



**CALIFORNIA STATE SCIENCE FAIR  
2015 PROJECT SUMMARY**

<b>Name(s)</b> <b>Andrew T. Land</b>	<b>Project Number</b> <b>J0316</b>
<b>Project Title</b> <b>Newton and Arduino Loop the Loop: Development of an Inertial Navigation System for Model Aircraft</b>	
<b>Abstract</b> <b>Objectives/Goals</b> Develop novel hardware and software for a compact, low cost inertial navigation system (INS) for use in model aircraft. Data recorded in-flight by the INS should allow an accurate reconstruction of the model's flight path. Instead of 'rule of thumb', INS data will allow quantitative evaluation of model aerodynamics. <b>Methods/Materials</b> INS hardware was constructed from an Arduino microcontroller, on-chip gyroscope and accelerometer sensors, and a micro-SD memory card. An Arduino C-sketch was written to acquire data during flight (90Hz). A control-line model aircraft, the Lil' iHacker, was custom built for flight duties. Video recordings were made of flights to compare with calculated results. Raw data were processed with a novel C application. Results were exported for 3D-plotting with a custom Gnuplot script. <b>Results</b> Accelerometer data showed high levels of various forms of noise. High frequency vibration noise (230Hz) from the model's electric motor was removed using a data smoothing algorithm. Airframe 'flutter' noise at ~6Hz remains a challenge. Data from the gyroscope's "yaw" axis correlated very well with the model's main circular rotation. Gyroscope "pitch" data showed significant baseline drift, probably caused by the high-g flight conditions. Linear fits to sections of the data allowed recreations of the flight path to be calculated, comparing well with video. <b>Conclusions/Discussion</b> A compact, lightweight, low cost INS has been developed and evaluated. Software applications to acquire, process and plot the data have been written. Plots and animations of actual model flight paths have been generated. A novel technique for utilizing gyroscope data for recording circular control line flight paths has been developed.	
<b>Summary Statement</b> A compact inertial navigation system suitable for use in model aircraft has been developed, allowing reconstruction and display of actual flight paths.	
<b>Help Received</b> My Grandpa taught me about data smoothing. My Dad helped with the computer graphics.	