Road defects such as cracks, edge breaks and potholes can have a negative economic and social impact. These road defects can damage motor vehicles, endanger the lives of motorists and pedestrians and lead to more costly road repairs. Timeous identification of road defects can help with the maintenance of road infrastructure. In response to this need, the CSIR developed a visual surveying platform to support road infrastructure inspections.
A CSIR-DEVELOPED VISUAL
surveying platform assists
with the maintenance of road
infrastructure by timeously
identifying and geo-locating
road surface defects such
as cracks, edge breaks and
potholes.

The visual surveying platform
consists of a vehicle-mounted
sensor system along with an
analysis and visualisation
software suite. The sensor
system comprises a high-
resolution camera, a global
positioning system (GPS) receiver
and a computer with peripherals
for wireless connectivity.

The sensor system is attached
to a vehicle and driven through
the area that is to be inspected.
The system records synchronised
video and GPS data which are
then uploaded to a computer
for analysis. The detections
that are produced during the
analysis stage are stored in a
geographic information system
(GIS) database where the defects
may be viewed and validated
by an operator. The operator can
use the visualisation tool, which
is a part of the system, to plan
maintenance operations.

Current imported state-of-the-art
systems that are used for
road inspections cost more than
R15m each. The visual surveying
platform can be produced for an
estimated R500 000. The lower
cost implies that more units
could be deployed, which would
result in a higher area coverage
at a higher frequency of updates.
The visual surveying platform
would thus provide decision-
makers with a timeous first level
estimate of the state of the road
infrastructure to enable more
effective planning of further
maintenance operations.

The CSIR has issued a technology
evaluation licence to Jetpatcher,
a local repair company, to trial
the visual surveying platform
as part of its regular
operations workflow. The
Johannesburg Roads Agency
has also expressed an interest in
using the technology as part of
its maintenance operations.

More about how it works:
image processing and machine
learning algorithms
The analysis module is a key
component of the system and
it uses a combination of image
processing and machine learning
algorithms to detect, classify and
quantify road defects.

The visual surveying platform
has three modes of operation –
a manual mode, an autonomous
mode and a hybrid mode.

In the manual mode the operator
uses the software suite to watch
the video stream and manually
detect the defects from the video.
Once detected, the size and
geographic location of the defect
are automatically calculated and
stored in the database.

In the autonomous mode, the
system automatically analyses the
video stream to detect the defects
before automatically calculating
the size and location of the defect.
During evaluation, the automated
detection algorithm was able to
detect a specified defect with an
accuracy of 89%.

To improve the overall accuracy
further, a human-in-the-loop or
hybrid mode of operation was
adopted. In the hybrid mode the
system automatically analyses
the video stream and suggests
possible defects to an operator
who then validates the detection.

The development team believes
that the manual mode and
hybrid mode would be suitable
for integrating into the existing
workflows of companies
and municipalities that are
involved in the maintenance
of road infrastructure. Further
improvements to the autonomous
mode would be incorporated into
the hybrid mode.

Future plans and applications
Although defects of different
types can be extracted from
the video stream, the current
version of the visual surveying
platform focuses on detecting and
estimating the size of potholes.
During one investigation the team
also developed an algorithm to
detect road signs. The team has

The visual interface for detected potholes.

The hardware system of the Visual Surveying
Platform.

future plans and applications

since received requests from the
South African Road Traffic Sign
Manufacturers Association and
a road defect repair company to
further develop the road sign
detector, as they have a need to
geo-locate road signs to determine
if they are placed correctly or if
they may be missing.

Future development plans for the
system include improvements
on the detection and estimation
accuracy of the system and
the development of a backend
that integrates the data over
all deployments of the visual
surveying platform.

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