Piezoelectric Sensors for Taxiway Airport Traffic Control System

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Abstract

A preliminary version using piezoresistive thin film sensors has been presented and published (*2011 IEEE Forum on Integrated and Sustainable Transportation System* **)**

These sensors enable the detection of moving objects as well as their automatic classification according to their tire arrangements, speed, and direction of movement.

Preliminary experimental results using thin film piezoelectric sensors confirm the predicted operation characteristics and show the applicability of piezoelectric sensors for monitoring airport surface movement.

Objective

- To develop direct warning systems to alert air traffic controllers for situations leading to runway incursions.

- (Each year, approximately one thousand runway incursions occur at American airports.)

- To develop innovative (sustainable) techniques to record, analyze, and display annotated spatial data for situational awareness of ground operations.
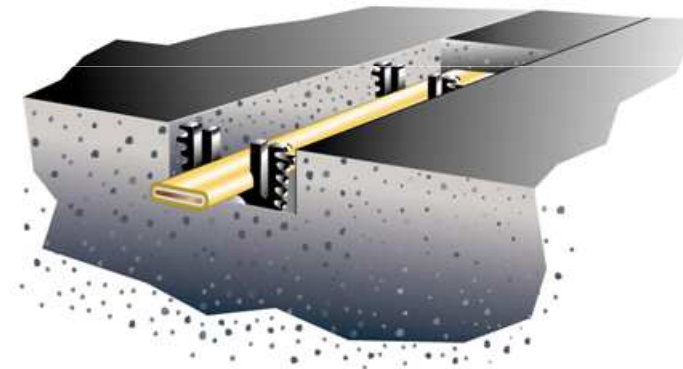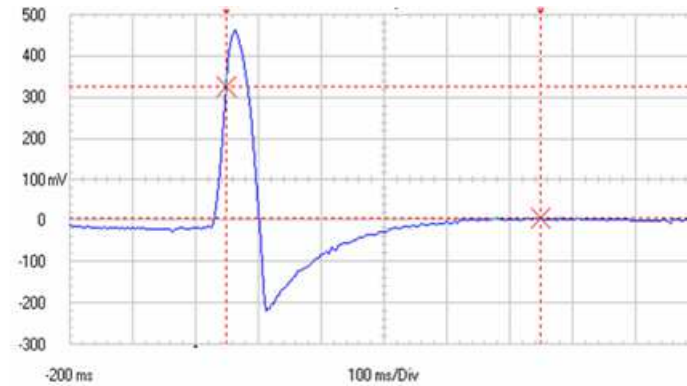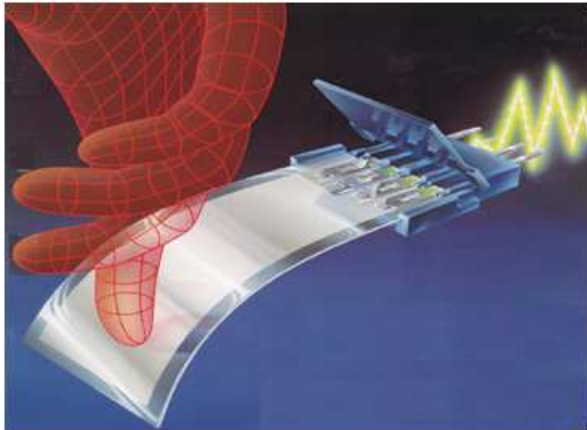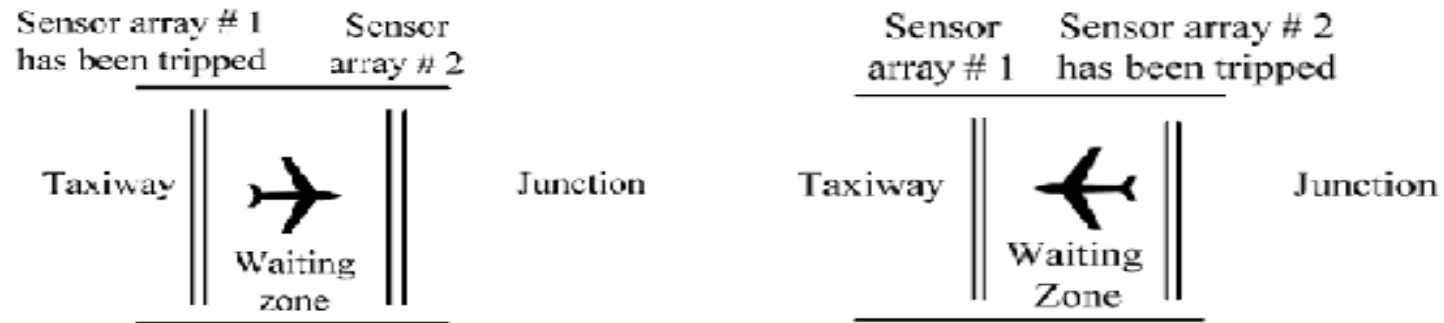
BL Piezo-electric Sensor for Weight-in-Motion.
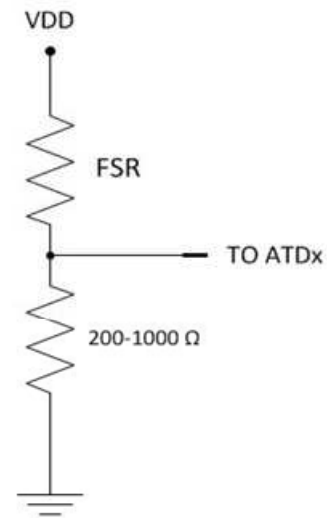
**Force Sensitive Resistor (FSR) and Sensor Circuit.**

METHODOLOGY

- **Place a sensor array in the runway that will detect an airplanes velocity, model, and direction when crossing a junction .**

- **The sensor's output signal will be processed by a microcontroller. When the output of the sensor is logically high, the microcontroller will send a signal to a host PC indicating which sensor has been triggered. The process is shown on next slide.**

- **The signal will be interpreted by the computer and displayed as a real-time virtual simulation of a plane at a runway intersection.**
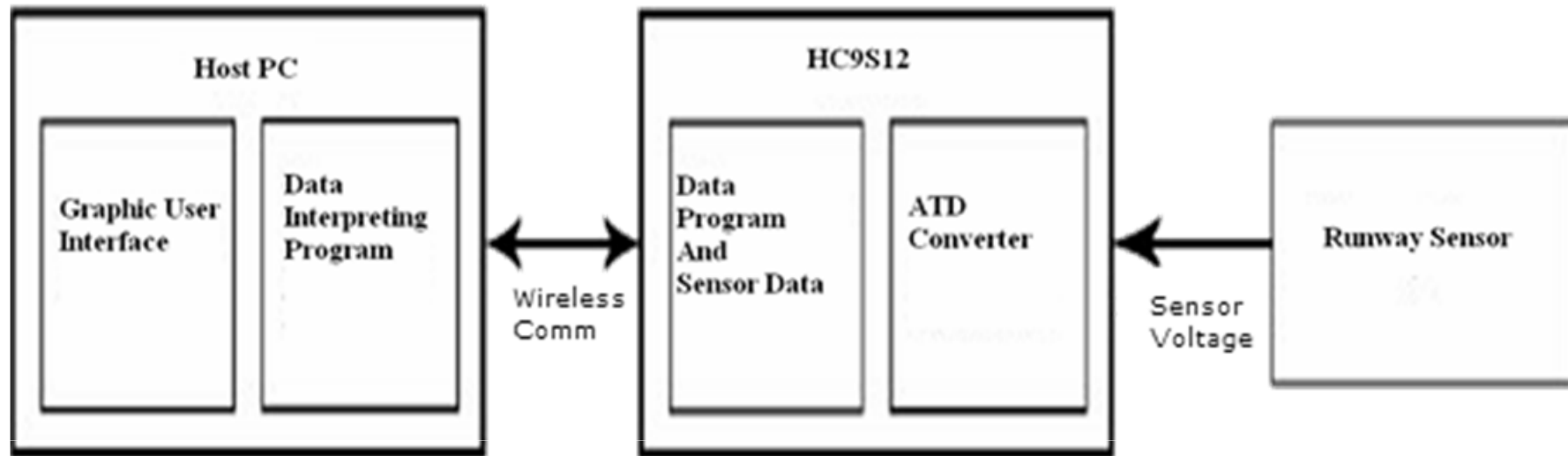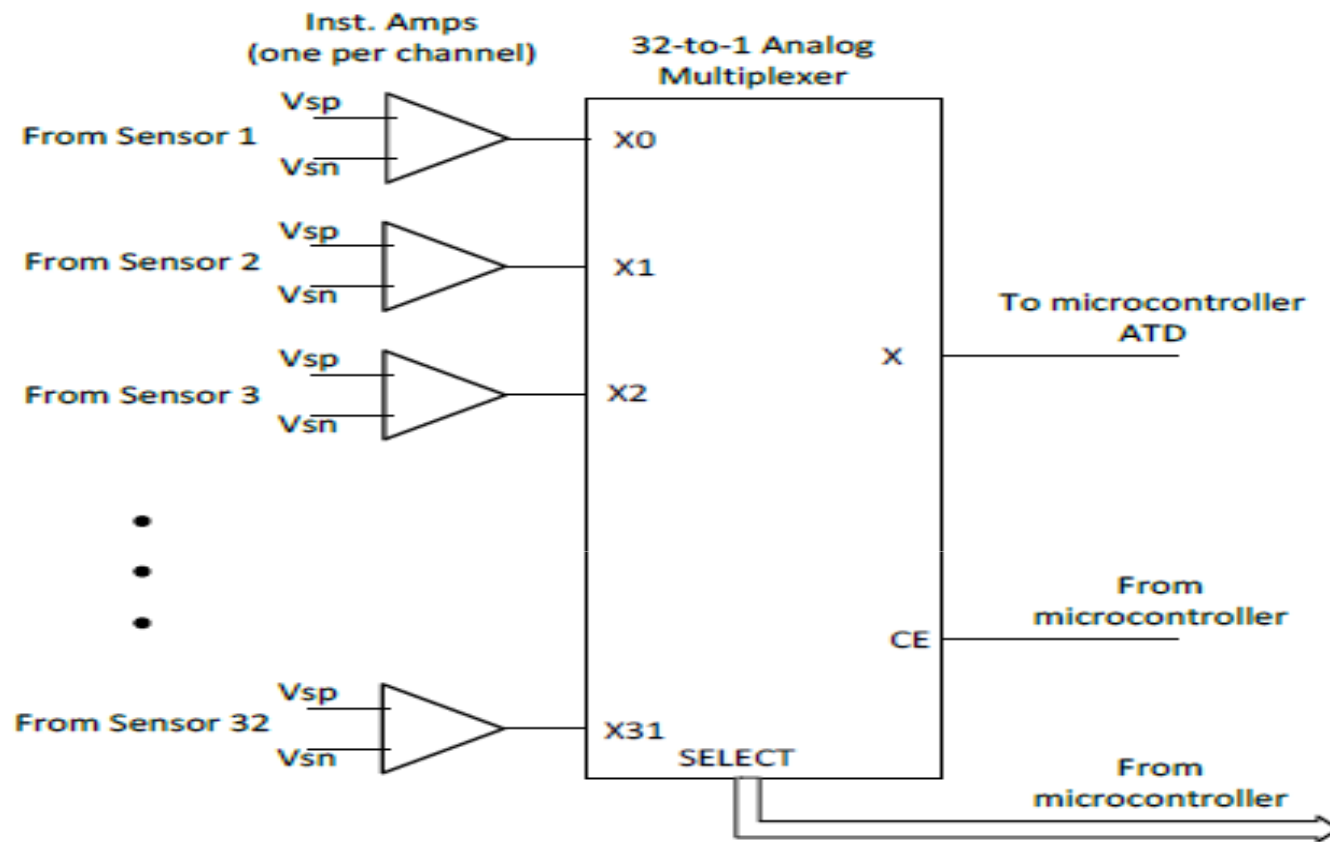
Hardware Block Diagram
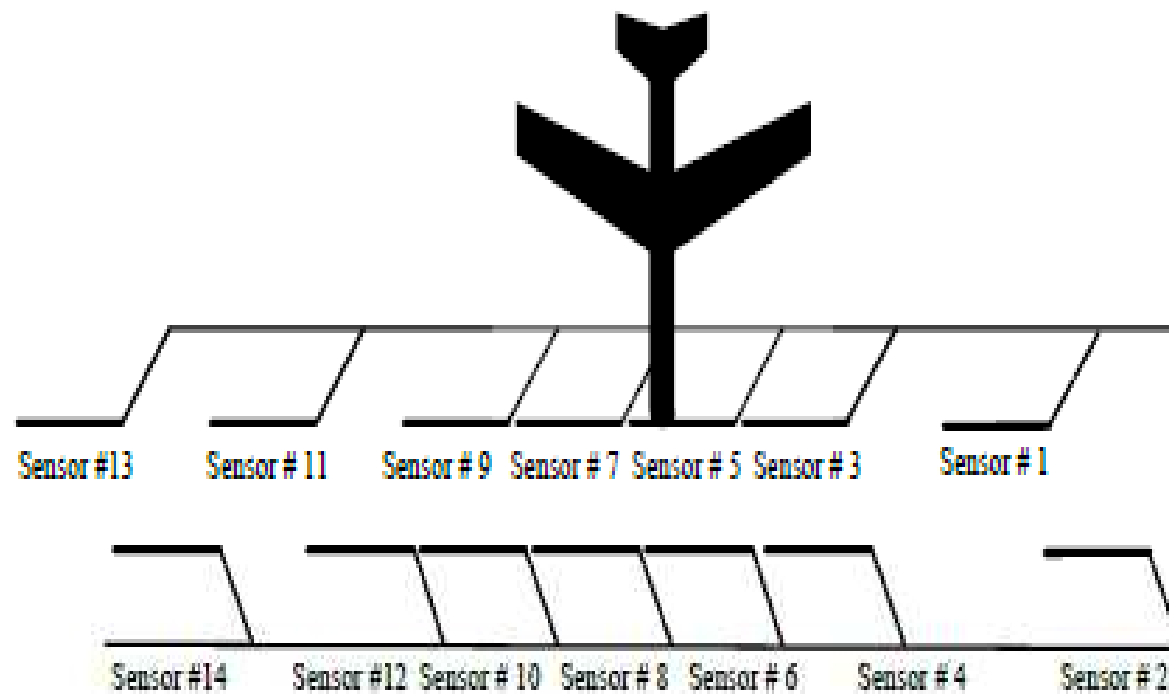
A configuration of sensors array to span taxiway for ground speed and aircraft model estimation.

Block diagram for using 32 amplifiers and a 32-to-1 multiplexer.

SOFTWARE IMPLEMENTATION

The software would interpret the signals received from the microcontroller and display the results onto the host PC GUI.

The software used to design and implement the airport display software is Microsoft Visual C# and XNA 3.1.

The software is designed as a monitoring system, each plane passing over a sensor would be displayed at the sensors location. The software also calculates the aircrafts position and velocity before and after moving from junction to junction.
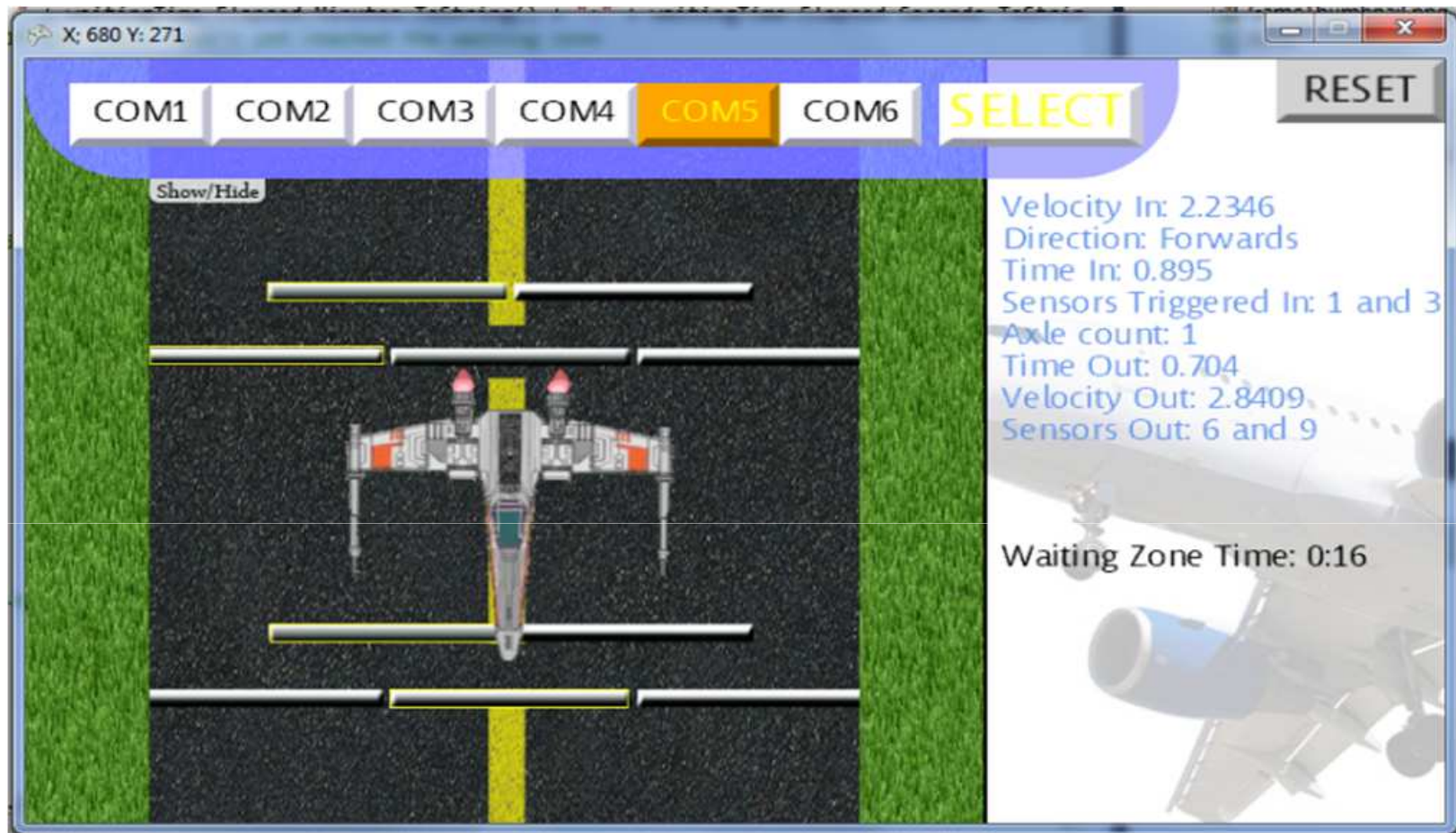
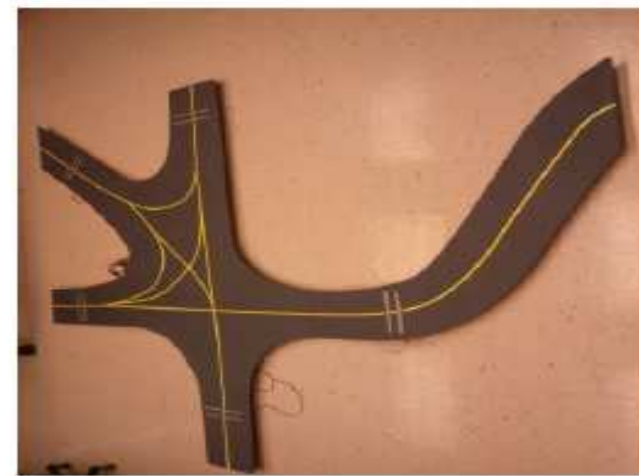**Real-Time Display System**
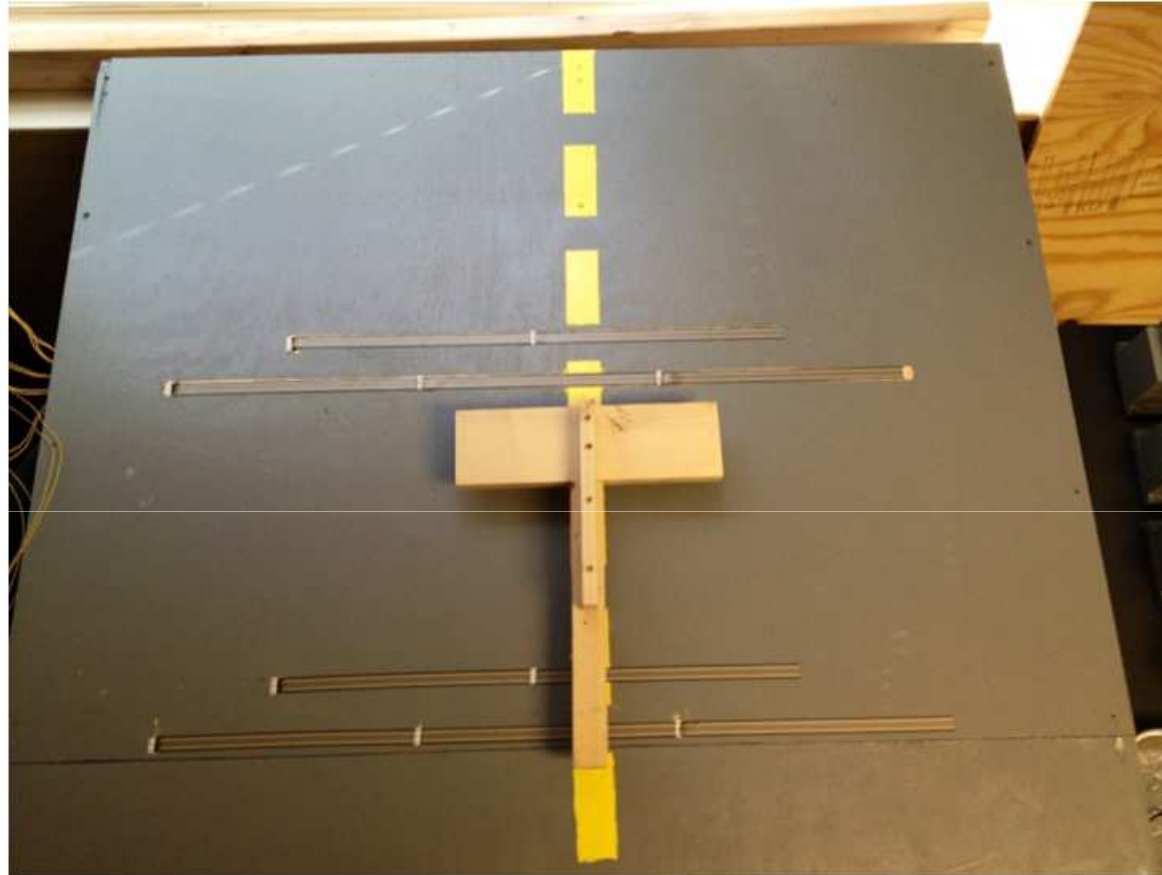
Prototype Taxiway Junction
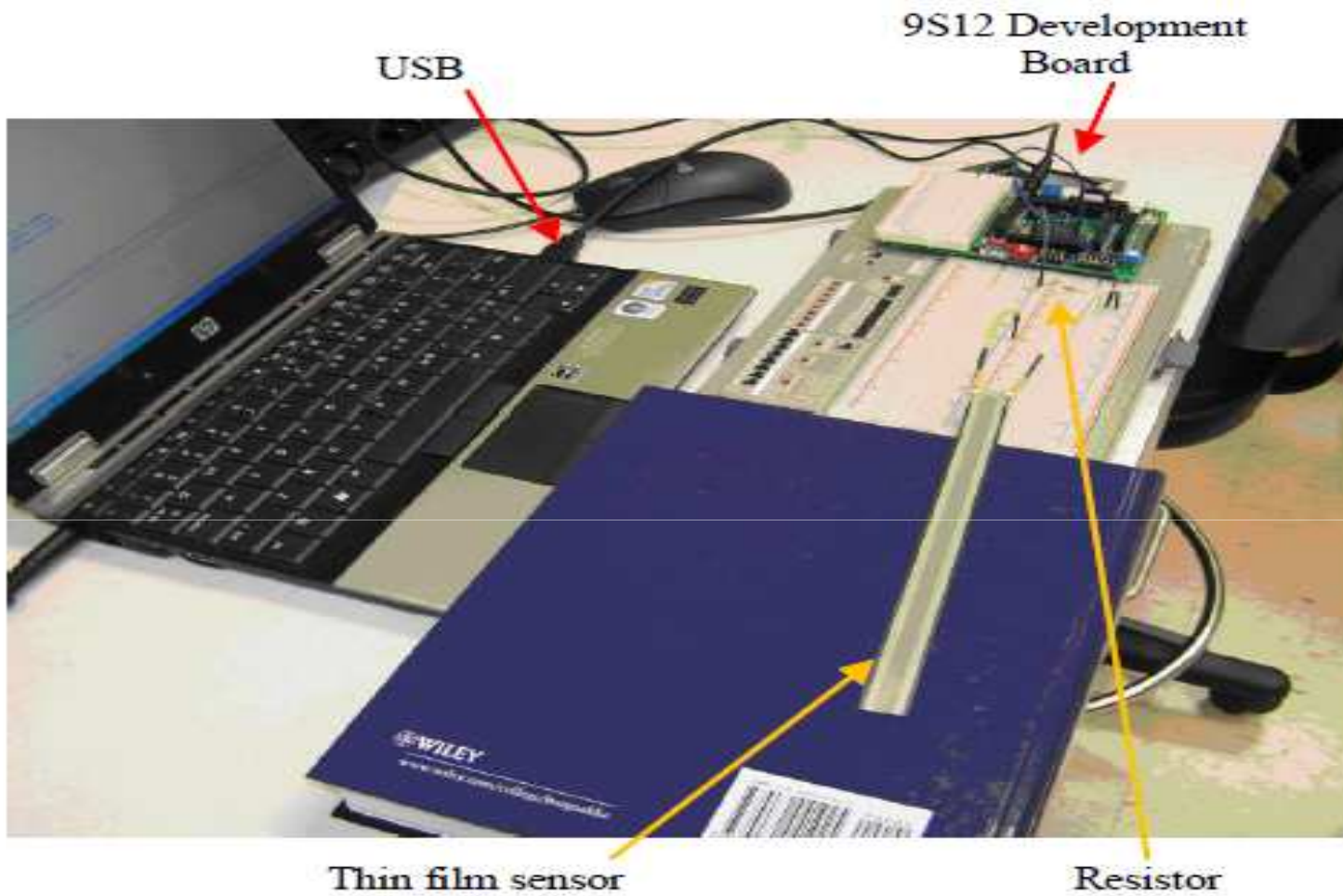
Network for testing the force sensitive resistor (FSR)

The layout of a junction in Corpus Christi International Airport, TX, USA.

The prototype of a taxiway junction.

The graphic display of a junction on the monitor.

RESULTS

The hardware and software were interfaced and tested. The system worked as expected. A small model aircraft was used to trip the sensors. When the model aircraft rolled over the sensors at a particular location, the computer display would show an airplanes location, velocity, and direction. If the model then passed over the sensors at a different location, the display would show the airplane move though the model aircrafts calculated trajectory.

SUMMARY

It has been demonstrated that a simple monitoring system can be implemented at airports to detect airplanes on the ground level. The hardware portion of this system consists of sensors, a microcontroller, a wireless communication system, and a host PC. The software part consists of a program running on a host computer that receives the data from the sensors on the ground and displays the data as a virtual simulation of the traffic on the taxiways. This economically feasible design is directed towards vulnerable airports to help prevent runway incursions and increase air traffic controller awareness.