This objective of this dissertation is to develop a comprehensive Structural Identification (St-Id) framework with damage for bridge type structures by using cameras and computer vision technologies. The traditional St-Id frameworks rely on using conventional sensors. In this study, the collected input and output data employed in the St-Id system are acquired by series of vision-based measurements. The following novelties are proposed, developed and demonstrated in this project: a) vehicle load (input) modeling using computer vision, b) bridge response (output) using full non-contact approach using video/image processing, c) image-based structural identification using input-output measurements and new damage indicators. The input (loading) data due vehicles such as vehicle weights and vehicle locations on the bridges, are estimated by employing computer vision algorithms (detection, classification, and localization of objects) based on the video images of vehicles. Meanwhile, the output data as structural displacements are also obtained by defining and tracking image key-points of measurement locations. Subsequently, the input and output data sets are analyzed to construct novel types of damage indicators, named Unit Influence Surface (UIS). Finally, the new damage detection and localization framework is introduced that does not require a network of sensors, but much less number of sensors. The main research significance is the first time development of algorithms that transform the measured video images into a form that is highly damage-sensitive/change-sensitive for bridge assessment within the context of Structural Identification with input and output characterization. The study exploits the unique attributes of computer vision systems, where the signal is continuous in space. This requires new adaptations and transformations that can handle computer vision data/signals that are continuous in space, i.e., a signal with an infinite number of inputs in the space domain for structural engineering applications. This research will significantly advance current sensor-based structural health monitoring with computer-vision techniques, leading to practical applications for damage detection of complex structures with a novel approach. By using computer vision algorithms and cameras as special sensors for structural health monitoring, this study proposes a significant breakthrough in bridge monitoring through which certain type of data that could not be collected by conventional sensors such as vehicle loads and location, can be obtained practically and accurately.

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The public is welcome to attend.