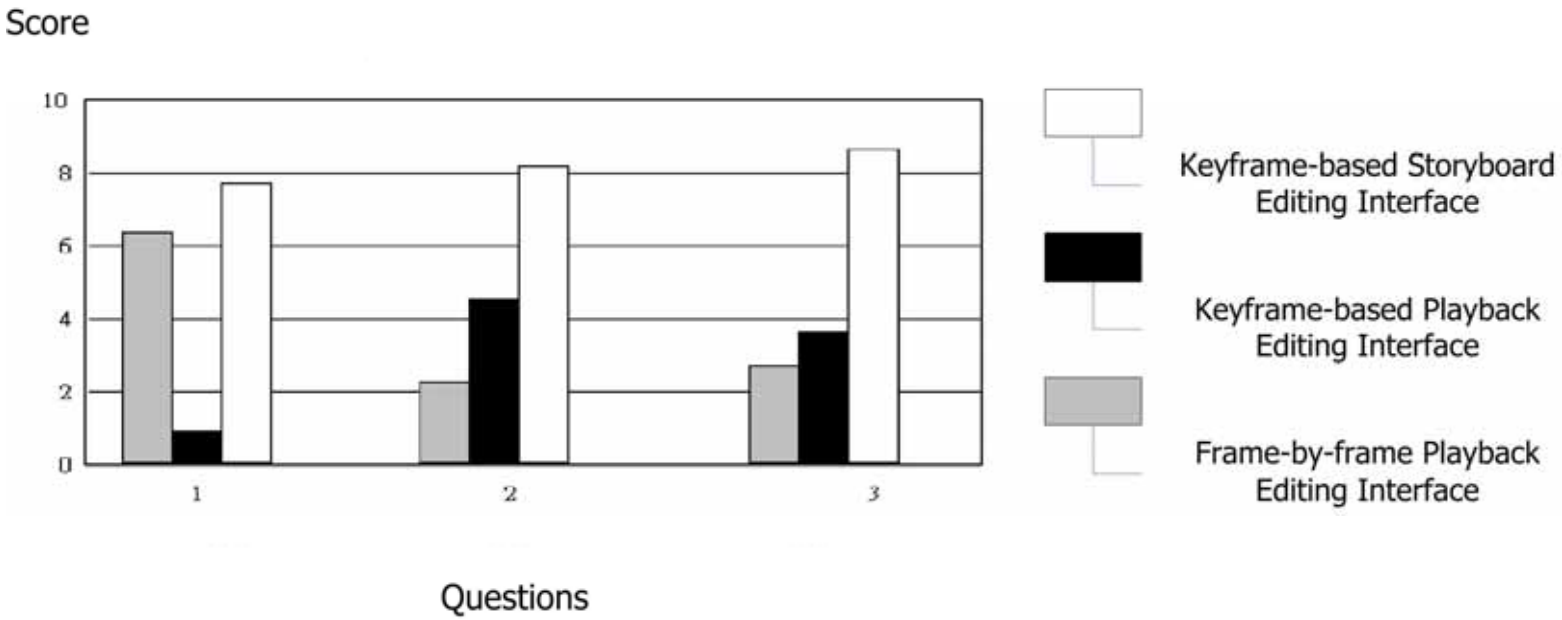
Keyframe + storyboard

User Studies #1 Result
Interview on task completion time

- Storyboard UI helps them to see several keyframes at the same time, so they can quickly identify which frames or shots they did not like and remove them.
- Problem with frame-by-frame editing was that it required uninterrupted, focused attention on the screen. Mobile environment can be distracting and make it difficult to maintain continuous attention for a long period of time.
  - Friends calling, people walking by, surrounding noises, etc.

User Studies #1 Result:
Subjective Satisfaction on 3 Editing Interfaces

	Questions (Rank three editing UIs)
1	Perceived quality of editing
2	Ease-of-use
3	Ease of learning
4	Overall editing experience



User Studies #1 Result
Interview on subjective satisfaction

- Keyframe-only storyboard UI produced the best perceived editing qualilty
  - Even better than frame-by-frame!
  - Why? Casual users not willing to spend time finding mark-in & mark-out boundary points for unwanted contents. Our shot boundary detection algorithm finds better boundary points.
- Advantages of keyframe-only storyboard UI
  - Users can quickly move among shots, very useful during editing.
  - Users can quickly delete unwanted shots with a single click.
- All participants found keyframe-only + storyboard best
- 7/11 participants found keyframe-only + slideshow better than frame-by-frame

User Studies #2 Setup
(overall user experience)

- Location-based content management & keyframe-based storyboard editing UI
- Participants:
  - 5 males & 2 females
  - 21 ~ 33 years (mean 24)
  - 3 have experience with PDA
  - 3 have experience PC video editing tool
- Procedures:
  - Brief them on software with demo
  - Each participant was asked to shoot any type of footage on campus about 10 minutes, 2+ clips
  - Each participant was asked to edit two clips chosen randomly, and to think aloud.

User Studies #2 Result
(overall user experience)

- Participants feedbacks were very possible.
  - “A pretty cool tool to use”
  - “The keyframe-only storyboard is very helpful for me to delete contents that I do not like. Editing tools on desktop PCs should incorporate this feature too!”
  - “Map based content management is very informative for choosing which clip to edit”
  - Slideshow interface is better for understanding, whereas storyboard is better for editing
  - Provide location tracking indoor

Related Work

- Lots of related work on automated indexing of media:
  - Annotating 5W: Who, Where, When, What, How
  - ContextCam (Gatech), Garage Cinema (Berkeley), Context-Aware Photography (Viktoria Institute), Audio-Based Memory Aid (MIT)
- Keyframe-based editing on PC:
  - speed up editing of home videos by grouping similar keyframes in piles (based on color similarity)
  - Require a large screen for displaying piles
- Collaborative editing tools by Lara to download and edit at different fidelity
  - Focus on replica inconsistency, did not address limited storage & UI issues
- To our knowledge, this was the first ever mobile video editing tool.

Conclusion

- Future mobile contents = personal experiences
- Future content production:
  - Average consumers use mobile device to capture and edit personal experience contents
  - Everyone becomes a news reporter!
- Casual interface for editing of personal experiences on the fly

References

- http://www.csie.ntu.edu.tw/~hchu
- Chao-Ming Teng, Hao-hua Chu, Chon-In Wu, “mProducer: Authoring Multimedia Personal Experiences on Mobile Phones”, IEEE International Conference on Multimedia and Expo (ICME’2004), Taipei, Taiwan, June 2004. (pdf)
- Chao-ming Teng, Chon-in Wu, Yi-chao Chen, Hao-hua Chu, Yung-jen Hsu, “Design and Evaluation of mProducer: a Mobile Authoring Tool for Personal Experience Computing”, to appear in Mobile and Ubiquitous Multimedia (MUM) 2004, College Park, Maryland, October, 2004. (pdf)

Future Work

- Port it to cell phone
  - Smaller screen size
- Sharing of personal experience
  - Dissemination with privacy & security protection
- Explore other types of sensors (orientation, emotion, voice, accelerometer, etc.) to automate
  - Editing personal experiences
  - Sharing personal experiences
  - Recalling personal experiences
- Do you have any cool ideas or applications on personal experience computing?
  - Let me know!