

Wade Wilkison: Mechanical & Industrial Engineering

Mentor: Ronald June -- Mechanical & Industrial Engineering

Characterization of Initial Flight Path by Optical Applications and Sensor Technology

Initial rocket flight movements, although small, are crucial and can significantly impact the overall flight path and chances for success. In small rockets, powered by various model engines, there is large variability in construction and performance that can have disastrous effects without caution and adherence to recommended standards. These flight movements and associated safety issues were studied previously resulting in the current model rocket regulations defined by the National Association of Rocketry (NAR). The focus of this research project was to determine whether current standards are adequate for safely maintaining and monitoring amateur rocket projects. Four test status categories were established to examine launch and safety conditions for n=16 rocket launches. First, all initial preparation was categorized as "setup stage follows regulation." Secondly, the launch environment itself was analyzed in terms of personnel safety. All 16 launches followed these basic regulations and therefore met organizational or specific personnel regulations. The third safety category was the flight path, which ranked each path based on the angles of deviation from vertical. "Safe flight" was defined as 0 to 10 degrees, and "moderate concern" was defined as 10 to 30 degrees. Optical images were gathered using a Canon 60D and angles were determined using image analysis with Image J software. All flight paths of the first 8 launches were categorized as "safe flight" with mean difference of 2.856 ± 1.322 . In the second flight series only 2 flight paths fell outside the "safe flight" range at values of 10.48 and 10.79 degrees. This series averaged 7.37 ± 3.09 degrees. Finally, the fourth testing category included the deployment of a parachute or drag inducer and landing implications. Two launches did not fully deploy a drag inducer but all 16 launches resulted in safe and undamaged landings. In conclusion, the NAR regulations appear sufficient: there were no injuries or damage during this study and almost all launches ($14/16 = 87.5\%$) were defined as "safe flight." These data emphasize the benefits of defining and using well-established protocols for rocketry safety. Proper adherence to NAR regulations can result in research, education, and enjoyment.