a runway outline, ψ was neither significantly influenced by V, nor by γ.

In accordance with the previous, TTC at onset of the flare was not significantly influenced by the runway width when the scene contained texture. Without texture, the runway width did have a significant effect on TTC. Not withstanding our attempt to prevent this phenomenon from occurring, ψ was significantly influenced by the runway width for all scenes containing a runway, irrespective of the presence of texture.

These results indicate that a display showing a runway outline without ground texture provides less accurate information to enable a pilot to initiate the flare on the basis of TTC only, than a display showing ground texture. Instead, subjects seem to prefer for a particular runway a certain value of the optical angle ψ to trigger the flare. However, the results presented by Advani et al. (1993) suggest that in such conditions the initiation of the flare maneuver might as well been based on a combination of values of both ψ and TTC.

In the present experiment, the texturized scenes provided information which enabled subjects to base the onset of the flare almost completely on TTC alone. Further, the presence of a runway outline appears to have no effect at all on the perception of TTC.

Conclusion

Addition of ground texture to a runway scene in a visual simulation was shown to significantly improve the perception of the Time-to-Contact and hence the landing performance. The effect of a runway outline appears to be negligible. In fact, when such an outline is the only visual cue, subjects seem to time the onset of the flare maneuver on the basis of the optical angle ψ.

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The Influence of Stimulus Length on Static Haptic Curvature Discrimination

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Abstract

The influence of stimulus length on static haptic discrimination of curvature was investigated for different placements of the stimulus on the hand. The sensitivity for curvature discrimination does not appear to depend consistently on the region of the hand with which the stimuli are touched. The discrimination thresholds in terms of radius of curvature and in terms of base-to-peak height difference as a function of contact length are shown to increase monotonically. In our experiment, the effective stimulus for discrimination of curved strips is found to be the total change of local surface attitude, a first order variable.

Introduction

In an earlier investigation static haptic discrimination of curved strips from a straight strip was tested for nine different placements of the stimulus on the hand (Pont et al., 1995). The length over which the strips were touched seemed to covary with the discrimination thresholds for the nine different placements. Here we systematically study the influence of the length of the strips, and thus of the contact area, on static haptic discrimination of curvature. Discrimination thresholds for different lengths of the stimuli and different placements of the stimuli on the hand are compared. We investigated whether the sensitivity for curvature discrimination correlates with the part of the hand with which the strips are touched or with the zeroth, first or second order geometrical properties of the stimulus. The latter variables are represented by the base-to-peak height difference, the total change of local surface attitude and curvature respectively.

Method

Stimuli

The stimuli are curved strips with a length of 8 cm or 20 cm, a width of 2 cm, and a base-to-peak height of 5 cm (see figure 1A). We tested how well subjects could discriminate a straight strip from 8 different curved strips with a constant curvature in the range -1.6/m to +1.6/m. The curvature is the reciprocal of the radius of curvature, so a curvature of k=0.2/m is represented by a circle with a radius of (1 / 0.2) m=5 m. All conditions tested are presented schematically in figure 1. In the case of the thumb (placement 5), middle finger (placement 7) and little finger (placement 9) two conditions were tested with strips with a length of 8 cm: in one condition these shapes were touched with the finger only and in the other condition the shapes were touched just with the part of the palm of the hand which is involved in these placements (figure 1B). In placement 1 (figure 1C) one condition was tested in which the subject had to spread the fingers as much as possible. For this placement we also tested a condition in which the subject had touch the strips with the fingers held together (figure 1D). In these two conditions we used strips with a length of 20 cm, because in the "wide" condition the area over which the strips were touched exceeded 8 cm. Figure 1E depicts the nine conditions tested in earlier research (Pont et al., 1995). The results of these experiments are taken into account in the analysis of the results of the present experiment.

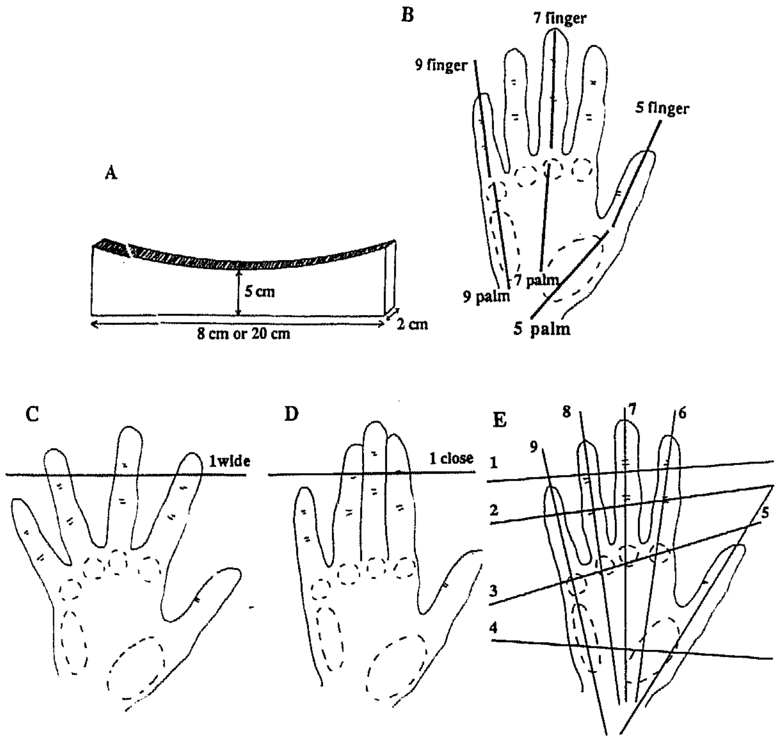

Figure 1 A concave curved strip and a schematic representation of the different conditions. The strips have a length of 8 cm or 20 cm, a width of 2 cm, and a base-to-peak height of 5 cm (A). B shows the six placements of the 8 cm strips on the hand. C and D show the conditions in which the strips are presented in placement 1. E depicts all nine different placements in which discrimination of 20 cm long strips was tested.

Subjects and experimental setup

Three subjects participated in the experiments. Subjects RB and IH were naive and paid, whereas subject SP (not one of the authors) is experienced in haptic experiments. They were seated behind a curtain which prevented them from seeing the experimenter and the stimuli. The subject put the palmar side of his or her right hand under the curtain to touch the stimuli presented by the experimenter.

Procedure

In this experiment a two-alternative forced choice procedure was used. The subjects had to judge by using static touch which of two successively presented stimuli was the more positively curved.

The range in which discrimination was tested differed for the different conditions and subjects and was adjusted after each session, on the basis of the estimations for the thresholds in the previous experiment. We fitted psychometric curves to the percentages of judgements in which the test shape was judged more convex than the reference shape, as a function of curvature. The data points were weighted linearly with the number of trials to which these percentages applied. Sigma represents the steepness of the curve or the discrimination threshold at 84% correct. The bias represents the 50% point.

Results and discussion

None of the biases is significantly different from 0/m, as we expected. For none of the three subjects did we find a consistent variation in the discrimination thresholds as a function of the part of the hand with which the stimuli are touched. Thus apparently, the local structure of the hand is not the main factor determining the curvature discrimination thresholds. For this reason we looked at the data in terms of geometrical properties of the stimuli.

The discrimination thresholds were calculated in units of radius of curvature and in units of the base-to-peak height difference over the contacted area. These values are shown as a function of the length of contact for subjects IH and RB (figure 2). It is perhaps surprising, in view of the differences between the conditions, that these datasets show correlation. For both these datasets and for all three subjects we determined the Spearman Rank-Order correlation coefficients and the level of significance. These values are shown in table I. It is clear that the thresholds in units of radius of curvature and the thresholds in units of base-to-peak height difference show a monotonically increasing relation as a function of contact length. So, models in which discrimination of curvature is based on constant curvature differences or constant height differences (the second and zeroth order structure of the stimulus, respectively) are rejected. However, a model in which the judgements are based on the first order variable cannot be ruled out. In other words, in our experiment the total change of local surface attitude is the effective stimulus for the discrimination of curved strips. This effect was also found by Gordon and Morison (1982) for discrimination and rating of curvature by active touch with the index finger.

In future research, we will study the way in which cutaneous stimulation and kinesthetic stimulation from different parts of the hand integrate in haptic curvature discrimination.

Table I The values of the Spearman rank-order correlation coefficients and significance levels for the three subjects RB, IH and SP for the thresholds in terms of radius of curvature (R) and in terms of height differences (h) as a function of the total length of contact (x).

	R(x)		h(x)	
subject	r_s	P	r_s	P
RB	.822	$7.9\ 10^{-6}$	.463	.023
IH	.488	.017	.856	$1.5\ 10^{-6}$
SP	.625	.002	.821	$8.2\ 10^{-6}$

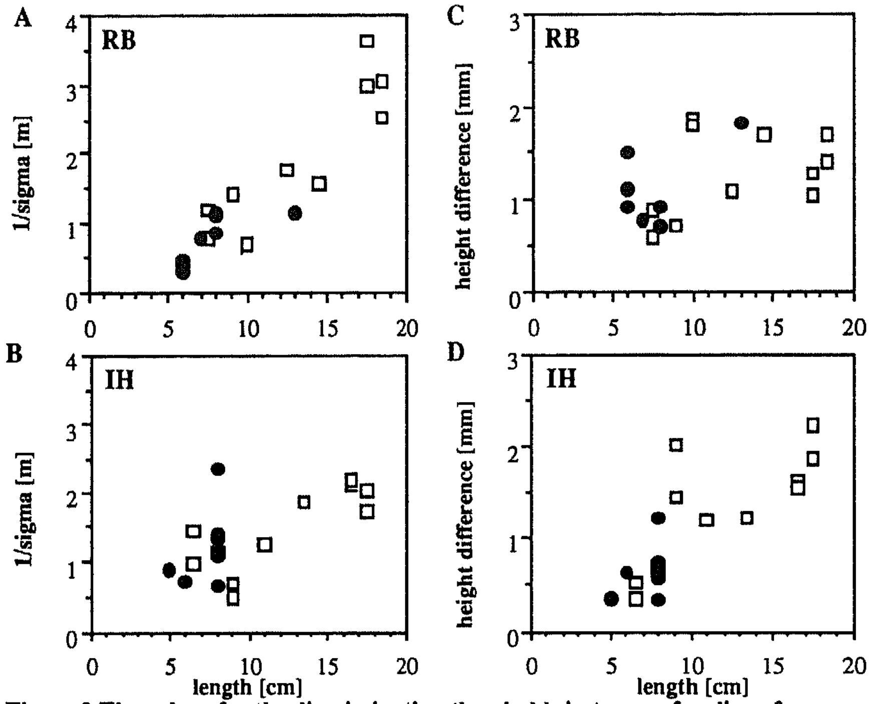

Figure 2 The values for the discrimination thresholds in terms of radius of curvature (A and B) and in terms of base-to peak height difference over the touched part of the stimulus (C and D). The values for all different placements are shown as a function of the total length over which the stimulus was touched in the corresponding positions. Open squares represent the data from the earlier investigation, filled circles indicate the results of the present experiment.

Acknowledgement

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Inconstancy of observer-movement, a perceptual tool?

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Abstract

Interaction is a fashionable label put on a wide range of phenomena. Why would someone want to interact with her environment at all? If personal interaction is not necessary some device might do the job instead. In this respect a tool can be seen as an interface to the outside world, often removing natural forms of interaction, without replacing new forms of interaction.

In our favorite tool, the car, high-tech is setting new standards of locomotion which is highly balanced in speed and heading. This means that the visual information during car driving is smooth. Yet the visual system seems to be well adjusted to the visual information aroused when moving in curly instead of straight paths (De Poot, Bruil and Van de Grind, 1994, Turano and Wang 1994) or moving at inconstant instead of constant speed (Stappers, 1994, De Poot and Van de Grind, 1995). These undulating movements are typical for walking (Stappers, 1992), an old skill, possibly partly mastered through evolutionary experience (Bril, 1996) giving it practical advance over modern skills.

Here a proof is given that observation during biological, namely inconstant, locomotion leaves room to pick up more information from the environment, than modern car driving, giving it a theoretical advantage. This advantage concerns the identification, the localization and interpretation of moving objects in the environment. Experimental results are presented of cases in which observers can effectively interpret the object motion information by active vision. A 'back to the nature' might eventually apply to the visuals during car driving. Promising visualization techniques are presented.

Introduction

It is known that interaction with (active exploration of) the environment allows to pick up information from the environment. Therefore devices have been invented that utilize interaction to allow exploratory sensory perception of simulated or distant realities (virtual reality and teleoperation), especially interactive visual displays responding to the observer's manipulations within a few tens of milliseconds. These systems can be useful for design purposes, but they have also been used for visualization of three-dimensional structures and have been used in vision research. (e.g. Overbeeke and Strattman, 1988, Van Damme and Van de Grind, 1993). A nice low-tech device for active visualization of a static structure is the 'self-statue' mirror (fig 1) specially invented for this presentation in which the viewer can actively pursue her frozen face. The psychological consequences of this deserve to be discussed separately.

For unoccluded static environments the first move an observer makes, arouses already all information available through active vision, namely the depth structure and scale of the environment. (De Poot, 1995, p.7). So in static environments different observer movements arouse similar information. If interactive visual displays visualize *dynamic environments*, different observer movements arouse different, not predictable, information, explained in the theoretical section.