Supporting information

Wetting characterisation on complex surfaces by an automatic open-source tool: DropenVideo

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Comparison of advancing and receding contact angle data: manual vs. DropenVideo analysis

To explore the errors caused by manually analyzing wetting evolution videos and determining the advancing and receding contact angles, we selected three example videos: V1, V5, and V9. As discussed in the 'Results' using Figures 4 and 5, and Table 1, while the analysis of V1 and V9 was not challenging, the analysis of V5 encounters challenges due to the superhydrophobicity of the sample. Indeed, DropenVideo was successful in measuring the advancing and receding contact angles in V5 by defining advancing, transition, and receding phases in $\theta - D$ space and the fitting criteria. Table 1 shows that DeroenVideo determined the advancing contact angle in V1, V5, and V9 as $106°$, $144°$, and $116°$, respectively. The receding contact angle in V1, V5, and V9 was also determined by DropenVideo as $80°$, $138°$, and $75°$, respectively.

Here, a fixed protocol was employed to manually analyze the videos, providing snapshots from the advancing and receding frames, and subsequently measuring the contact angles using the DropSnake plugin in ImageJ. This protocol is similar to what is employed in the commercial software, as discussed in 'Introduction'. During this study, a blind exercise was conducted by five users familiar with the concept of wetting. Their results were compared with the automatic analysis by DropenVideo. The deviations in the manually selected frames and measured contact angles from those obtained by DropenVideo are presented in Figure S1.

The protocol to manually analyze wetting evolution videos:

1. Find the frame where the drop contact diameter on the surface is at its maximum for the first time. Take a snapshot of that frame. Measure the left and right contact angles using the DropSnake plugin in ImageJ. Record the frame number and the left and right contact angles as the 'First-Advancing frame n.', 'First-Advancing CA-Left', and 'First-Advancing CA-Right', respectively.
2. Take a snapshot from 50 frames before the frame with the maximum contact diameter found in the previous step. Measure the left and right contact angles using the DropSnake plugin in ImageJ. Record the frame number and the left and right contact angles as the 'Second-Advancing frame n.', 'Second-Advancing CA-Left', and 'Second-Advancing CA-Right', respectively.
3. Find the frame where the contact diameter has shrunk by at least 5 pixels compared to the maximum diameter found in step 1. Measure the left and right contact angles using the DropSnake plugin in ImageJ. Record the frame number and the left and right contact angles as the 'Receding frame n.', 'Receding CA-Left', and 'Receding CA-Right', respectively.

Accordingly, 'First-Advancing frame n.' and 'Receding frame n.' are considered as frames related to the advancing and receding phases, respectively. The advancing contact angle is calculated by averaging 'First-Advancing CA-Left', 'First-Advancing CA-Right', 'Second-Advancing CA-Left', and 'Second-Advancing CA-Right'. The receding contact angle is calculated by averaging 'Receding CA-Left' and 'Receding CA-Right'.

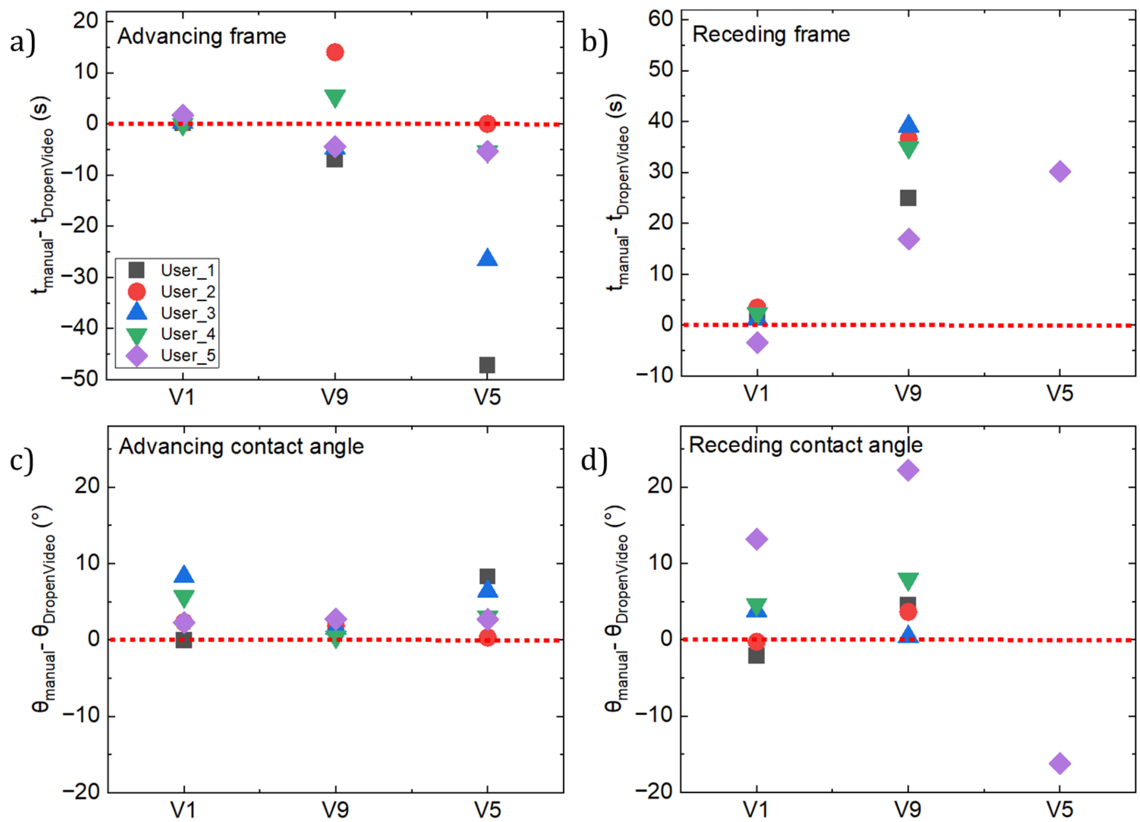

Figure S 1: The difference between the manual determination of advancing and receding contact angles and the automatic analysis by DropenVideo is shown. (a) and (b) depict the advancing (=maximum contact diameter) and receding moments. (c) and (d) illustrate the advancing and receding contact angles. Samples V1, V9, and V5 are presented on the x-axis in the order of increasing advancing angle. The length of the vertical axis in (a) and (b) is the same, as is the length of the vertical axis in (c) and (d).

According to Figure S1(a) and (b), human users could identify the advancing and receding frames in V1 with a minimum deviation from the automatic code, DropenVideo. Identifying these frames in V9 faced more challenges particularly in receding phase where all users overestimated the receding frame. In V5, the superhydrophobic case, finding both the advancing and the receding frames were difficult for the users as the contact diameter was not changing drastically during the video. As such, only one user could guess the receding frame in V5 with a large deviation from the receding frame identified by studying the $\theta - D$ curve, see Figure 5(d).

Figure S1(c) illustrates a none-systematic underestimation in the advancing contact angle calculated by circle fitting in DropenVideo comparing with the calculations done by DropSnake in ImageJ, which is studied in details in the previous paper on Dropen [1]. However, the deviation the calculated receding contact angle by manual determination shows a very larger difference from the automatic DropenVideo which confirms the influence of inaccurate and biased determination of the receding frame by human presented in Figure S1(b).

Reference:

[1] R. Akbari, C. Antonini, Contact angle measurements: From existing methods to an open-source tool, Adv. Colloid Interface Sci. 294 (2021) 102470. https://doi.org/10.1016/J.CIS.2021.102470.