## 2017 UDOT RESEARCH PROBLEM STATEMENT

**Title:** Long-Term Fatigue Crack Monitoring Technology for Highway Bridges  
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### 1. Describe the problem to be addressed:
Highway bridges are a key component to the surface transportation system. There are over 2,900 highway bridges in the State of Utah. The estimated replacement value of all those bridges is over $ 5 billion dollars. The Utah Department of Transportation (UDOT) maintains 1,888 of these bridges. The ages of Utah’s bridges vary, with the oldest having been constructed in the early 1990s. Over half of the bridges were built between 1970 and 2010, and nearly %25 have been constructed since 1990. Also, one-third of Utah’s bridges will be reaching their 50-years design life by the end of this decade. Fatigue is underlying maintenance problem for steel bridges reaching their design life and therefore UDOT must be prepared and equipped to address this critical maintenance issue.

In general, given the aging US infrastructure and the trend towards asset management and life extension; the need for reliable, cost effective monitoring technologies to alert bridge owners when fatigue cracks are growing is higher than ever.

In this research, an innovative Long-Term Electrochemical Fatigue Sensor (LTEFS) is introduced to meet the growing demand for sensors that have the ability to continuously monitor fatigue cracks over long periods of time. This study demonstrates the performance of the LTEFS technology for UDOT in terms of timely detecting of fatigue crack, improving safety as well as reducing the maintenance cost and resources. This system can be easily integrated into the data management center for UDOT where live status of bridges can be accessed and monitored. This will be invaluable resources for Utah bridge maintenance team to significantly improve their inspection and also make critical decision about the repair.

### 2. Explain why this research is important:
Currently all DOTs including UDOT heavily rely on results and findings from visual inspection to make critical decision about the fatigue status of bridges. According to the Federal Highway Administration, 90% of fatigue cracks are missed by visual inspectors, and 56% of bridge ratings, that is, the long term structural quality of the bridge, are incorrect. This is very important for UDOT and in particular the bridge maintenance team since one-third of the Utah’s bridges are reaching their 50-years design life by end of 2020.

Integrating the LTEFS technology into the maintenance plan will significantly improve the safety of Utah’s highway bridges and also support the UDOT to better manage the maintenance budget and resources by reducing the maintenance cost and need for field maintenance personnel.

### 3. List the research objective(s):
1. Demonstrate the efficiency of the LTEFS for remote fatigue crack monitoring of highways bridge in Utah.
2. Demonstrate the significant effect of the LTEFS on the safety of Utah highway bridges.
3. Demonstrate the significant effect of the LTEFS on the assess management for UDOT (life cycle analysis).

### 4. List the major tasks:
1. Identifying steel bridges in different regions across Utah state to demonstrate the efficiency of the LTEFS.
2. Design and develop an instrumentation plan for the selected bridges.
3. Develop a cloud based dashboard into the UDOT data center for continuous monitoring of the selected bridges.
4. Performing a life cycle analysis and compare the cost of visual inspection with the LTEFS over an extended period of time.

### 5. List the expected results:
1. Improving the safety of Utah highway bridges
2. Improving the maintenance assess management
3. Develop a risk based maintenance approach for UDOT

6. Describe how the research results will be implemented:

The results from this research can be directly integrated into the bridge maintenance strategy for UDOT. The outcomes of this study can be utilized to develop a risk based maintenance approach for fatigue assessment and monitoring of steel bridges and in particular the fracture critical bridges.

7. Requested from UDOT: $65000  Other/Matching Funds: $35000  Total Cost: $100,000
(or UTA for Public Transportation)

8. Outline the proposed schedule, including start and major event dates:

The proposed research is scheduled for a period of 12 months. The estimated start date is July 2017. The proposed schedule is presented as followings:

1. Identifying the best bridge candidates for instrumentations: 2 months (July 2017 through August 2017)
2. Design and instrumentation of the selected bridges: 2 months (September 2017 through October 2017)
3. Data processing and showing the efficiency of the LTEFS in terms of detecting fatigue crack and also evaluating the crack retrofits: 3 months (November 2017 through January 2018).
4. Integrating the user interface (online dashboard) into the UDOT data management system: 2 months (February 2018, March 2018)
5. Life cycle cost analysis (LTEFS versus visual inspection): 2 months (April 2018, May 2018)