NASA UAV Deflection And Strain Monitoring

Flight Validation

NASA began using fiber optic shape and strain sensing systems for flight validation in 2008. By applying fiber with over 3,000 fiber Bragg gratings (FBGs) to the wings of the Ikhana unmanned aerial vehicle (UAV), NASA Armstrong was able to monitor stress and observe the deflection of the wings in real-time throughout each mission. This served as the first step to achieving control of the shape of subsonic fixed wing aircrafts. The capability demonstrated by the sensing system also provided a practical approach to accomplish structural health and loads monitoring. The fiber optic sensing system was environmentally qualified and integrated in the avionics bay of the Ikhana vehicle. In addition to the 3,000 FBG sensors, 16 strain gages were used to validate the FBG strain measurements. Eight thermocouples were bonded to the upper wings of the vehicle and used for strain gage thermal compensation. The sensor layout is depicted in Figure 1 below.

Ground Validation Testing

Prior to flight-testing, ground validation testing was conducted using a high resolution, high speed optical measurement system. The optical system utilized bar

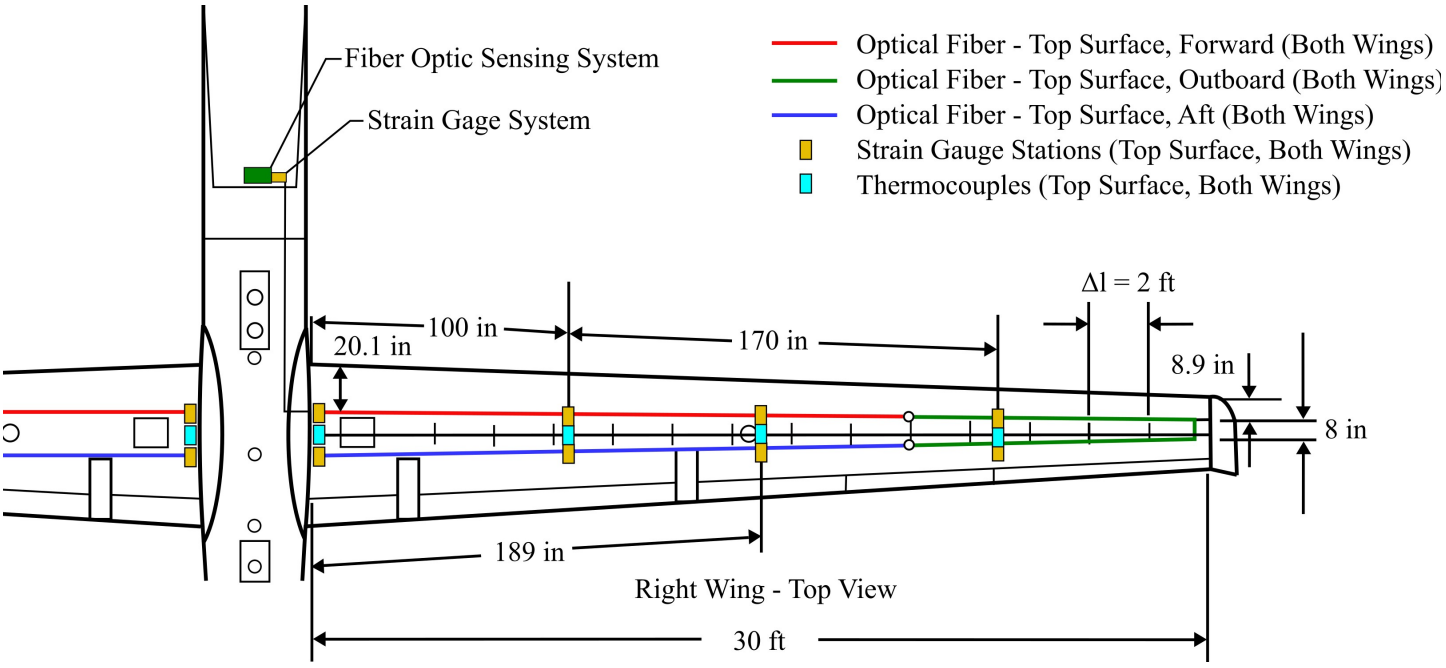

Figure 1: Ikhana sensor layout.

-coded targets placed on the left wing and center fuselage at 10 measurement locations (Figure 2). The maximum loads applied to the wings were

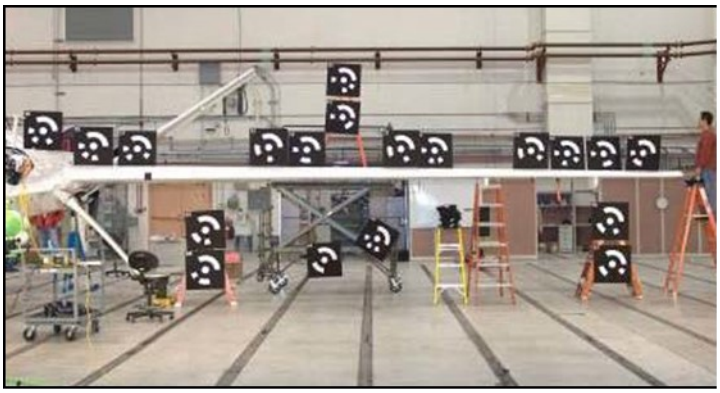

Figure 2: Barcoded targets used for the optical system measurements.

limited to 200 lb. This produced displacements at the wing tips of approximately 3 inches. Despite the small displacements, agreement between the fiber optic sensing system and the optical system at the wing tip was 2.8%.

Flight Testing

In a four month period, NASA Armstrong conducted 18 flight tests for a total of 36 flight hours using the Ikhana. Figure 3 shows the superimposed real time flight data. During the test, the pilot pushed down on the stick quickly, then swiftly pulled up for several cycles. The yellow data are the fiber optic sensing strain measurements, shown in micro strain, from wing tip to wing tip with measurements every 10mm. The strain values located under the fuselage are not measured values, but are FBG sensors on the optical fiber spooled in the fuselage on unsupported regions. The red data are wing displacement measurements from wing tip to wing tip.

For more information regarding strain and deflection monitoring in flight, contact Sensuron at +1-512-827-2040 or sales@sensuron.com.

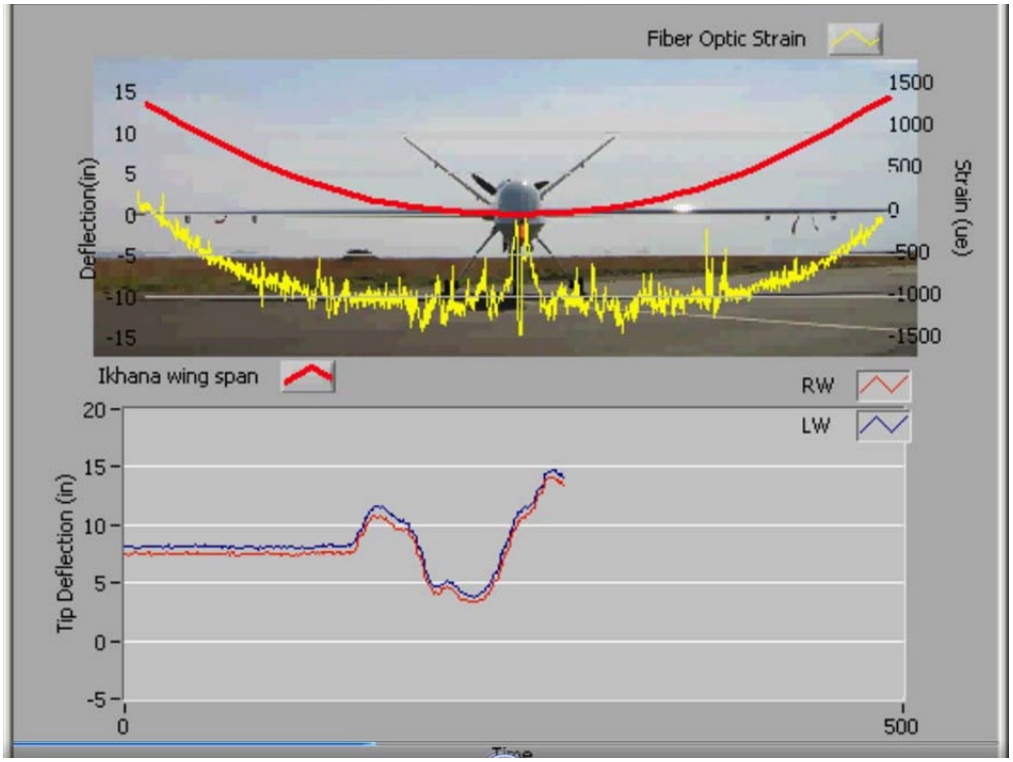

Figure 3: Real time strain and deflection data obtained by the fiber optic sensing system from one of the Ikhana flight tests.