Monitoring and modelling human-human and human-structure interactions on grandstands

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Modern grandstands not only host sporting contests but also serve as venues for music and other entertainment events. Consequently they are exposed to increasingly severe dynamic loads that can cause excessive vibrations, structural damage and alarm among spectators. The extent of dynamic loading largely depends on the ability of a crowd to synchronise their actions typical for stadium environment, such as jumping, bouncing, and swaying. The degree of synchronisation that can be achieved is a function of several factors: number of people present, type of event and crowd action, presence or absence of external stimuli (e.g. audio, visual or tactile), demographics of the spectators, and level of structural vibration perceived by the crowd. Current research is mainly limited to investigating some of these factors in isolation, and in laboratory conditions.

The analysis of human behaviour using computer vision algorithms is a rapidly advancing field. There exists a large body of work aimed at analysing crowd behaviour in real time. Despite the apparent potential offered by computer vision analysis, such techniques have yet to be effectively leveraged in the civil engineering field.

The aim of this project is to utilise image processing and computer vision techniques for developing a methodology for video-based evaluation and modelling of dynamic forces, synchronisation levels within crowds, and the corresponding structural responses at real-life events on grandstands. In this way, the humans would be observed and their dynamic actions characterised in a natural environment, i.e. without physical or psychological bias encountered when they are instrumented with, say, accelerometers, or observed in the laboratory conditions. The methodology would then be used at different events to investigate the relationship between crowd synchronisation and aforementioned factors. The success of the project will enable real-time evaluation of crowd-structure behaviour, and allow for efficient crowd management and monitoring of structural performance. The outputs of this project have potential to transform design of grandstands for human-induced dynamic actions.