

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

April 12, 2018

Video Study

NTSB Case Number:
CEN17FA170

A. ACCIDENT

Location: Hollis, Oklahoma
Date: April 28, 2017
Time: 1300 CDT
Aircraft: Air Tractor AT-602

B. AUTHOR

Dan T. Horak
NTSB

C. ACCIDENT SUMMARY

On April 28, 2017, about 1300 central daylight time, an Air Tractor AT-602 airplane, N604RH, impacted terrain while on final approach for runway 35 (3,008 ft by 60ft, asphalt) at the Hollis Municipal Airport (O35), Hollis, Oklahoma. The pilot was fatally injured. The airplane was substantially damaged. The airplane was registered to the pilot and operated by Gray Ag Air as a Title 14 Code of Federal Regulations Part 137 aerial application flight. Visual meteorological conditions prevailed at the time of the accident. The flight was not operated on a flight plan. The local flight originated from O35 about 1200.

D. DETAILS OF INVESTIGATION

The purpose of this study was estimating the ground speed of the airplane as it was approaching the runway. The estimate was based on video from a camera suspended on a tree that was located about 10,000 feet from the point of ground impact. The video had resolution of 1280x720 and frame rate of 15 frames per second.

Figure 1 is an aerial view that shows the location of the camera and the location of the runway. Also shown in Figure 1 are a road and a street. Figure 2 is a frame from the

video. The original video frame had significant barrel distortion because of the wide-angle lens of the camera. Figure 2 shows the frame after the barrel distortion was mathematically corrected. The black areas near the edges of the frame correspond to areas that were outside of the original distorted image. The road marked in Figure 2 is the same road that is marked in Figure 1. Arrows A, B, C and D point to walls of buildings located along the street marked in Figure 1.



Figure 1. Aerial Image of the Accident Area

The analysis of the video was based on a mathematical model of the camera optics. Parameters of a camera optics model are the 3D location and 3D orientation of the camera and the horizontal field of view (HFOV) angle of the camera lens. The location of the camera was known. As can be appreciated in Figure 2, the camera, which was suspended on a tree, had significant roll and pitch angles with respect to the ground. The road seen in the frame in Figure 2 was the main reference for estimating the roll and pitch angles of the camera with respect to the ground. Reference points A, B, C and D were used for estimating the yaw of the camera and its HFOV. Once all camera parameters were estimated, the camera model could accurately map points seen in Figure 1 onto their images seen in the video frame in Figure 2.

Figure 1 shows in red the assumed ground track of the airplane as it was approaching runway 35. Six reference points, spaced by 100 meters, are marked on the

ground track. The airplane impacted ground north of reference point No. 6 and before reaching the runway.



Figure 2. Video Frame (after barrel distortion corrected)



Figure 3. Video Frame Showing Reference Lines and the Airplane

Figure 3 shows the frame from Figure 2 onto which six reference lines were mapped by the camera model. These lines are located at the six reference points seen in Figure 1 and they extend from 30 meters to 90 meters above ground. Also shown in Figure 3 is the location of the airplane when it was between reference lines No. 3 and 4. Because of the 10,000 feet distance from the camera, the airplane is barely visible. However, by stepping through the video frame-by-frame, the location of the airplane with respect to the reference lines can be measured.

Airplane ground speed was estimated by first identifying the video frames in which the airplane was at a reference line. Since the frame rate of the video was constant and known to be 15 fps, the times when the airplane was at the reference lines were also known. Figure 4 shows a plot of the horizontal distances flown vs. time. The distance and the time were set to zero at reference line No. 1.

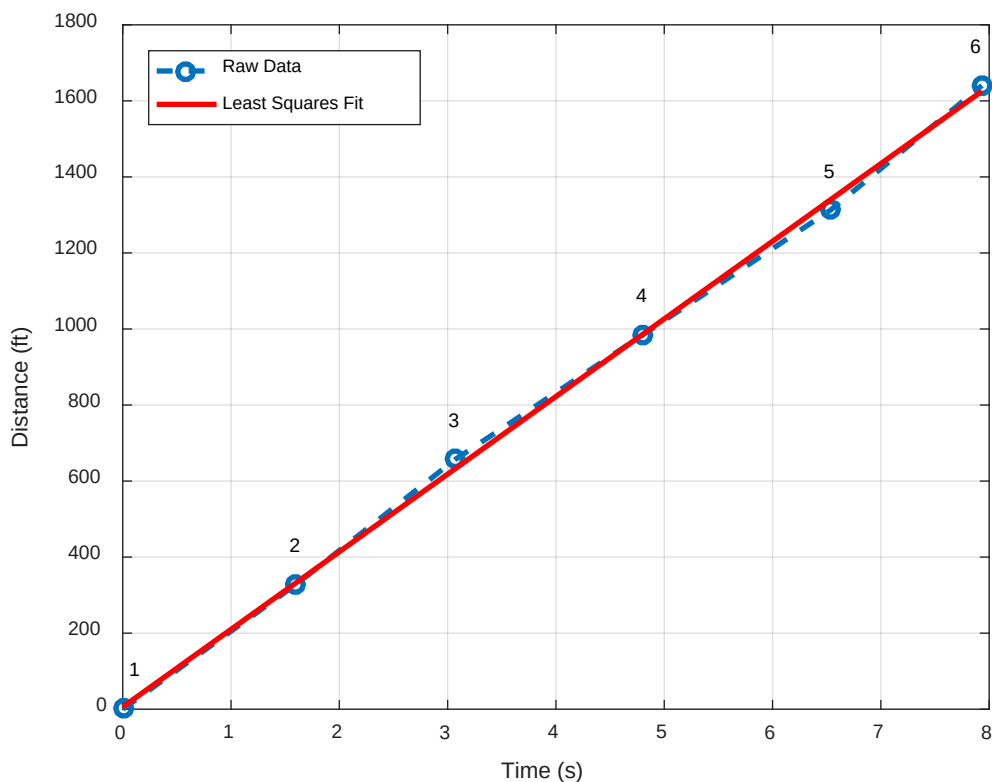


Figure 4. Flown Horizontal Distance vs. Time

Superimposed on the raw data plot in Figure 4 is a constant speed least-squares fit to the data. Its slope indicates a ground speed of 121 knots. Because of the extrapolation the camera model has to handle, with the calibration references being 3000 feet or closer to the camera and the runway about 10,000 feet away, a $\pm 15\%$ tolerance is assigned to the estimated speed. Therefore, the speed estimate is 121 ± 18 knots.

It was estimated that when the airplane was at reference line No. 1, its altitude was approximately 140 feet above the runway. When it was at reference line No. 6, its altitude

was approximately 92 feet above the runway. The average vertical speed during these 8 seconds was $(140-92)/8=6$ ft/s or 3.6 knots. This speed is negligible relative to the estimated horizontal ground speed of 121 knots.

Once the airplane was past reference line No. 6, its altitude decreased rapidly at the rate of about 80 ft/s. One second after crossing reference line No. 6, the airplane was behind the trees seen in Figure 3 and no longer visible. About 3.5 seconds after the airplane disappeared from view, smoke resulting from a post-crash fire became visible in the video.

E. CONCLUSIONS

Ground speed of an airplane that impacted terrain on final approach to a runway was estimated as 121 ± 18 knots based on a video. This speed was constant for 8 seconds starting when the airplane first became visible in the video. Between time 8 seconds and 9 seconds after the airplane first became visible, the airplane altitude decreased rapidly. At time 11.5 seconds, smoke resulting from a post-crash fire is visible in the video.