Pen-based Input of Geometric Constructions

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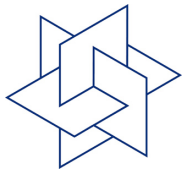
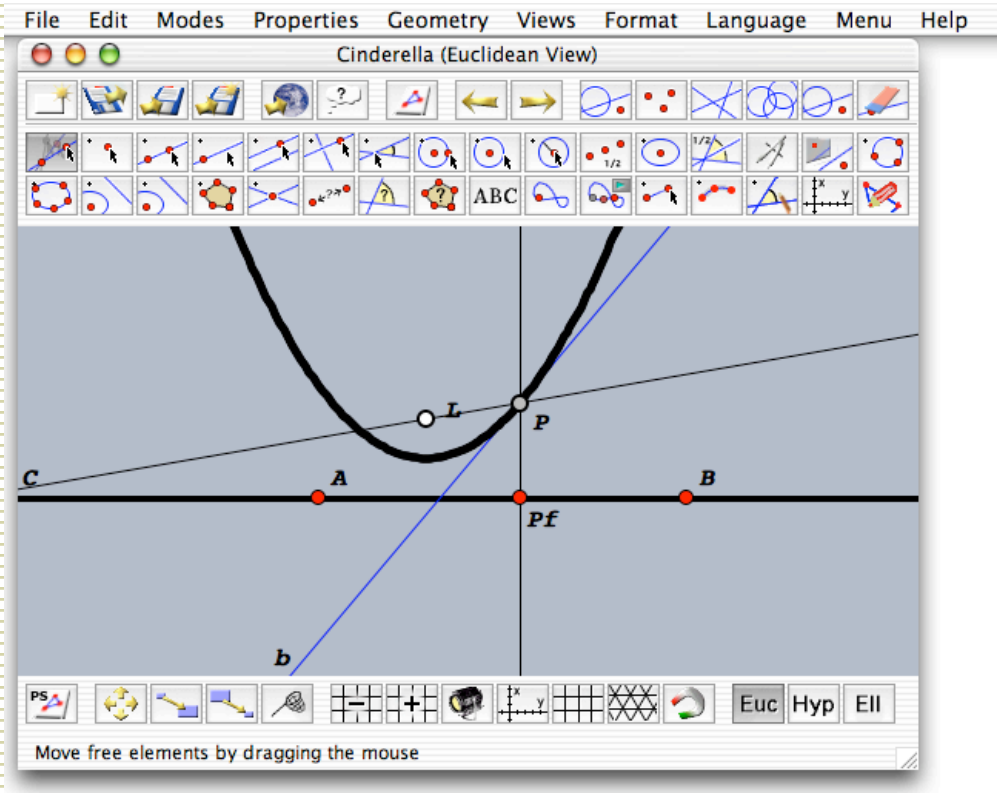


DFG Research Center Matheon
“Mathematics for key technologies”

Technical University Berlin

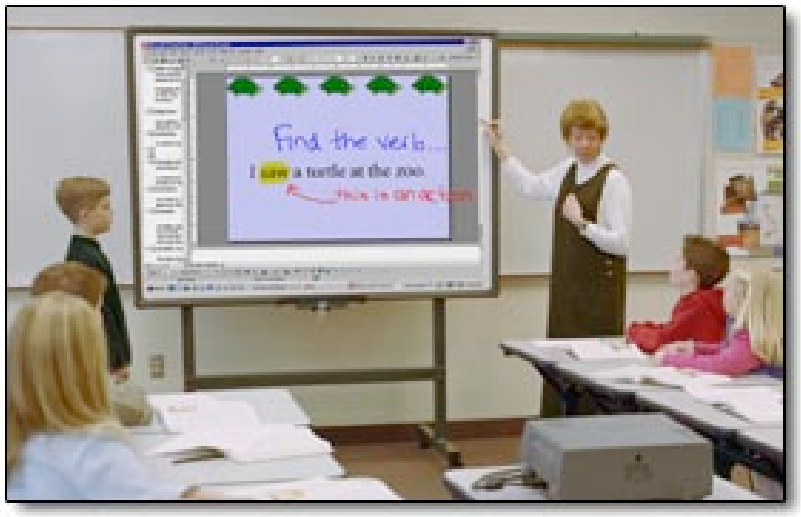
Cinderella



- Dynamic Geometry
- Advanced Mathematics
- Written in Java
- Target platform: standard computers

Interactive Whiteboards

- Large
- High Resolution
- Special Pen
  - Pointer at pen position
  - Two buttons
- Acts as a mouse
- Normal computer



Pen-driven devices

- Interactive Whiteboards
- PDAs
- Graphics Tablets
- Tablet PCs

Common properties

- Logical movement by physical movement
- Classical User Interface is problematic
  - Large movements awkward
  - Exact pointing more difficult
  - Multiple windows confusing

Goal: Use like pen and paper.

➔Eliminate modes!

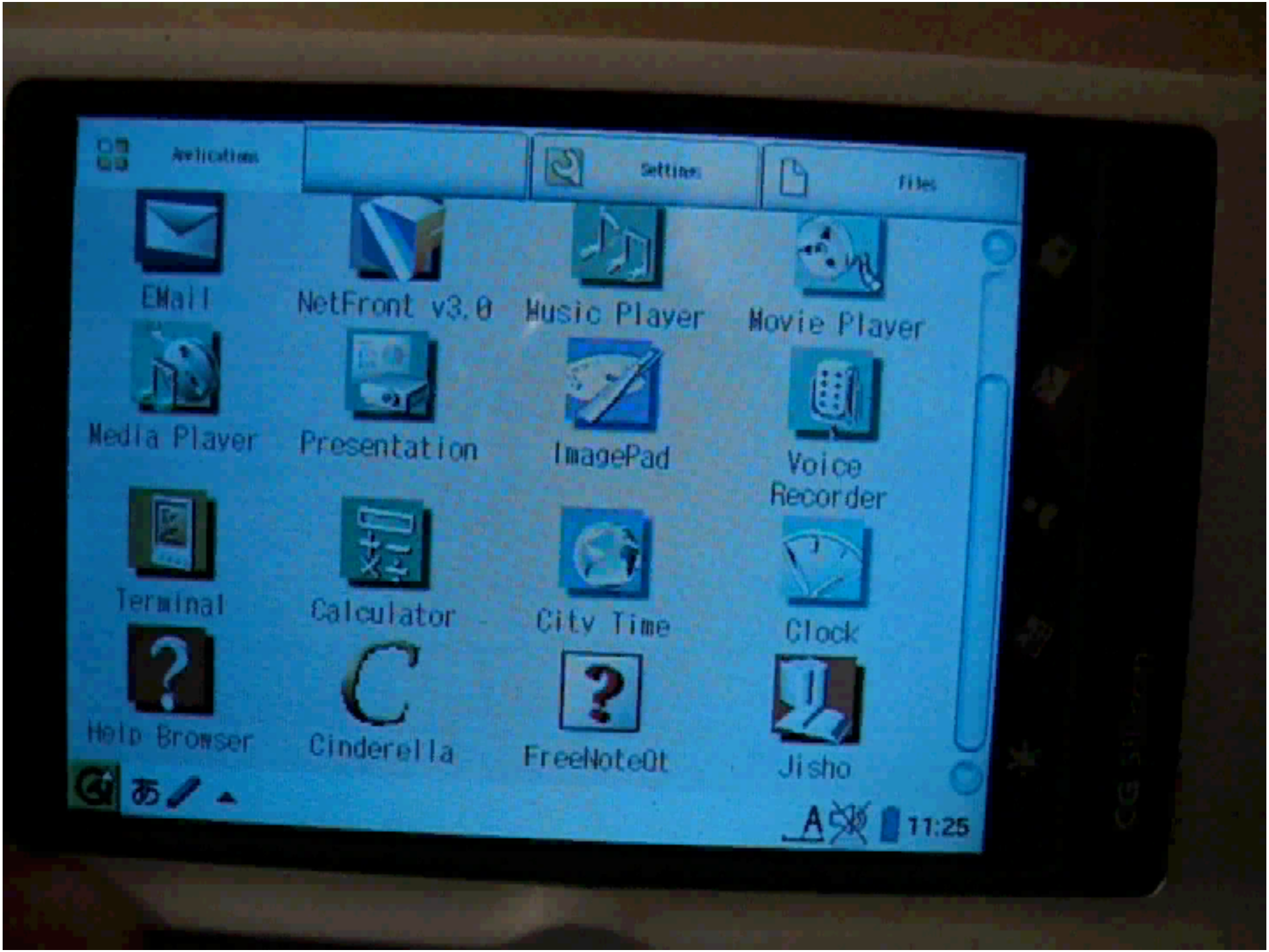
– Demo –

Triangle

Intersection of perpendicular bisectors

Circle through vertices

Moving


Applications
Settings
Files
EMail
NetFront v3.0
Music Player
Movie Player
Media Player
Presentation
ImagePad
Voice Recorder
Terminal
Calculator
City Time
Clock
Help Browser
Cinderella
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Scribbling Capabilities

- Create
  - Points
  - Lines
  - Circles
  - Polylines
- Modify
  - Select
  - Move
  - Undo / Redo
  - Edit Label
  - Inspect
  - Right click

Annotations vs. Preselections

- Problem: Recognize dependant objects
  - Easy for “Point on Line” etc.
  - Hard for “Orthogonal”, “Midpoint” etc.
- Approaches
  - Preselections
  - Annotations

– Demo –

ScribbleJ Orthogonals / Parallels

Annotations

- Advantages
  - More “natural” gesture
  - Can be done as an afterthought
- Problems
  - Not possible for every element
  - Aggravated by Undo/Redo-Facilities
  - Needs many gestures

Preselections

- Advantages
  - Simple concept that can be applied everywhere
  - Modify meaning of gestures
  - Exact
  - Less false positives
- Disadvantages
  - User has to decide in advance

“Hand-drawn” presentation

- Do not correct the user
- But relations have to be right

– Demo –

- *Pappos’ Theorem*
- *Circumference again*
- *Incremental Smoothing*

Timeline

- Incorporated into Cinderella 2.0
- Now: Beta-Version
  - Regular version
  - PDA
- Future directions
  - Physics (prototype available)
  - More devices
  - More gestures, more recognized objects

To become a beta tester:
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Design goals

- ~~Intuitive~~ Easy To Learn
- Fast to use
- Natural with a pen
- Flexible
- Anticipate future hardware developments
- Alleviate need for modes and menus

Conclusion

- It is feasible to recognize mathematical entities from user-drawn sketches
- In real-time
- On small and large devices
- Hand-drawn appearance can be preserved

- Mathematical knowledge in the kernel enables these possibilities

Done.

- Questions?

- More Demos?
  - *Physics*
  - *Flow Menus*
  - *Scribbled Cube*
  - *Scribbled Euler-Line*