Computer Scientists Build Pedestrian Remover

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The dog stands alone (bottom image) after a UC San Diego pedestrian remover automatically removed the man walking the dog (top image) and filled in the hole with building, grass, curb and sidewalk.

(PhysOrg.com) -- Imagine encountering leashed dogs without dog walkers, or shoes filled just with ankles - when scoping out potential apartments using Google Street View. These are the sorts of visual hiccups that an experimental computer vision system occasionally generates when it automatically removes individual pedestrians from images that populate Google Street View.

Computer science graduate student Arturo Flores from the University of California, San Diego developed this proof-of-concept system. Flores and UC San Diego computer science professor Serge Belongie presented the work in June 2010 at the IEEE International Workshop on Mobile Vision. Their paper:"Removing pedestrians from Google Street View images."

The as-yet unnamed system removes pedestrians from urban scenes pulled from Google Street View - which provides panoramic views of cities, towns and rural areas across the world. Street views are constructed by stitching together overlapping images taken from a moving vehicle.

Removing Pedestrians

The UC San Diego project explores one way that computer vision could be used to preserve privacy in public environments in our digital age.

The system removes pedestrians and replaces the holes in the images with an approximation of the actual background behind each pedestrian. These corresponding background pixels are pulled from the image taken right before or right after the image in question.

When the automatic pedestrian remover replaced the woman (top image), the umbrella remained (bottom image).

One next step, according to Flores, is to remove groups of pedestrians from single images.

Google Street View currently blurs faces and license plates from its images. Nevertheless, clothes, body shape, and height combined with geographical location can be enough to make some pedestrians personally identifiable even if the face is blurred out, say Flores and Belongie in their paper.

The pedestrian removal is relatively “ghost free” - meaning that the artifacts caused by the pixel swapping are usually not distracting. But the pedestrian remover does occasionally produce strange results - like dogs on leashes with no owners, and shoes with feet but nothing else.

In addition, the system struggles to generate background pixels when the

pedestrian happens to be walking in the same direction as the vehicle at just the right speed. In these cases, the pedestrian may cover up the same spot in multiple frames, foiling the computer scientists' pixel-swapping approach to removing pedestrians.

The pedestrian remover only works in urban settings - where the pixels blocked by people are often "on a dominant planar surface" - which makes them simpler to replace.

The system, for example, can replace the pixels blocked by a person walking by a mural of horses grazing in a pasture. But the system cannot replace the pixels behind a person on a country road walking by actual horses grazing in a pasture, because this background is not predominately flat.

The man walking past the glass door (top image) is automatically removed and replaced with the actual glass door (bottom image)

It All Started in Class

Flores developed the project during CSE 190A, a project-based computer vision and machine learning class taught by Serge Belongie, a professor in the Department of Computer Science and Engineering (CSE) at the UC San Diego Jacobs School of Engineering.

Belongie encourages his students to take on computer vision projects that tap freely available tools and datasets. Flores, for example, leveraged the pedestrian detector for Street View created by computer science professor Bastian Leibe from RWTH Aachen University. From this technological base, Flores developed his automated system that replaces pedestrians with the actual urban scene the people are blocking.

“This is a cute idea that, as far as we know, has not been explored,” said Belongie.

While students are free to choose their own CSE 190A projects, Belongie keeps a running list of project ideas, such as analyzing coral reef videos, and finding swimming pools in neighborhoods with aerial photos. The project blogs for Flores and his Winter 2010 CSE 190A classmates are here. Check out some of the"dancer detector" videos here .

“I’m always trying to get the students to think about applying computer vision to real-world data,” said Belongie. “CSE 190A is a perfect opportunity for students to do so.”

More information: Paper: Removing pedestrians from Google Street View images presented in June 2010 at the IEEE International Workshop on Mobile Vision.