

NATIONAL TRANSPORTATION SAFETY BOARD
Office of Research and Engineering
Washington, D.C. 20594

October 15, 2019

Video Study

NTSB Case Number:
WPR17FA155

A. ACCIDENT

Location: Mesa, Arizona
Date: July 17, 2017
Time: 1652 MST
Aircraft: Lancair Evolution

B. AUTHOR

Dan T. Horak
NTSB

C. ACCIDENT SUMMARY

On July 17, 2017, at 1652 mountain standard time, a single-engine experimental Lancair Evolution, N571JM, impacted a golf course and erupted into flames following a loss of control while on approach to Falcon Field, Mesa, Arizona. The private pilot and passenger were fatally injured and the airplane was substantially damaged. The airplane was owned and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91. The business flight departed from Phoenix Deer Valley Airport, Phoenix, Arizona about 1555 with a planned destination of John Wayne-Orange County Airport, Santa Ana, California. Visual meteorological conditions prevailed and an instrument flight rules (IFR) flight plan had been filed and activated.

D. DETAILS OF INVESTIGATION

The goal of this study was estimating the trajectory, altitude and speed of the accident airplane based on a video. A dashboard camera installed in a vehicle driven east on E McDowell Road in Mesa, near the Falcon Field airport, recorded the airplane during the last 25 seconds prior to ground impact. The camera was a Polaroid PD-E53H. The recorded video had 1920x1080 resolution and frame rate of 25 fps. Figure 1 shows a frame from the video recorded shortly after the airplane entered the field of view of the

camera. The vehicle was approaching the traffic lights at the North Higley Road intersection with E McDowell Road.



Figure 1. Frame from the Video

The distance from the camera to the airplane was over 2000 feet, resulting in a small size of the airplane image in the video frames. As the airplane moved from the right side of the frames to the left side of the frames, its image became even less visible than it is in Figure 1 because of clouds. The analysis of the video was based on a mathematical model of the camera optics, as described next.

Camera Calibration

The analysis of this accident required a calibrated mathematical model of the dashboard camera optics. 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 (HFOV). All seven camera parameters had to be estimated.

The estimation was based on references that were visible both in aerial images and in video frames. The references used for camera calibration were road markings, curbs, light poles, fence posts and traffic lights that can be seen in Figure 1. The camera had a wide field of view angle that resulted in barrel distortion of the video frames as can be seen in Figure 1. The distortion was mathematically corrected before camera calibration.

A computer program that simulates camera optics was then used to project the references onto frames from the video in an iterative process in which the seven camera parameters 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 seven parameters were their optimal estimates. At that point, the model of the camera optics was calibrated.

Since the vehicle was moving, the camera was changing its longitudinal location along the road, which was the X coordinate. The Y coordinate was the vehicle lateral location with respect to the road and calibration showed that it was constant. Consequently, the calibration resulted in six of the seven camera parameters constant and the seventh, the X coordinate, changing from frame to frame. The location of the airplane was estimated at five times, corresponding to five video frames. At two of these times, the X coordinate of the camera was identical because the vehicle was stopped due to traffic lights. Therefore, the X coordinate of the camera had to be estimated four times.

Airplane Trajectory and Speed Estimation

The location of the airplane was estimated in a process similar to the calibration process. A wireframe model of the Lancair Evolution, consisting of points at its nose, tail and wingtips was superimposed on frames from the video with the calibrated camera model. The model was then moved and rotated until it coincided with the airplane image in the frame. Once optimal match was reached, the location of the wireframe model was the optimal estimate of the location of the accident airplane at the time the analyzed video frame was recorded.

Figure 2 shows the five estimated ground track locations of the airplane superimposed on an aerial view image of the area. The location of the camera when ground track points No. 3 and No. 4 were estimated is marked in the figure. The camera vehicle was stopped due to traffic lights at these two times. The crash location marked in the figure was known from post-accident investigations.

The five estimated ground track locations shown in Figure 2 were used to estimate the ground speed of the airplane by dividing segment length by the time it took to fly over it. The time was known because the frame rate was known and constant. There were four segments and the estimated speed was assigned to the end of a segment. For example, the estimated speed between points 1 and 2 in Figure 2 was assigned to the time the airplane was over point 2. Figure 3 shows the estimated ground speeds. The last two estimated speeds were 83 ± 4 knots. Time in the figure was set to zero at the first analyzed video frame.

The airplane location estimation process also estimated the above ground altitude of the airplane. It is shown in Figure 4 relative to the elevation at the crash site. The elevation of E McDowell Road at the camera location shown in Figure 2 is about 10 feet lower than the elevation of the crash site. The altitude estimates in Figure 4 have $\pm 5\%$ uncertainty. The maximum altitude shown in the figure was 410 ± 20 feet.

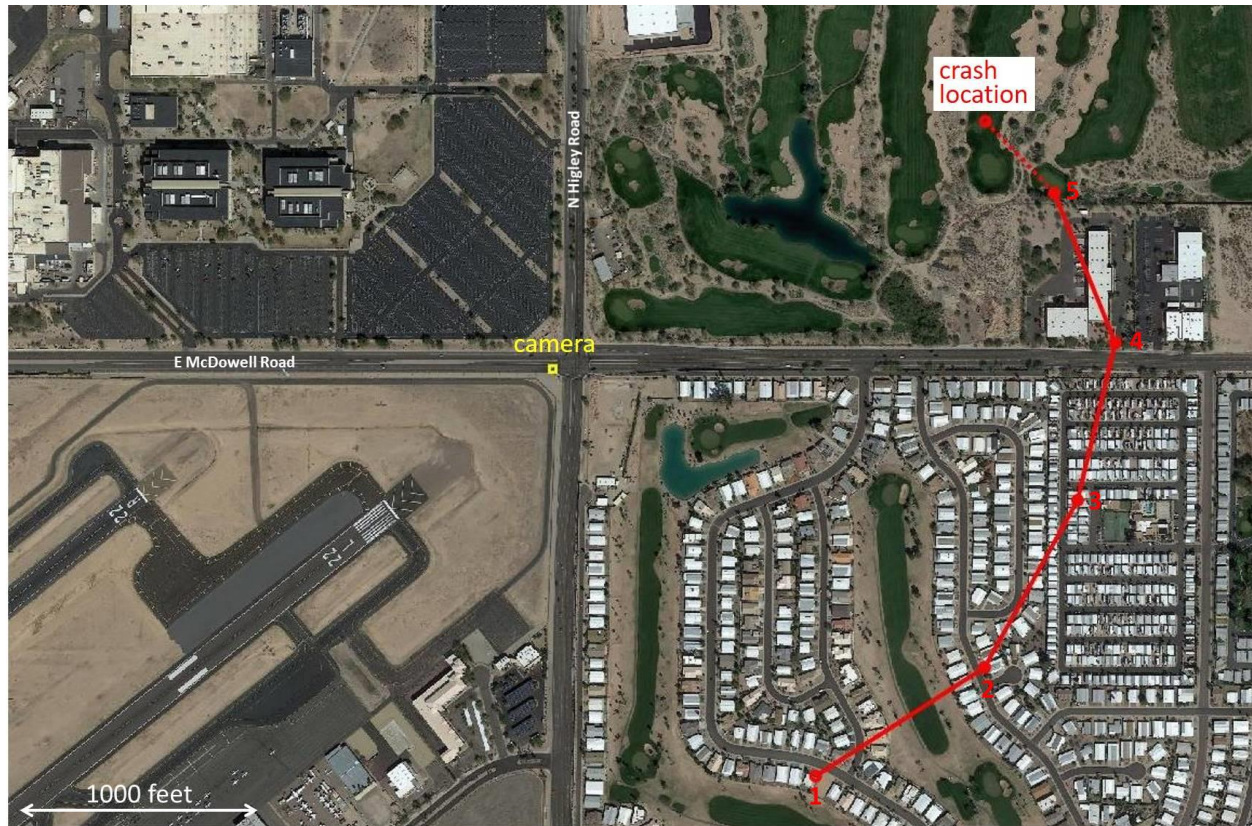


Figure 2. Estimated Ground Track of the Airplane

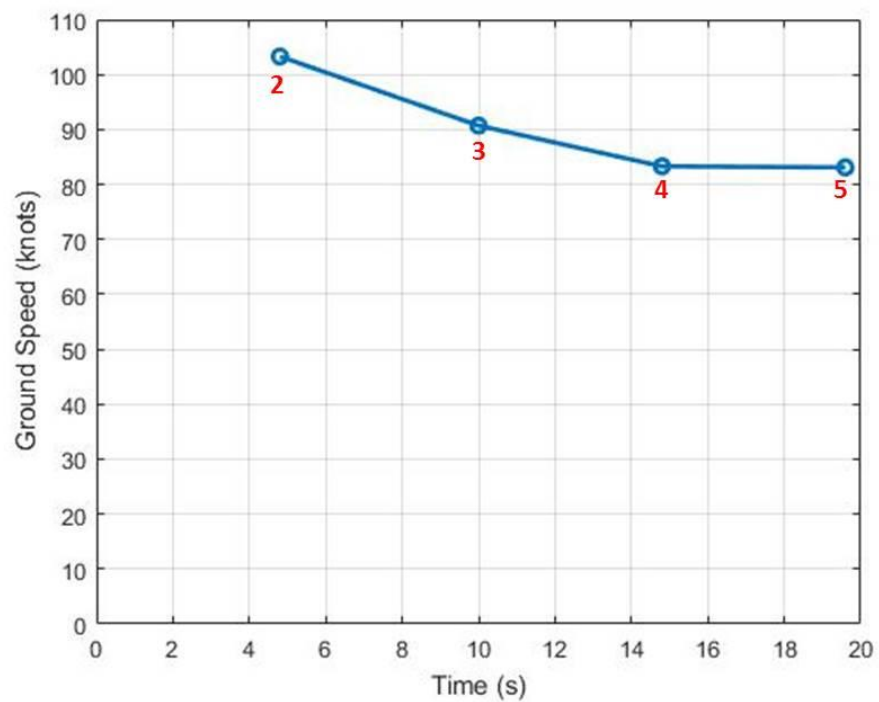


Figure 3. Estimated Ground Speed of the Airplane

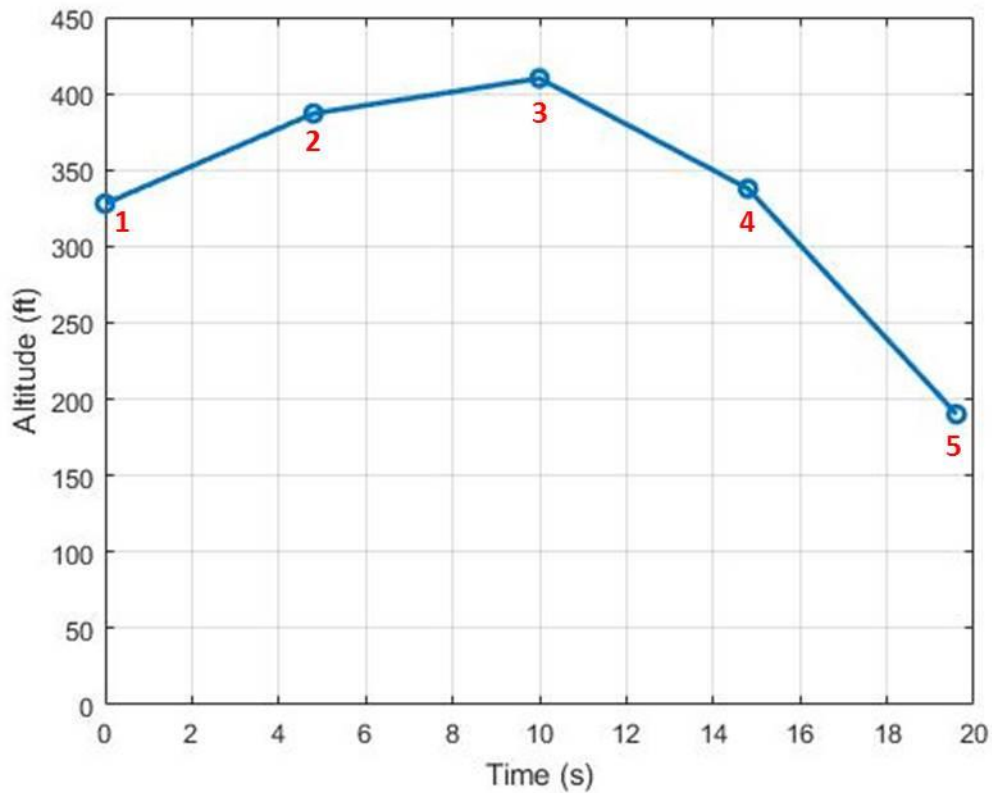


Figure 4. Estimated Altitude of the Airplane

E. CONCLUSIONS

Video recorded by a dashboard camera in a moving vehicle was used for estimating trajectory, speed and altitude of an airplane that crashed while attempting to land. It was estimated that the airplane ground speed was 83 ± 4 knots at the last two ground track locations where speed estimation was possible. The maximum estimated altitude above crash site during the analyzed time period was 410 ± 20 feet.