

INTERNSHIP AT INRIA LABORATORY LIFL

Manipulating curves by innovative plastic multitouch interactions

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Presentation plan

- 1 **Motivation**
- 2 **Highlights**
 - Curve and interpolation
 - Intuitive and immersive experience
 - Shape maintaining
- 3 **Implementation**
 - Software design
 - Features
- 4 **Demonstration**
- 5 **Conclusion**

Motivation

Gap between final users :

- Need to control the variations of a parameter
- With various mathematical knowledge

and technical tools

The project : Curve editor



Curve creation and manipulation

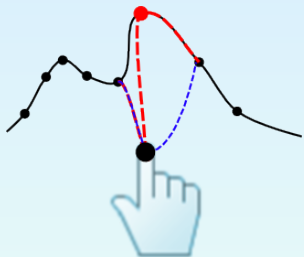
- No mathematics visible
- Innovative plastic manipulations
- Immersion through multitouch interactions
- User-intent driven

1D curve

Variation of one parameter in respect to another one (time)
⇒ sorted list of Y-coordinates, indexed by X-coordinates

Overwriting paradigm

Dealing with input frequency



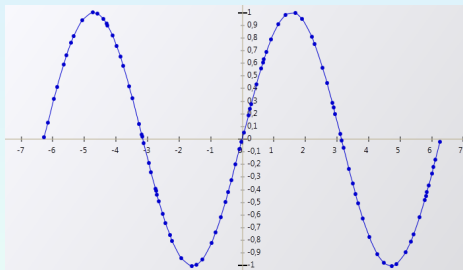
Sampled list of positions of a finger
⇒ irregular, not precise.

- **Pointing** : erasing surrounding area
- **Moving** : erasing since last position

Cardinal spline interpolation

Smooth join of user inputted points

⇒ Cardinal spline interpolation by hermite polynomials.



Keypoints with coordinates plus tangents

⇒ Sequence of 2nd degree polynomials

Keeping only necessary keypoints

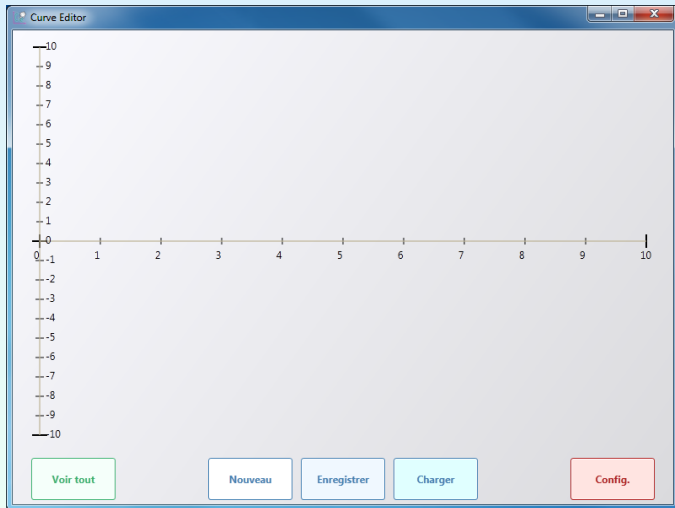
```
KeyPoints = [];  
OriginPoly = PreviousPoint = DrawnPoints.First ();  
foreach (CurrentPoint in DrawnPoints) {  
    Check that all the points in [ OriginPoly ; CurrentPoint ]  
    are close to their value in H(OriginPoly, CurrentPoint)  
    Else {  
        Add PreviousPoint to KeyPoints;  
        OriginPoly = PreviousPoint;  
    }  
    PreviousPoint = CurrentPoint;  
}  
Add DrawnPoints.Last () to KeyPoints;
```


Shape manipulation

Michael Leyton's "Shape Form Deformation" theory :

- Initial drawing of a simple shape
- Sequence of manipulations

Light interface



Light interface

Curve Editor configuration

Interpolation settings

Allowed error in the interpolation (in px)
◀ [Slider] ▶ 2

Gap between two drawn pixels (inprecision)
◀ [Slider] ▶ 4

Maximal gap between two keypoints (in px)
◀ [Slider] ▶ 40

Curve settings

Radius of erasement around a single point (in px)
◀ [Slider] ▶ 10

Maximal distance to select the curve (in px)
◀ [Slider] ▶ 20

Smoothing settings

Smoothing radius
◀ [Slider] ▶ 30

Coordinates system settings

Default extrema
10
0 —+— 10
-10

Show the grid

Show key points

◀ [Slider] ▶ 40 ◀ [Slider] ▶ 30

Curve Manipulation Settings

Smoothing (elastic resistance) when pulling
◀ [Slider] ▶ 2

Radius of effect in a pulling manipulation (in px)
◀ [Slider] ▶ 50

Radius of effect in a tangent manipulation (in px)
◀ [Slider] ▶ 100

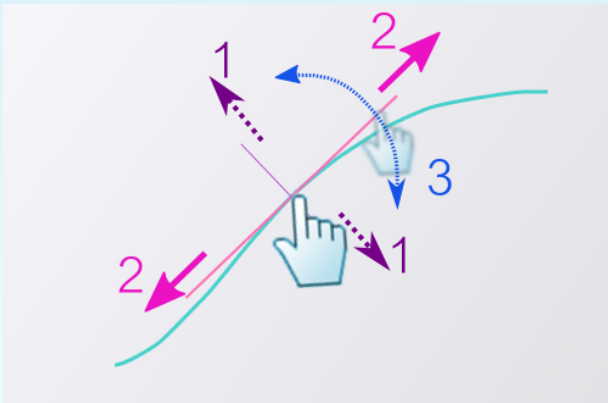
Vertically limit ball manipulations

Record temporary shape between local operations

Reset Validate

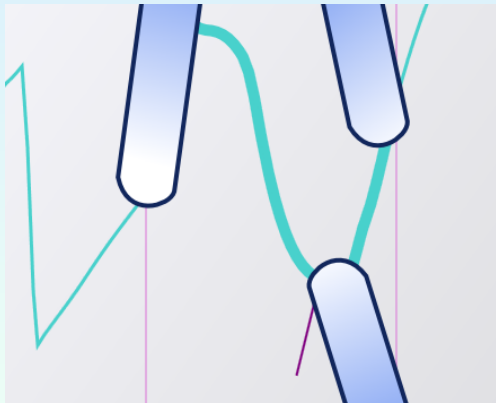
Constant visual feedback

Every user action provides a notification



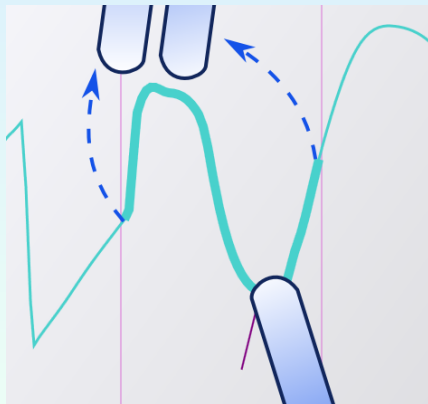
Constant visual feedback

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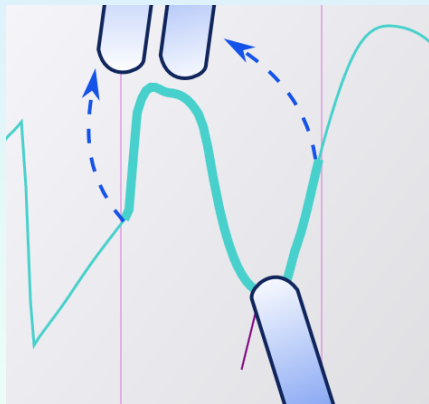
Levels of expertise

Beginner/expert paradigm



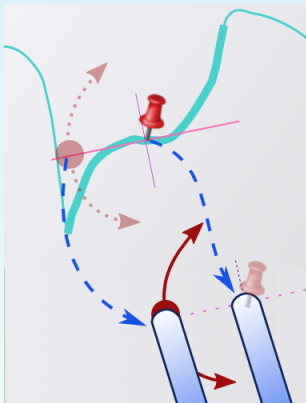
Dealing with occlusion

Gain visibility over the action



Dealing with occlusion

Gain visibility over the action



User intent determination

Implicit determination in context and in real time thanks to :

- Number and position of finger down
- Recent absolute or relative movement of fingers



Drawing buffer for indeterminated states

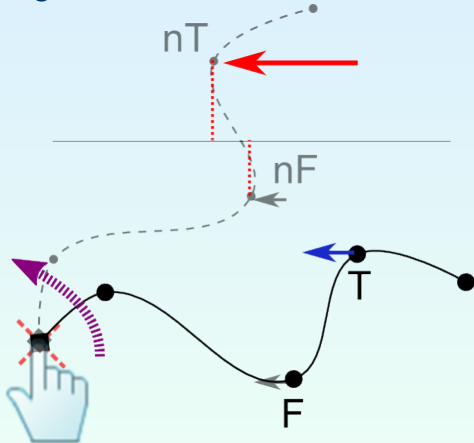
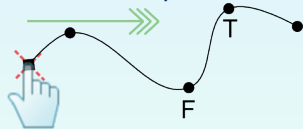
Manipulation attenuation

- Linear attenuation
- Elastic attenuation to maintain the 1D invariant (symmetrical around the center) :
Moderation factor

Attenuation algorithm in a nutshell

T goes towards the left :

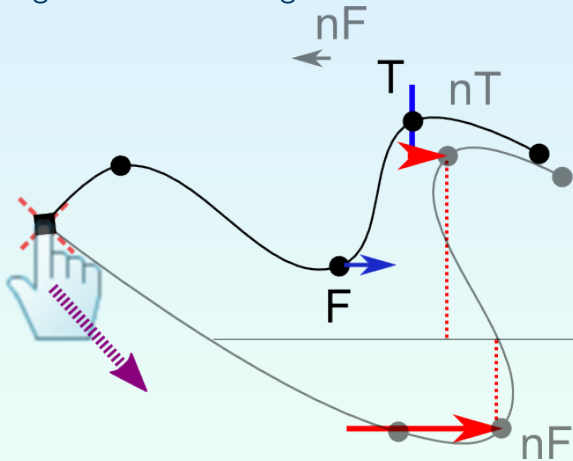
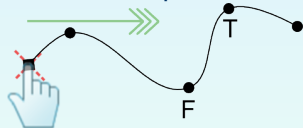
Before manipulation :



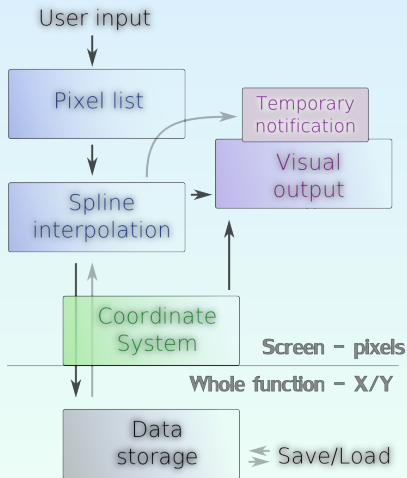
Attenuation algorithm in a nutshell

T goes towards the right :

Before manipulation :



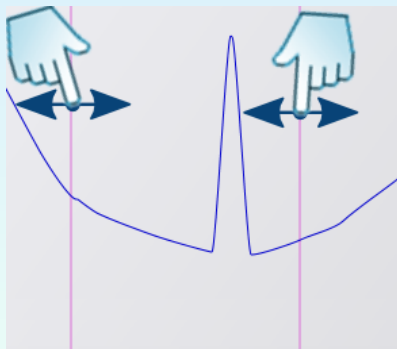
Software design



Features

- Axes manipulation : stretching, translating...
- Curve drawing
- Curve translating
- Various inovative plastic manipulations...

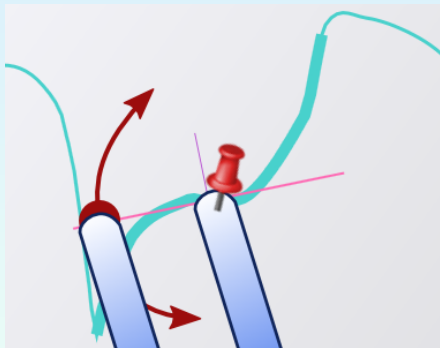
Stretching



Sanding



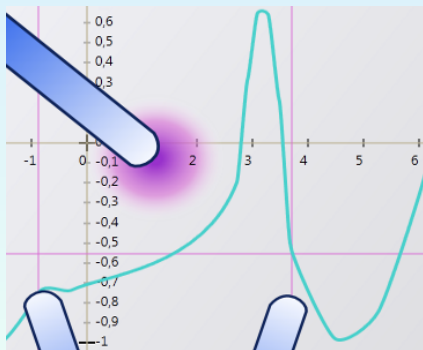
Rotating



Pulling



Ball manipulation



Demonstration

No multitouch computer available, but a presentation video.

Conclusion

Immediate link between the user and the computer :
A fixed finger pinpoints the curve, a moving finger drags it.

Intuitive immersive experience thanks to the optimal use
of the multitouch interface