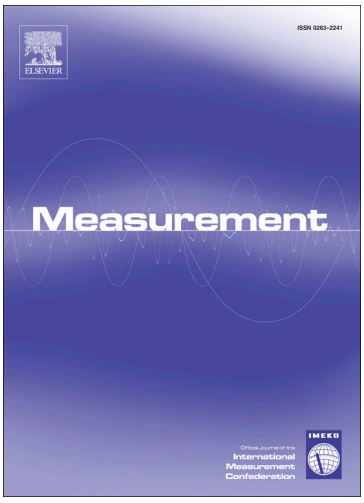


# Wireless Differential Pressure Measurement for Aircraft

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# Wireless Differential Pressure Measurement for Aircraft

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**Abstract**

Pressure distribution measurement over the surface of an aircraft can contribute to drag reduction on the flight, increasing aerodynamic efficiency and decreasing fuel consumption. Current methods for pressure distribution measurement include the use of Pressure Sensitive Paints (PSPs), which can only be used during the design phase, and Fiber Bragg Grating (FBG), which is not easy to install on existing aircraft. Drag reduction can be achieved by active flow control by using pressure taps for pressure distribution measurement as shown in the literature. In this paper, we present investigations on the realization of a wireless pressure sensor that can be attached to the outer skin of aircraft, thus offering minimal installation effort. In order to analyze the feasibility with respect to sensing capabilities and wireless communication, experiments were carried out on an HQ17 wing profile segment. Pressure measurements were performed at different positions on the wing to analyze its behavior in the presence of different flows and compared to a reference pressure sensor in order to estimate airspeed.

*Keywords:*
Drag reduction, pressure measurement, wireless sensors

## 1. Introduction

Pressure measurement has many applications in aviation, including speed and altitude determination as well as drag reduction. Wireless sensor networks can be used on several systems and for aircraft they would bring advantages such as weight reduction, ease of maintenance and also better monitoring capability [1].

With a wireless and portable system, pressure measurements could be performed over the surface of an aircraft in order to obtain pressure distribution, as illustrated in Figure 1, which could be used to perform drag reduction, something that would save billions of dollars annually in the aviation industry [2].

To retrieve the pressure distribution, many sensors need to be placed on the surface. However, the number of pressure transducers necessary to obtain an accurate pressure distribution measurement is low [3], therefore such a system could be achieved at low cost. In addition to that, it was shown that when sensor fault occurs, data can be reconstructed using neural networks [4], which would make the system more reliable.

The same pressure sensors employed for pressure distribution measurement and drag reduction could also be used for airspeed determination at different points on an aircraft. When only one pressure sensor data is collected, then altitude variations affect the pressure value together with the velocity. However, when differential pressure measurement is used, these altitude variations can be compensated and the pressure variations related to the speed can be retrieved, similar to a Pitot tube.

The main requirements for this application are: the device needs to have a small thickness so that it does not affect aerodynamics, be robust to different environmental conditions, be wireless and it needs to have low power consumption.

Figure 1: Proposed measurement system, which consists of many pressure sensors distributed on points of interest on the surface of an aircraft [5].

In this paper, we present a wireless sensor concept for pressure measurement. We describe the concept and experimental results obtained with an experimental airplane wing. A profile HQ17 [6] wing model was fixed on top of a car in order to test the system in real atmospheric conditions as the car drives at different speeds on a road with altitude variations.

The data from the sensors is transmitted to a base station using wireless communication and the pressure difference between the sensor located on the wing and the reference sensor can be used to estimate speed.

## 2. Background

Pressure measurement has been used in aviation for many years, also finding many applications in Unmanned Aerial Ve-