

Optics and Photonics Crucial to Strengthening and Protecting Critical Infrastructure Investments

Improvements to our nation's infrastructure is a policy priority shared by both political parties. There is consensus on the need to invest in and rebuild our nation's aging infrastructure. Such a large and important public investment will demand that the most sophisticated U.S. technology is used to protect and preserve our nation's economic infrastructure.

Optics and photonics, the science and application of light, should be a critical component of new and existing infrastructure projects. Applying this technology will make American roadways and waterways safer as well as the outlay more cost effective.

Optical imaging techniques can contribute greatly to rebuilding our aging infrastructure. For example the structural integrity of bridges, roads, railways, tunnels, and pipelines could be monitored and inspected in real-time using rapid optics-enabled data collection. Defects and maintenance needs could be identified with unprecedented precision and efficiency using optics and photonics technology. Better monitoring means better maintenance, which means more efficient expenditure of taxpayer dollars.

New, advanced optical fiber transmission could vastly improve our nation's communication and information technology infrastructure, leading to business growth and new applications, services, and the expansion of the internet to rural and other under-served communities.

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OPTICS & PHOTONICS USED FOR EFFICIENT INFRASTRUCTURE MANAGEMENT

Optical and imaging techniques can address the challenges of managing aging civil infrastructure. Rapid data collection and modeling of civil infrastructure (e.g., bridges, buildings, roadway, railway, tunnels, airports, pipelines) are changing the inspection and monitoring practices of these systems and will be critical for future management.

- 3D digital shearography (digital image correlation), holographic interferometry, and LiDAR (Light Detection and Ranging) help detect excessive deformation and surface crack mapping of bridges, roadway, retaining walls, pipelines, and airports.
- 3D point cloud models offer a new approach for better damage/defect registration and tracking compared to other structural health monitoring (SHM) and non-destructive testing/evaluation/inspection (NDT/E/I) methods.
- Spectroscopic remote sensing (passive or laser based) from airborne platforms to sense leakage and propagation of specific chemicals, such as natural gas leaking from pipelines or storage facilities.
- Imaging techniques such as computed tomography (CT), synthetic aperture radar (SAR), and holography enable researchers and engineers to detect hidden and subsurface defects in infrastructure systems.

Adding optical sensors to the emerging platform technology of drones, unmanned aircraft systems (UAS), unmanned aerial vehicles (UAV) and unmanned marine systems (UMV) can provide efficient, rapid, and precise infrastructure monitoring and asset management. These platforms also create opportunities for natural hazard management (e.g., wildfire monitoring, landslide monitoring), emergency response, search and rescue, and counter-terrorism. Improved mobility of optical and imaging techniques can significantly reduce risks and costs associated with traditional labor-intensive monitoring techniques.

EXAMPLE - FAILING DAMS IN WASHINGTON

According to a 2016 inventory, there are nearly twelve hundred dams in the state of Washington that are in disrepair, impacting communities throughout the state. For example, in 2014 a 65-foot-long crack was found underwater in the 185-foot tall Wanapum Dam on the Columbia River which will reportedly cost tax payers over \$70 million to fix. In 2009, the Howard Hanson dam was damaged by storms and began to leak. Although the Army Corps of Engineers began interim repairs, the U.S. Senate approved \$44 million in emergency funding to fix the dam's embankment. In both instances, optics and photonics technology would have detected these issues well before the cracks needed significant repair.

OPTICS & PHOTONICS TO HELP DEVELOP 5G INFRASTRUCTURE

The vast majority of data received from cell phones, cable TV, the Internet, and radio is encoded, disseminated, and received using optics and photonics technologies. Lasers, fiber optics, and optical detectors are the backbone of these networks.

Next-generation 5G communications networks will deliver information to communities far faster than current technol-

ogy allows. This sophisticated network infrastructure will result in vastly increased network speeds, supercharging consumers' internet access and new business opportunities alike. Much of the foundation for the 5G network is already in place, but the challenge lies in optimizing this base and expanding it to make economic opportunities available to more Americans. Optics and photonics technology can solve this challenge.