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Video Analysis of Crane Accidents

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Abstract

The goals of this project are to better understand crane tip-over accidents and to advance research to improve crane safety. Crane accidents occur at a large scale with varied conditions, so analyzing real accidents is important to reveal accident causes and key behaviors during accidents. Many videos of crane tip-over accidents have been published online, and by using video analysis tools, the behavior of these tip-overs can be quantified. Results from the video analysis have also been used to develop and validate a dynamic model of crane tip-over events that can be used to further explore tip-over behavior.

Video analysis of crane tip-over accidents is often made difficult by the relatively lower quality videos of accidents available on the Internet. Most videos appear to be shot with a handheld mobile phone; this is due to crane tip-over accidents happening without warning, and when videos of accidents are captured it is often by bystanders filming by happenstance. Common issues include low resolution, shaky video, poor contrast, and moving camera position. All these factors make it difficult to track objects in the video and extract meaningful data.

A video analysis process has been developed using Adobe After Effects and MATLAB to track and analyze objects in such accident videos. This process is used to extract and analyze the crane boom angle and angular speed over time during tip-over accidents. The sophisticated object tracking tools available in Adobe After Effects, which can dynamically adjust for changing brightness and contrast, are used to track specific points on the crane boom and to establish a fixed horizon line. Then, the MATLAB image processing toolbox is used to track these points, fit lines through the boom and horizon points, and calculate the relative angle between these two lines for each video frame to obtain the tip-over angle vs. time.

Results from applying this process to one tip-over accident video (https://www.youtube.com/watch?v=x25G4_ShtUY) are presented as an example of the process and resulting data that may be extracted. Figure 1 shows a plot of the boom angle over time extracted from this example video, with a specific moment (frame 435) labeled. Figure 2 shows frame 435 from the video, with the boom angle and horizon lines shown. At frame 435 of the video, the payload crashes into the ground, which slows the tip-over, but the crane still has enough momentum to continue tipping. This is also seen in the concave shape of the boom angle plot in Figure 1, with the payload crashing in this example having a significant effect on the tip-over behavior. In this video, the crane also begins to tip sideways away from the camera around 14.5 seconds (frame 435). This likely also contributes to the tip-over slowing; the crane is still tipping, but out of the video's visible plane.

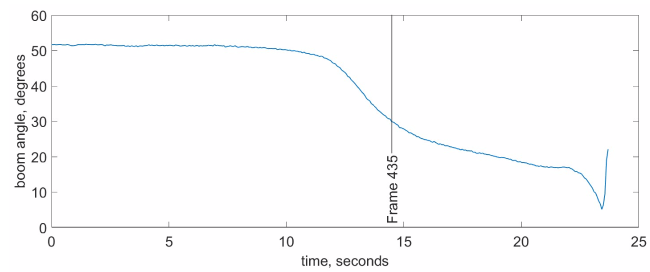

Fig. 1. Boom angle vs. time extracted from an example video.

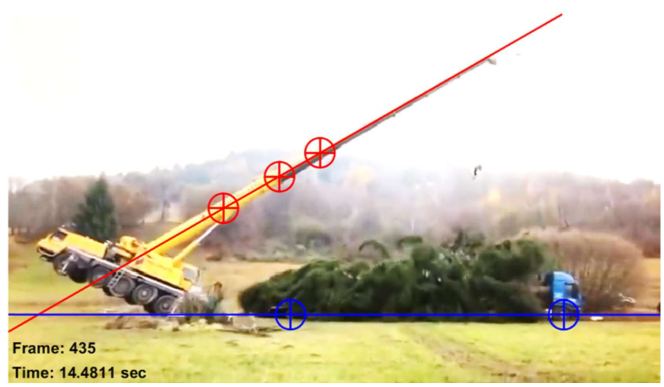

Fig. 2. Frame 435 from sample video, with horizon (blue) and boom (red) best-fit lines shown (Video source: https://www.youtube.com/watch?v=x25G4_ShtUY)

This video analysis process has been applied to several videos of mobile crane tip-over accidents to extract the angle and angular speed of the boom during the tip-over, identify the effects of key events that occur during these accidents (such as the payload hitting the ground), and to obtain an estimate of the total tip-over time of each accident. This method has also been applied to videos of other kinds of crane accidents, including tower crane collapses where it has been used extract the falling tower angle as a function of time as well as the distances that sections of the crane travel over the course of the collapse.

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