ABSTRACT
This vision-based control framework attempts to mitigate several shortcomings of current approaches to mobile navigation, including the requirement for detailed 3D maps. The framework defines potential fields in image space and uses a subsumption process to combine hard, physical constraints with soft, guidance constraints while guaranteeing that hard constraint information is preserved. In addition, this representation can be defined with constant size, which can enable strong run-time guarantees to be made for visual servoing based control.

MAIN POINTS
1. Many navigation systems require detailed 3D maps, but these can be difficult or expensive to create and maintain or unavailable
2. Agents often encounter large and varying numbers of entities in a scene, which can be problematic for approaches whose complexities are sensitive to entity counts
3. Many robotic systems may be subject to rigorous verification and validation procedures that are difficult to perform with current approaches.

To help address these issues, this paper expands on previous work [7] to present a subsumption control framework built around Image Space Potential (ISP) fields. Under this framework, sensor data is transformed directly into a potential field defined in an image plane where an Image-Based Visual Servoing (IBVS) routine computes control commands to guide the agent toward its goal. The use of image space can help mitigate the three problems cited above.

DEMONSTRATIONS
1. The first shows how soft constraint values guide navigation, and is performed with publicly available data sets [26]. Figure 3 shows the effect that modifying the user-defined soft constraint values has on the set of controls. The soft constraint values are color-coded in the figure across the top, and the control space output is shown varying with colors along the bottom.
2. In the second, perception input comes from the fiducial tracking system ar_track_alvar [29]. The sequence of detections in image space can be used to calculate estimates of t for each detection. Figure 4 describes the experiment and shows the mobile test platform as it navigates the slalom (link to video in caption).

CONCLUSIONS
Image Space Potential (ISP) fields are a visual servoing-based subsumption control architecture for mobile navigation. ISP fields are constant space complexity with respect to the image, which is crucial for ensuring scalability and running time of algorithms. Under reasonable assumptions, the formulation of the control architecture can also ensure collision-free navigation. An implementation of the framework described in this paper is publicly available [30] under the MIT open source license [31].