

Generating Flight Summaries Conforming to Cinematographic Principles (supplementary material)

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1. Preferred view computation

From a short review of films with flying vehicles (illustrated in Figure 1), we have observed that vehicles are often filmed from a side (or a 45° horizontal angle) and a close distance, when stopped or at landing/takeoff. Conversely, they are often filmed from back or front, from a longer distance, during flights. As well, we noticed that the view angle is also dependent on the surrounding context which it may be important to convey in the story.

We also observed that the preferred view proposed in [HLH*16], primarily accounts for travel speed. Yet, this is not always appropriate, especially when at high altitude and low speed. Indeed, when landing on top of a tall building, we would mainly see the vehicle in the sky, with little clue on city areas surrounding the skyport. Further, their vehicles travel at an accelerated speed, while ours travel at actual speed. Hence their mathematical definition of a preferred view angle and distance are not re-usable as is in our context, though it can serve as a source of inspiration.

We propose to redesign their viewpoint formulas, to account for the following key narrative elements: travel speed, vehicle altitude, and how much the trip should be summarized.

We first propose that the camera's horizontal angle is at a maximum angle when the speed is close enough to 0, and at a minimum angle when travelling fast-enough. Consequently, we express the horizontal view angle as a function of the travel speed:

$$\theta(r_v) = (1 - \sqrt[r_v]{r_v}) \cdot \theta_{max} + \sqrt[r_v]{r_v} \cdot \theta_{min}$$

where r_v is the speed ratio computed as $\dot{v}_p(t)$ divided by maximum speed v_{max} . In our tests, our vehicles can travel up to 170 miles per hour, while we set θ_{min} and θ_{max} to 15° and 60° respectively.

We now propose to extend Huang's view angle formula, to also account for the travelling altitude. More precisely, when the vehicle is at a low altitude, low view angles are sufficient to provide location clues. Conversely, when travelling at high altitude, one need a higher angle to provide better location clues. In a first step, we then design a vertical view angle which only depends on the altitude:

$$\phi_a(r_a) = (1 - r_a) \cdot \phi_{min,a} + r_a \cdot \phi_{max,a}$$

where r_a is the ratio between the current altitude and the maximum altitude reached during the trip. In our tests, we have use $\phi_{min,a}$ and $\phi_{max,a}$ to 5° and 40° respectively.

In a second step we use a formula similar to [HLH*16] to compute a vertical view angle depending only on the travel speed:

$$\phi_v(r_v) = (1 - r_v) \cdot \phi_{min,v} + r_v \cdot \phi_{max,v}$$

In our tests, we have used $\phi_{min,v}$ and $\phi_{max,v}$ to 10° and 30° respectively.

In a last step, we propose to combine both to reflect how altitude and speed influence the range of vertical angles enabling to provide location clues, and anticipation:

$$\phi(r_v, r_a) = \left(1 - \frac{r_v}{r_v + r_a}\right) \cdot \phi_v(r_v) + \left(\frac{r_v}{r_v + r_a}\right) \cdot \phi_a(r_a)$$

The shape of our vertical view angle function, regarding both speed and altitude, is illustrated in figure 2.

Finally, our camera should enable to capture an anticipated travel length around the vehicle. We propose to account for the ratio of summarization $r_s \in [0, 1]$, corresponding to the duration of our video divided by the trip duration. Hence, the shorter the summary is, the more we would like to anticipate (*i.e.* obtain wide views on the surrounding scene). We express this as a factor α , computed as a function of the ratio r_s :

$$\alpha(r_s) = 0.4 + (1 - r_s)^4$$

Then, we calculate a proper distance between the camera and the followed vehicle which allows to convey such an anticipated travel length. To do so, we simply reuse Huang's formula, which was designed exactly for that purpose, while we leverage our anticipation factor. They state that the anticipated travel length should cover an angle μ from the camera position, which we express as

$$\delta(r_v, r_a, r_s) = \alpha(r_s) \cdot \|\dot{v}(t)\| \cdot \frac{\sin(\psi + \mu)}{\sin(\mu)}$$

where we have set μ to 20°. ψ is the angle between the view vector (from the vehicle to the camera) and the vehicle's backward vector, both in the vehicle's local frame. Hence, in theory,

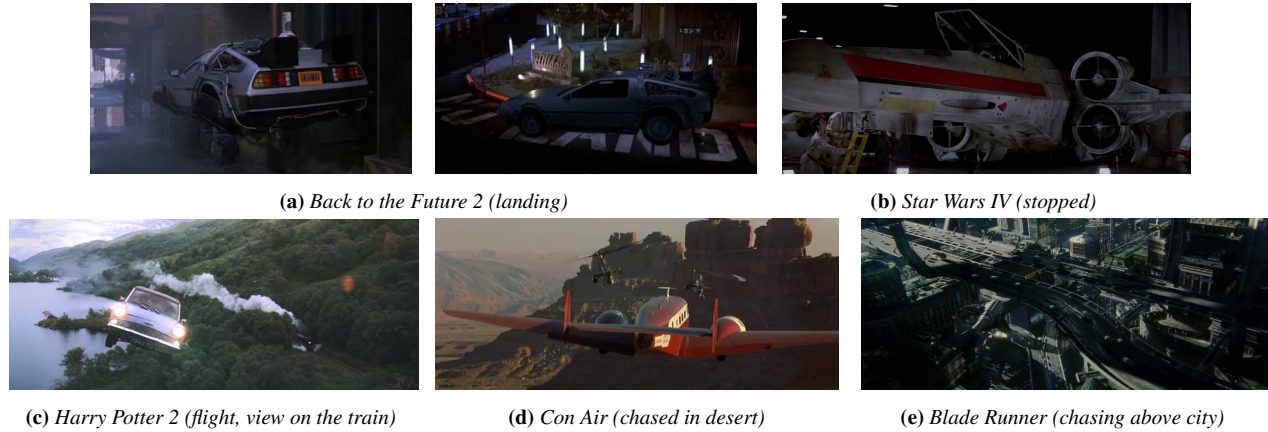


Figure 1: A short study of films shows that, when stopped or at takeoff/landing, flying vehicles are often pictured from a side or a 45° horizontal angle, and a short distance. During flight, they are more often pictured from their back or front, with a vertical angle and distance enabling to convey the context of the flight (e.g. where is the vehicle going? is another vehicle chasing, chased, or relevant to the story? is the vehicle above a city or landscape?)

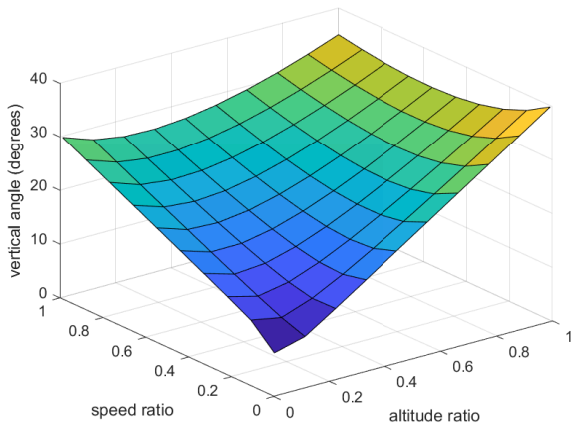


Figure 2: Vertical angle (in degrees) regarding altitude and speed.

$\psi = \arccos(\cos(\phi)\cos(\theta))$. This preferred viewpoint (i.e. camera position) can then be transformed from spherical coordinates to local then world coordinates.

References

- [HLH*16] HUANG H., LISCHINSKI D., HAO Z., GONG M., CHRISTIE M., COHEN-OR D.: Trip synopsis: 60km in 60sec. In *Computer Graphics Forum* (2016), vol. 35, Wiley Online Library, pp. 107–116. 1