Strain gauge AD-interface for the monitoring of pavement deformations

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With the growing population, road traffic is also increasing. Also more goods are being transported by lorry. The heavy weight puts a lot of strain on the asphalt pavement. The condition of the asphalt pavement can be monitored by installing strain gauges. This allows weak points to be recognized and rectified at an early stage. The monitoring makes it possible to recognize at an early stage when the asphalt pavement needs to be renewed and increases the safety of the road.

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Introduction

In order to ensure security and quality of the road network, a preventive maintenance approach is used. The latter is based on in site periodic measurements of the asphalt deformations via a strain gauge integrated in the pavement. As well as requiring trained personnel to conduct the measurements, period measurement does not allow to provide real time alarms in case of rapid deformation events.

Goals

For this first version of the project, the focus was on the electronic development of an initial version. The following objectives were defined:
-Power supply with 3.3V
-Current consumption below 100mA
-Communication with I2C
-Compatibility with the 'Sensor Network for the Preventive Maintenance of Airport Runways' project

Concept

The strain gauge is read in with a quarter-wheatstone bridge. The circuit is dimensioned so that a cable of any length can be used to connect the sensor. Possible losses due to the connection cable are automatically compensated. This is necessary as the losses can increase during use, due to changing cable temperatures. Strains in the micrometer range can be measured in asphalt with the selected strain gauge. The system can be tested individually with an ESP32 board and a battery. It is also in the Project 'Sensor Network for the Preventive Maintenance of Airport Runways' implementable. A suitable AD-converter had to be selected and tested for measuring the signal from the strain gauge accurately.

Results

The electronic board (Figure 1) was developed as the first version and contains all the features mentioned. A strain gauge with a cable of any length can be connected and installed in the asphalt. The measured value is converted with an analogue to digital converter and forwarded with I2C. For the AD-Converter the ADS1115 was chosen. It is a 16-bit AD-Converter with a sampling rate of up to 860 SPS. This required resolution was determined by calculating the measurement signal. It also has an adjustable amplifier where a gain of up to 16x can be set. Communication takes place via I2C. The measured value can be shown on the display on the ESP32 board. The Sensor-Board can be operated with a battery or inserted in the 'Maintenance of Airport Runways' project.

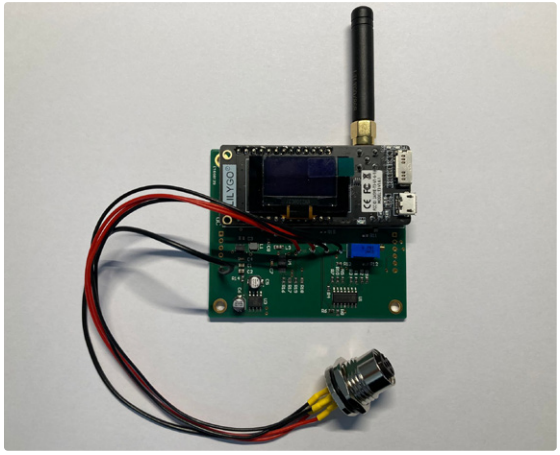

Figure 1: Sensor-Board with ESP32 Controller

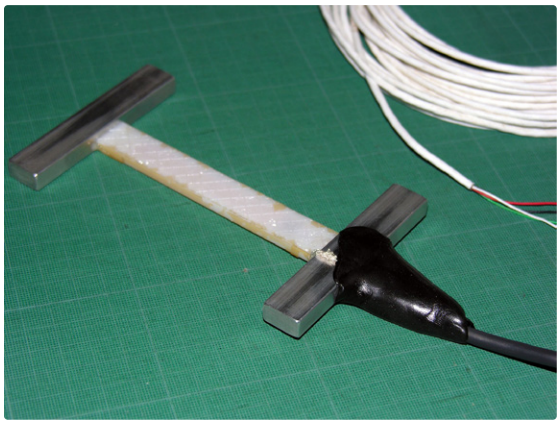

Figure 2: Strain gauge sensor