NATIONAL PHOTONICS INITIATIVE

CRITICAL ROLE OF OPTICS AND PHOTONICS IN PUBLIC INFRASTRUCTURE

ENSURE THAT OPPORTUNITIES TO INCLUDE OPTICS AND PHOTONICS ADVANCES IN EXISTING AND NEW INFRASTRUCTURE PROJECTS IN THE UNITED STATES ARE NOT MISSED.

The United States' aging public infrastructure poses a serious safety risk to millions of Americans, but the application of optics and photonics – the science and application of light – can be applied to existing infrastructure and new construction projects to make American roadways and waterways safer, smarter and more cost-effective.

Advances in optical imaging techniques are quickly becoming essential in addressing the challenges of aging and new civil infrastructure. Rapid, optics-enabled data collection and modeling of infrastructure systems including bridges, roadways, railways, tunnels, airports and pipelines are greatly improving the process of monitoring and inspecting in real-time the structural integrity and usage of these systems – enabling unprecedented precision and efficiency in the identification of infrastructure defects and overall maintenance concerns, reducing project delays and expense.

Furthermore, new, disruptive optical fiber transmission technologies can improve the infrastructure of our nation's communication and information technology – expanding the reach of the Internet to rural communities and those currently cut off from the Internet and other forms of communication.

Lessons Learned from Minneapolis

A recent report from the American Society of Civil Engineers (ASCE) deemed over 57,000 bridges in the United States "structurally deficient," and that number is growing. In 2007, the I-35 W Mississippi River Bridge in Minneapolis, Minnesota, which carried 140,000 vehicles daily, tragically collapsed as the result of a design flaw. Since being rebuilt, the bridge now has roughly 500 photonics-enabled optical sensors embedded through its concrete that are tracking data including strain on the bridge, accelerations, temperature and more to prevent future costly accidents, ensure greater public safety and save lives.

Smarter, Safer and Cost-Effective Infrastructure Management

Optics and photonics technologies contribute in a number of ways to better infrastructure management through advanced imaging, modeling, mapping and laser technologies. 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. 3D point cloud models – which are enabled through optics and photonics – offer a new approach for better damage and defect registration and tracking compared to other structural health monitoring and non-destructive testing and inspection methods.

3D mapping capabilities, made possible through LiDAR (Light Detection and Ranging), have a number of applications for architectural models and surveying for construction projects, including helping to detect excessive deformation and surface crack mapping of bridges, dams, roadways, retaining walls, pipelines and airports. The implications of growth in this field are wide-ranging for aerial and ground transportation, including air travel, rail and automobile travel. This includes laser wind and wake detection systems to improve safety on the ground at our nation's airports and in-flight as well as countermeasures to protect civilian aircraft.

Optics and photonics technologies are already underpinning new construction processes, improving quality, efficiency and safety in public infrastructure. Advances in laser welding technologies, for example, are making the construction processes cheaper and more efficient, and are producing higher-quality designs and products. 3D laser additive manufacturing is already cutting costs and development time for manufacturers around the world. With a growing need for renovations and enhancements to our outdated infrastructure systems, investment in high-power laser and 3D mapping technologies as well as remote sensing has never been more important.

Our nation also has large numbers of gas, oil and chemical storage facilities and pipelines, many of which are quite old. Fixed and drone-borne laser and imaging techniques are now available for remote leak detection. These photonics-enabled technologies can mitigate dangerous leaks of combustibles or toxins through early detection – a potentially lifesaving and cost-effective, preventative measure. This type of surveillance can also be used to protect and secure our ports and borders.

Expanding Communications and Information Technology Infrastructure

The vast majority of data we receive today from cell phones, cable TV, the Internet, radio and print is encoded, disseminated and received using lasers, fiber optics and optical detectors. Over the past 30 years, innovations in optical communication systems have dramatically increased performance and reduced costs. The sharply lower costs drove, and were driven by, exponential increases in telecom traffic: North American telecommunication capacity grew 100 times over the last decade alone. Demand for more bandwidth is expected to continue to rise, fed by new applications.

Given that Internet traffic continues to grow at a compounded annual rate of roughly 50 percent, new disruptive optical fiber transmission technologies will be needed over the coming several years to meet Internet growth and widen the reach of communications infrastructure – broadband – to bring vital services like distance learning and remote medicine to more isolated communities.

About the National Photonics Initiative (NPI)

The NPI is a collaborative alliance among industry, academia and government seeking to raise awareness of photonics and the impact of photonics on our everyday lives; increase cooperation and coordination to advance photonics-driven fields; and drive US funding and investment in areas of photonics critical to maintaining US economic competitiveness and national security. The initiative is led by a coalition of scientific societies, including the American Physical Society (APS), the IEEE Photonics Society (IPS), the Laser Institute of America (LIA), The Optical Society (OSA) and SPIE, the International Society for Optics and Photonics (SPIE).

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