University of Glasgow — IDI Inference Dynamics Interaction — more grasp

Gesture Typing through Indirect Absolute on-demand Touch Surfaces: Impact of Input Space on Performance.

Abstract

We are interested in bringing the gesture typing interaction to a tabletop scenario for users with limited hand mobility. Using on-demand touch surfaces with an absolute indirect mapping (Fig.1) is a solution exhibiting interesting properties. We can efficiently mitigate hand occlusions, palm rejection issues and the gorilla arm effect. Moreover, such a setup brings forth a lot of freedom in the design of the input space by relaxing requirements on the size, texture and material of the input surface.

We conducted a study on the task of gesture typing to understand how varying the surface size and aspect ratio may affects the writing performance.

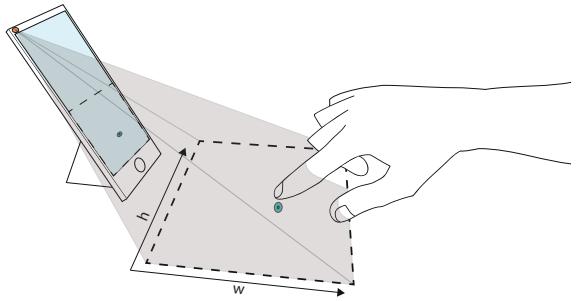


Fig.1: Mockup of the interaction setup, a mobile device expose its gesture typing capability through the creation of an on-demand touch interface which is indirect and absolute.

System Description

- based on an Intel RealSense SR300 for RGBD sensing.
- using open source software (OpenCV, PCL, SciPy, Keras).
- supports surface size ranging from A6 to A3.
- Android tablet for real-time visual feedback.
- Swype keyboard application for word decoding.

The user pointer (potentially his finger) is seeded from the closest point to the camera and grown as a ball of 2cm radius (Fig.2). Its location is tracked with a Kalman filter and its touch property is infered from the prediction of a neural network. The reconstructed touch events are then sent to an Android tablet for visual feedback and traces are decoded by a gesture keyboard (Fig.3).

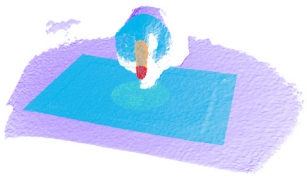


Fig.2: Segmented pointcloud from the camera, in blue the ROI, in red the pointer.

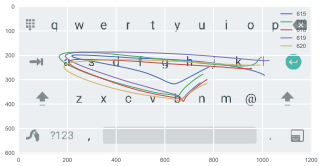
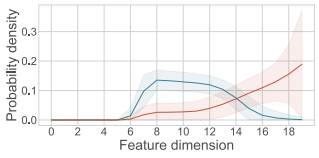


Fig.3: Several succesful attempts to gesture type the word "lab".

The classification of each video frame is critical to the quality of the interaction.



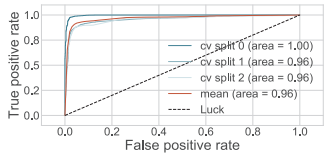


Fig.4: Extracted feature for classification (red is non-touching, blue is touching).
Fig.5: Area under curve for the classifier. A operating point of 0.5 was chosen.

Experimental Design

- pre-study in a clinical environment to validate the design
- experimental study in Glasgow with 12 able-bodied participants

We used a repeated measures within-subjects design. The task is to gesture type 20 words selected from the most common 200 english words between 2 and 5 letters. The independent variables were the *device* and the *shape* of the surface (Table 1). We recorded the error rate as well the mouvement time and the trace data.

level	*device*	*width[cm]*	*height[cm]*	*area[cm2]*	*ratio*	*gain*
OP1	optical	9.4	4.7	44.2	2	1
OP2	optical	18.8	9.4	176.7	2	1/2
OL2	optical	25.6	6.9	176.6	3.7	1/1.7
OP4	optical	37.7	18.9	712.5	2	1/4
TP1	tablet	9.4	4.7	44.2	2	1

Table 1: Different experiemental conditions and their properties. The shapes {P1, P2, P4 } allow to look at the influence of size.

Results

A statistical analysis shows a main effect of device on input rate ($F_{1,11}=37.77$, $p<0.001$) and error rate ($F_{1,11}=90.15$, $p<0.001$). However, a statistical analysis shows no effect of size on input rate ($F<1$), but a main effect on error rate ($F_{3,33}=10.2$, $p<0.001$), (Fig.6 and Fig.7).

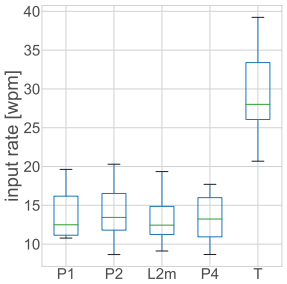


Fig.6: Input rate across all the conditions

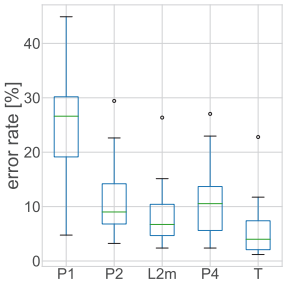
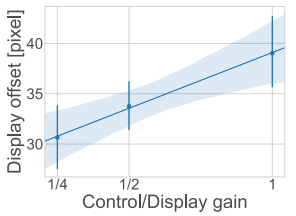


Fig.7: Error rate across all the conditions

In other words, the participants were capable of the same error rate as with the control condition when the size of the surface was big enough (P2 and upwards). They were however consistent in their text input rate which was in average half that of the control condition.

An analysis of performance shows that the participants did not managed to maintain the same level of precision across the size condition (Fig.8). They could however increase their average motion speed with the increase in size (Fig.9), performing the same gesture up to 4 times faster than P1 in the P4 condition.



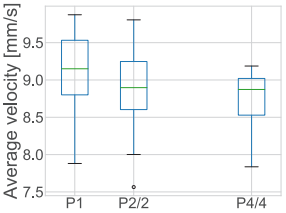


Fig.8: Pointer offset on touch down. The gain is related to the shape.
Fig.9: Average pointer velocity scaled against the gain.

Conclusion

- The proposed interaction paradigm is suitable for text input and produce half the input rate at the same error rate as a direct touch system.
- The size of the input space does not impact the text input rate (but impact the perceived quality of the interaction).
- Another effect is limiting the information transfert for the user and has also been reported by other comparable studies.
- Any factor that can improve the performance is interesting to investigate. The influence of visual feedback is one potential thread.

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