Tech Xplore

Spotlight on robotic system for bridge inspection

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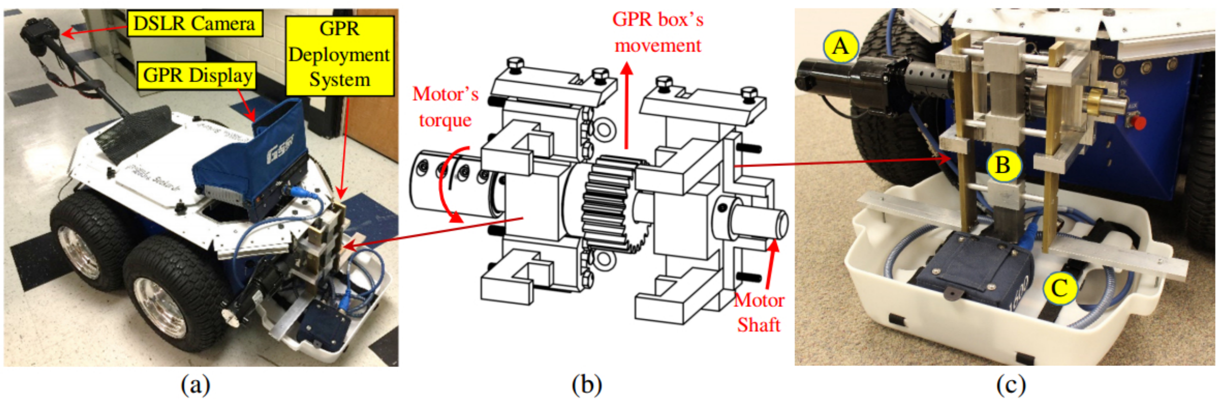

Autonomous robotic system for bridge deck inspection: (a) System overview; (b) Schematic of GPR deployment system; (c) Details of GPR deployment system: A - Motor, B - Gear shaft, C - GPR box. Credit: arXiv:1704.04663 [cs.RO]

(Tech Xplore)—Nothing lasts forever as the saying goes and that pretty much pertains to our bridges. Deterioration is a problem. Materials age, and the environment contributes its share of wear and tear. In some cases there may also be a problem of inadequate maintenance.

In the United States alone, here are some American Society of Civil Engineers notes. According to the 2017 Infrastructure Report Card, the U.S. has 614,387 bridges, almost four in 10 of which are 50 years or older. 56,007—9.1%—of the nation's bridges were structurally deficient in 2016, and on average there were 188 million trips across a structurally deficient bridge each day.

A robot helper has been designed to help check bridge conditions.

A four-wheeled robot has been created to check bridges for dangerous defects.

The robot helper has potential to be a cost-effective, accurate way of detecting problems.

The University of Nevada, Reno team designed the robot to inspect conditions such as corrosion. They authored a paper, which is on arXiv. "Autonomous Robotic System using Non-Destructive Evaluation Methods for Bridge Deck Inspection" describes their work.

The authors made the point that "Bridge deck condition assessment is the most important part for bridge health maintenance"; that is what the robot sets out to do.

The authors wrote that the system was capable of "performing real-time, cost-effective bridge deck inspection, and is comprised of a mechanical robot design and machine learning and pattern recognition methods for automated steel rebar picking to provide realtime condition maps of the corrosive deck environments."

Reasons to focus on a robot helper for bridge-condition assessments are clear when considering scenarios involving human efforts.

Alice Klein on Friday in *New Scientist*: "Surveying a bridge used to involve drilling into the road to check the concrete and steel structures underneath. Although radar has simplified the work since the 1980s, sending out teams of people to check bridges is still expensive and can require extended road closures."

Klein added, "Human inspections aren't immune to error either."

The wheeled robot can shuffle back and forth in the course of its mission. The *Daily Mai*l: To collect data, the robot has to move from one end of the bridge to the other, turning around and continuing its movement, until the entire bridge deck is covered.

The technology used in its back and forth movements are ground penetrating radar (GPR) and electrical resistivity (ER) sensors, and a camera for data collection. The robot is designed to locate any corroded steel parts or deteriorating concrete. The camera, said *New Scientist*, could pick up on any surface cracks. The authors said this is a digital single-lens reflex (DSLR) camera.

The team said their robot provides realtime condition maps" of the corrosive deck environments. Colors are used to describe conditions. How does that happen? *New Scientist*: "A machine-learning algorithm converts the readings in real time into a colour-coded map of the bridge, highlighting any areas of weakness. The results are sent to human inspectors, who can keep tabs on the robot as it does its rounds."

Reports pointed out that among its advantages is that the robot can move along the narrow deck without disrupting traffic.

The authors said they used the Seekur Jr mobile robot, a waterproof platform, suitable for this kind of bridge inspection task. The Omron Adept site carries details about this robot.

The authors said, "With a smaller form, the Seekur Jr. robot can manage to move in narrower environments."

How did the researchers test the robot's capabilities? They carried out tests on the robot on four road bridges in Nevada, New Hampshire, Maine and Montana.

So will this develop into realtime robot inspectors replacing humans? A Queensland University of Technology in Australia professor said cost-effectiveness will depend on how the robot compares with other technologies such as sensors built into bridges themselves.

He thinks robots should be a complementary technology for bridge inspections. "Human experience is precious so, at least for now, I don't see robots replacing humans altogether," said Tommy Chan. "But robots do cut out human error so we should definitely consider them as a way to help."

More information: Autonomous Robotic System using Non-Destructive Evaluation methods for Bridge Deck Inspection, arXiv:1704.04663 [cs.RO] arxiv.org/abs/1704.04663

Abstract
Bridge condition assessment is important to maintain the quality of highway roads for public transport. Bridge deterioration with time is inevitable due to aging material, environmental wear and in some cases, inadequate maintenance. Non-destructive evaluation (NDE) methods are preferred for condition assessment for bridges, concrete buildings, and other civil structures. Some examples of NDE methods are ground penetrating radar (GPR), acoustic emission, and electrical resistivity (ER). NDE methods provide the ability to inspect a structure without causing any damage to the structure in the process. In addition, NDE methods typically cost less than other methods, since they do not require inspection sites to be evacuated prior to inspection, which greatly reduces the cost of safety related issues during the inspection process. In this paper, an autonomous robotic system equipped with three different

NDE sensors is presented. The system employs GPR, ER, and a camera for data collection. The system is capable of performing real-time, cost-effective bridge deck inspection, and is comprised of a mechanical robot design and machine learning and pattern recognition methods for automated steel rebar picking to provide realtime condition maps of the corrosive deck environments.