Bridge Inspection Request for Proposal

Request for Proposal (RFP)
A Request for Proposals is an invitation to enterprising organizations or individuals to help a client solve a problem. Read the background below, and see if you can offer a solution!

Sponsor Overview
Tri-State Confluence is a medium-sized county in western Pennsylvania, including 3 cities and 52 smaller townships and other municipalities. Its geography is composed largely of small hills and waterways, but also includes the notable Three Rivers Point, where three major waterways meet. The county manages over a thousand bridges ranging in size from pedestrian walkways over small gullies to major roadways over 400 meters long.

CDOT, the Confluence Department of Transportation, is concerned that as the bridges age – some are more than 40 years old – there will be an increased risk of structural wear that will render them unsafe. A critical part of CDOT’s mission is to inspect the bridges at least once a year in order to ensure that they remain safe for traffic.

Research Description
CDOT is offering a three-year contract to a company that can develop and demonstrate a proof-of-concept prototype of a system that can aid in the inspection of bridge structures, especially the undersides, which are difficult for work crews to access. CDOT has created a model bridge (shown at right) for this demonstration; your prototype must work with this model.

The prototype should be able to demonstrate a capability to detect visible fissures (cracks) and regions where the anti-corrosion paint coating has worn off the model bridge. You must also be able to explain how your system would handle additional, more advanced detection tasks if equipped with the proper sensors.

Overall Project Deliverables:
1. Written Proposal
2. Prototype Demonstration
3. Follow-Up Proposal
Deliverable 1: Written Proposal
The initial written proposal will be submitted by ___________ (date).

The Written Proposal should be a professional-quality typed submission including the following information:

- Company introduction, including names and background of all team members
- Description of team member responsibilities
- List of materials needed to complete the project
- Evaluation of the benefits of using robots for inspecting bridges; may include a list of material and cost savings as well as direct impacts to worker health and safety
- Clear description of methods or technologies you will use to create solution

Deliverable 2: Prototype Demonstration
The small-scale prototype will be demonstrated on ___________ (date).

The prototype and analysis team must be able to identify all visible defects in the model bridge’s underside without generating “false positives”. Because different test patterns have different defects to detect, the total possible points may vary.

Your coordinator (instructor) has a practice setup for the bridge inspection demonstration. You should practice and refine your technique to make sure that your team can detect and identify the necessary features even when they occur in different configurations – when it’s time for the final demonstration, you will be working with a pattern you have never seen before!

Defect report format
In order to submit an incident report for a defect that the prototype has detected, a written report must be generated with the following information:

- Type of defect identified
  - Crack or Worn Paint
- Location of defect
  - Identify the location of the center of each defect, or use multiple points to describe its boundaries
  - Give locations using distance from the edges of the bridge
- Size of defect
  - Crack: Measurement of length
  - Worn paint: Calculation of area of worn paint region
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Deliverable 2: Prototype Scoring Criteria

The more accurate and specific information your solution can provide, the better it will score.

- **Is there a problem?** Identify all wear-related defects present in the model.
  - +5 pt per defect successfully detected (report submitted)
  - -5 pt per defect reported when there is not one there

- **What is the problem?** Distinguish between cracks and worn paint.
  - +5 pt per defect correctly categorized as a crack or worn paint

- **Where is the problem?** Estimate position of all defects. For each defect, take only the highest point value that you qualify for in this category (e.g., if you meet the +5 point condition for a crack, you do not get +3 more points from meeting another condition for the same crack).
  - +5 pt for identifying the midpoint of the crack or center of the worn region within 3 cm of the actual midpoint or center
  - +5 pt for identifying EXACTLY which cells the crack or worn region occupies on a 3x3 cm or smaller grid (no missing or extra cells)
  - +3 pt for estimating the midpoint of the crack or center of the worn region within 5 cm of the actual midpoint or center
  - +3 pt for identifying mostly correct grid cells, with up to 2 extra or missing cells

- **How extensive is the problem?** Estimate the length or area of the defect. For each defect, take only the highest point value you qualify for in this category.
  - +3 pt for measuring the length of a crack within 1 cm of the actual length
  - +3 pt for calculating the area of a worn region within 1 cm² of the actual area
  - +1 pt for measuring the length of a crack within 3 cm of the actual length
  - +1 pt for calculating the area of a worn region within 4 cm² of the actual area

**Additional Conditions**

- Use of non-standard parts must be approved by an agent or supervisor before it will be allowed in the design.
- CDOT may request, at its discretion, notes or logs of meetings and other group communications. Adequate records must be kept of decisions made by the development group.
- CDOT may also request, at its discretion, an explanation of the role each member of the team plays, and an assessment of each member’s performance by the other members.
Deliverable 3: Follow-Up Proposal
The follow-up proposal will be submitted by ___________ (date).

The follow-up proposal should be a professional-quality typed submission including the following information:

- Description of the prototype you created
  - Diagram of the apparatus
  - Explanation of the key features of the design
  - Explanation of the technique used to analyze the sensor data
- Evaluation of the successful and unsuccessful aspects of the current design
- Analysis of the scalability of the solution
  - What parts of the design and analysis technique can be “scaled up” to a full-sized unit, and which cannot?
  - What additional kinds of defects might be detectable, and what sensors (LEGO or otherwise) might be helpful in identifying them?
- Recommendations
  - Is it worth it to continue down this path of research?
  - What should happen next?
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Project Grading Criteria

Written Proposal (20%)

- Follows correct format, includes all required parts, and exhibits professional quality (5%)
- Gives a well-reasoned analysis of the potential benefits (and drawbacks, if any) of a robotic inspection system (10%)
  - Demonstrates understanding of client/industry need
  - Demonstrates understanding of current inspection practices
  - Clearly explains benefits of a robotic solution and how it would meet the client’s need better than the currently existing solutions
  - Optionally, lists possible drawbacks to the robotic solution
- Explains clearly how the robotic solution will work (5%)
  - Explains prior experience or research that will be applied to this new problem (e.g. how this solution is similar to the technology used to compose satellite maps, or how you were able to detect color differences using the Light Sensor in a prior investigation)
  - Explains the important principles of the solution in a way that would be understandable to a non-technical expert
  - Clearly indicates the intent of the design

Prototype Demonstration (30%)

- Scoring criteria specified in the Deliverable description
- Score is a percentage of the possible points for the test pattern used
  - Example: Earning 13 points on a pattern that had a total of 15 possible points will earn (13/15 = ) 86.7% of the points for this section, or (86.7% of 30 = ) 26% toward the total project points

Follow-up Proposal (35%)

- Follows correct format, includes all required parts, and exhibits professional quality (5%)
- Gives a clear review of the prototype and analysis procedure for data (10%)
  - Includes clearly labeled diagram
  - Explains key design features
  - Clearly explains the procedure used to interpret the data that the robot gathers
- Gives a thoughtful evaluation of the success of the current design (5%)
  - Explains which parts did and did not work during testing
  - Proposes future solutions to unsuccessful aspects
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- Evaluates the scalability of the solution (10%)
  - Gives a thoughtful analysis on what aspects of the prototype robot will translate well to a full-sized unit, and which will not
  - Discusses the applicability of the current design and analysis technique to potential new sensors
- Gives honest recommendations on how to proceed (5%)
  - Gives a reasonable, honest opinion on whether or not the project has potential if it continues on its current course

Diligence (15%)
- All deliverables are completed and turned in on time (5%)
- Teamwork (5%)
  - Team members work efficiently together, with clear and even distribution of responsibilities
  - Team resolves conflicts in a mature way
- Independence and initiative (5%)
  - Team members discuss and solve problems using their own ideas and research
  - Team operates with a minimum of teacher intervention