

NATIONAL TRANSPORTATION SAFETY BOARD

Office of Research and Engineering
Washington, D.C. 20594

August 5, 2021

Video Study

**NTSB Case Number:
WPR21FA223**

A. ACCIDENT

Location: Porterville, California
Date: June 7, 2021
Time: 1420 Pacific daylight time
Aircraft: Van's RV-6A

B. AUTHOR

Dan T. Horak
NTSB

C. ACCIDENT SUMMARY

On June 7, 2021, about 1420 Pacific daylight time, a Van's RV-6A, N94PJ, was substantially damaged when it was involved in an accident at Porterville Municipal Airport (PTV), Porterville, California. The pilot sustained fatal injuries.

D. DETAILS OF INVESTIGATION

The goal of this investigation was estimating the ground track, ground speed and altitude of the airplane based on a video recorded by an airport camera. The video was four minutes long, had 1920x1080 resolution and frame rate of 30 fps. The airplane entered the field of view of the camera at video time 76 seconds and it is seen impacting ground at video time 96.7 seconds. The location of the camera and the ground impact location are shown in Figure 1 that displays an aerial view of the accident area. The yellow arrow indicates the direction of the airplane motion on or above the runway before ground impact.

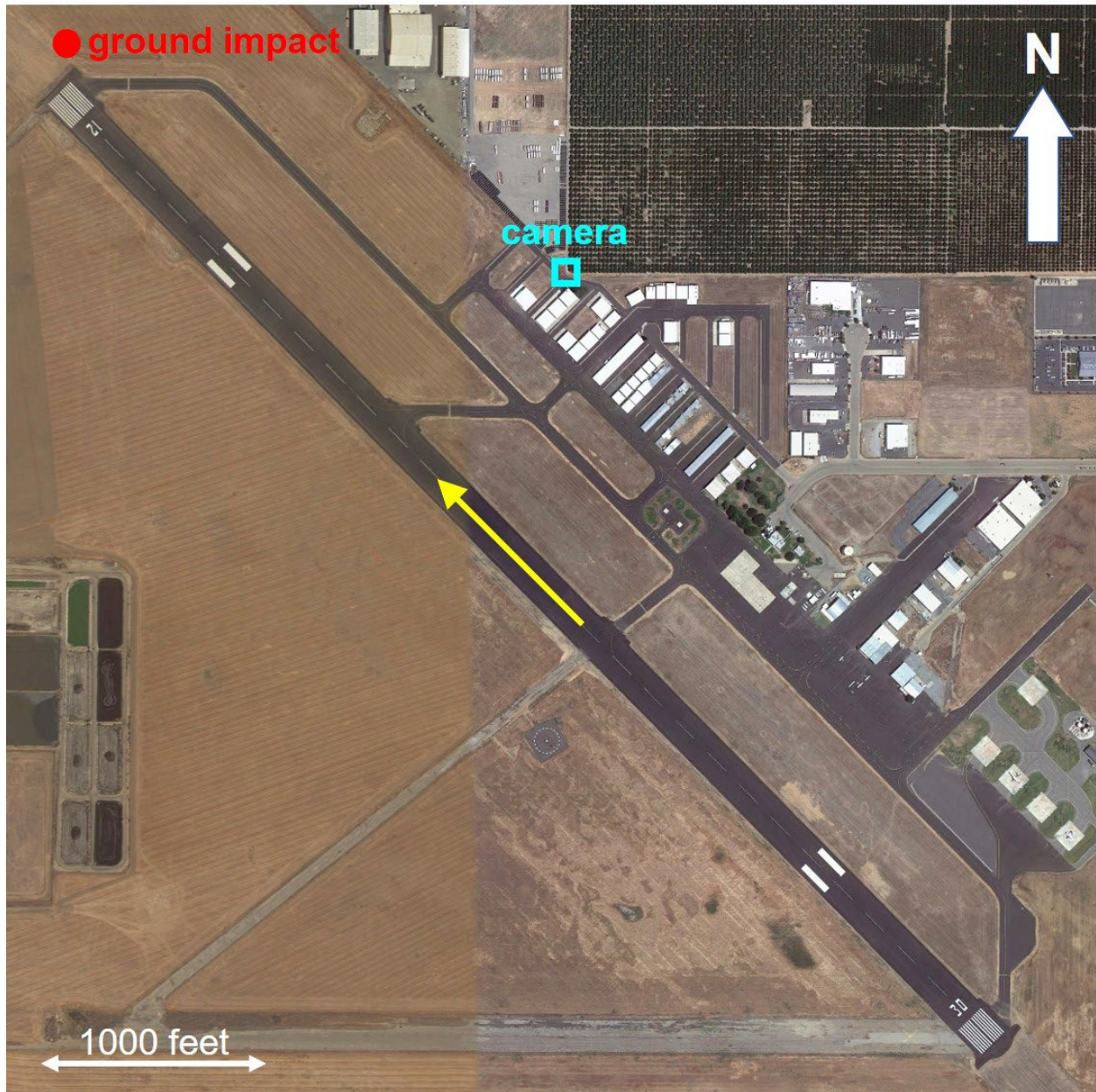


Figure 1. Aerial View of the Accident Area

Figure 2 shows a segment of a video frame recorded at video time 90 seconds. The distance from the camera to the airplane was about 1300 feet when the airplane entered the field of view of the camera, and it was about 2500 feet when the airplane impacted the ground. Consequently, the image of the airplane in the video frames was small. In most of the video frames, the visibility of the airplane detail was poor due to clouds.



Figure 2. Segment of a Video Frame Recorded at Time 90 seconds

Camera Calibration

The camera used a wide field-of-view angle lens that caused significant barrel distortion as seen in Figure 2. The distortion was corrected mathematically before calibrating the camera and analyzing the video.

The estimation of ground track, ground speed and altitude based on the video required a calibrated model of the optics of the camera that recorded the video. Such a model must be calibrated against references on the ground.

The mathematical model of camera optics requires seven parameters. Three are the X, Y and Z camera location coordinates. Three are the yaw, pitch and roll camera orientation angles, and the seventh parameter is the camera horizontal field of view angle (HFOV). The three location coordinates of the camera were known. The four angles had to be estimated as described next.

The estimation was based on references that were visible both in aerial images such as Figure 1 and in video frames such as the one in Figure 2. The references were the paved airport surfaces, airport surface markings, light poles, buildings, and the fence seen in the figures. A computer program that simulates camera optics was used to project the references onto a frame from the video in an iterative process in which the four unknown angles were varied so as to align the projected references with their images. When the projected references were aligned optimally with their images in the frame, values of the four angles were the optimal estimates of these parameters. At that point, the model of the camera optics was calibrated.

Estimation of Airplane Ground Track, Ground Speed and Altitude

The calibrated camera optics model was then used to estimate the locations of the airplane at times corresponding to fourteen video frames. A wireframe model of the Van's RV-6A airplane was constructed, consisting of points on its nose, tail and wingtips. An analysis program that used the calibrated camera model was then used to project the wireframe model onto a video frame. The wireframe model was moved and rotated until it matched optimally the image of the airplane in the video frame. When optimal match was reached, the location coordinates (X, Y and Z) of the wireframe model were the optimal estimates of the location of the accident airplane at the time when the analyzed video frame was recorded.

Figure 3 shows the estimated ground track of the airplane. The first analyzed point, pt. 1, is at a location where the airplane was shortly after entering the field of view of the camera. The last analyzed point, pt. 14, is at the ground impact location.

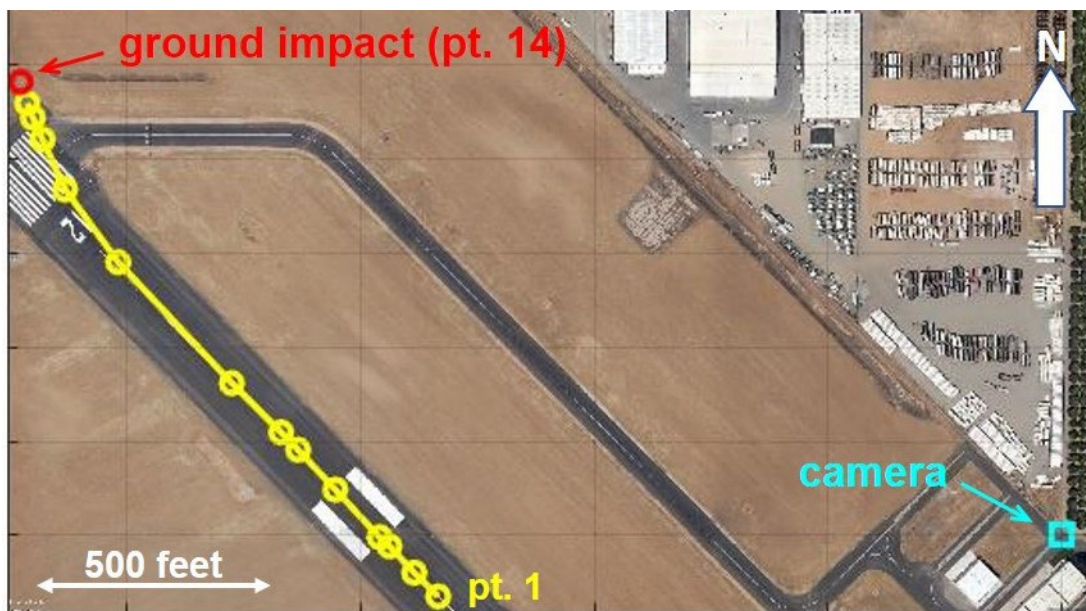


Figure 3. Estimated Ground Track of the Airplane

The times when the video frames were recorded were known because the video frame rate was known. Therefore, once the X and Y location coordinates were estimated, the ground speed could be estimated by dividing the traveled distances between adjacent video frames by the elapsed time. The estimated AGL altitude of the airplane was the airplane Z location coordinate estimated as described above.

Figure 4 shows that the estimated AGL altitude at pt. 1 was about 158 feet and the ground speed at that time was about 62 knots. This speed is above the stall speed of the Van's RV-6A and near the typical takeoff speed of the airplane. The climb rate estimated during the first two analyzed seconds was about 1500 feet/minute. The airplane continued climbing for about 8 seconds past pt. 1 but its ground speed was decreasing.

When the airplane reached its maximum AGL altitude of about 240 feet at about video time 85 seconds, its ground speed was down to about 14 knots, well below the stall speed. Past time 85 seconds, the speed was increasing because the altitude was decreasing. Past time 93 seconds, the descent speed was increasing rapidly, reaching about 3850 feet/minute at the time of ground impact. The ground speed past time 92 seconds was decreasing because the horizontal component of the airplane speed vector was small during the rapid descent toward the ground.

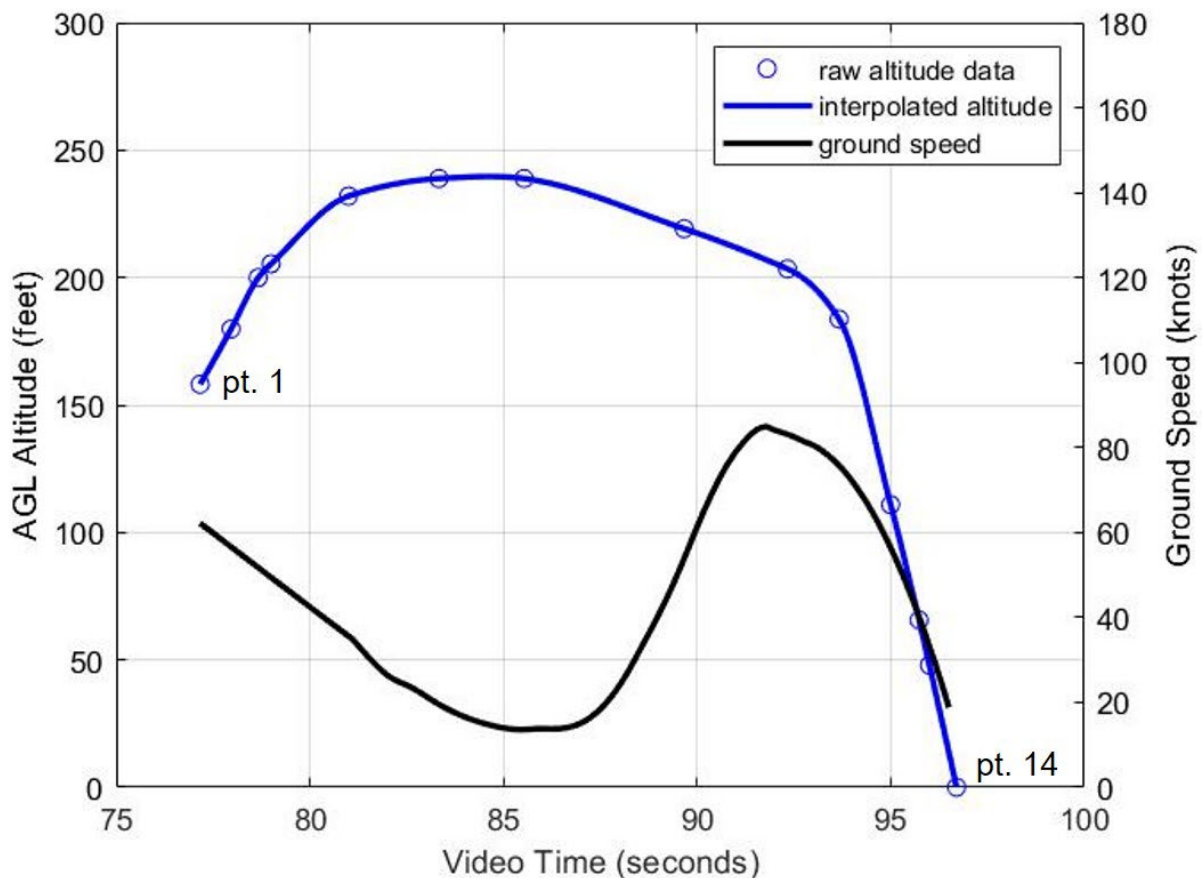


Figure 4. Estimated AGL Altitude and Ground Speed

E. CONCLUSIONS

The ground track, ground speed and altitude of an airplane that crashed shortly after takeoff were estimated based on a video recorded by an airport camera. The ground speed of the airplane went as low as 14 knots as it started a rapid descent toward ground impact at a short distance past the end of the runway.