When Chickens Attack

A computer system can tell when hens have murder on their minds

Robotics engineer Stephen Roberts was taking his lunch at Somerville College at the University of Oxford, in England, when the conversation turned to chicken. It wasn't the food, though. His dining companion was animal welfare specialist Marian Dawkins, and she thought that the pattern-recognition technology Roberts was explaining might help identify misbehaving hens.

Laying hens aren't ordinarily antisocial, but under the stress of incarceration, they are known to peck one another, sometimes to death. It usually starts with a couple of chickens and can spread quickly. Once a bird starts to peck, others follow suit. For poultry farmers, the behavior is costly and difficult to deter. Many farmers resort to clipping the chickens' beaks, but some countries ban the practice on humanitarian grounds. Environmental adjustments, such as dimming the lights or improving foraging material, can prevent attacks, but those work only if farmers know which hens need the changes, and each adjustment has its costs.

The key to detecting unruly hens might be in observing how they run, Roberts says: "Movement patterns [at an early age] are a proxy for behavior later on."

Dawkins hoped that by recording the shuffle and flow of chicken flocks over time, Roberts might train his software to distinguish between healthy flocks and stressed-out, violent ones before the feathers flew. Previously, Roberts studied human crowd movement using a machine-vision system based on optical flow. Optical flow is a measure of the pixel-to-pixel changes between subsequent frames of a video. The principle is the same for humans and

EVIL INTENT? Laying hens sometimes peck their coop mates to death. Applying image-processing algorithms to a video feed of a flock can predict when hens will cause trouble.

PHOTO: OLENA ISTOMINA/ ISTOCKPHOTO

update

Frankfurt Tower's Power Trick

A sensor-tuned facade lets fresh air in without throwing energy out

You don't need to seal yourself in to live green. That's the message from the engineers of the Westarkade, a colorful high-rise that officially opened in Frankfurt in July.

The 15-story glass tower glows with natural light and offers windows that open—a comfort that can wreak havoc with energy efficiency. But the Westarkade's first-of-a-kind "pressure ring" facade and sophisticated, sensor-rich control scheme promise to consume no more than 100 kilowatt-hours of energy per square meter per year. That would make it a world-class energy miser, using half as much energy as a conventional office building in Europe and as little as a third of the U.S. average.

"It's an aggressive goal, especially with this building that's all glass," says Mark Perepelitza, a facade expert with Zimmer Gunsul Frasca Architects, based in Portland, Ore.

The Westarkade's dynamic facade is a descendant of a 1990s German design that was developed to manage excess sunlight in glass towers. Horizontal venetian blinds installed outside of the tower's glass envelope reject unwanted summer heat, while a pane of glass installed over the blinds and ventilated at the top and bottom protects the blinds from high winds. The "double skin" design comes up short, however, when architects add windows that open, which is typically mandated under European labor codes. Winds create

SENSIBLE SYSTEM: The Westarkade tower integrates data from dozens of sensors to keep the tower from consuming power. *PHOTO: KFW BANKENGRUPPE*

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chickens: Each image is slightly different from the last, with humans or chickens moving relative to one another within the video's frame, and each kind of crowd has its own signature flow pattern.

To show that the method could apply to hens, Dawkins, Roberts, and their colleagues did experiments in which some statistics from the optical-flow pattern correlated well with an established but much more arduous method: watching how individual chickens walk. Farmers can hire trained experts to evaluate the health of flocks by scoring each chicken's gait, but those experts can't constantly monitor a flock, says animal behaviorist Harry Blokhuis of the Swedish University of Agricultural Sciences, in Uppsala.

"It was an engineering challenge," Roberts recalls. "Could we mimic the laborious labeling with a computer?"

Roberts turned to hidden Markov chains, a kind of mathematical model that uses noise in a data set to estimate the underlying "normal" signal and then identify when the signal is going awry. Then the team applied it to footage of more than 300 000 commercial free-range chickens. They found telltale behavioral disturbances in the flocks that had the most feather damage. Zoologists who saw the results "were certainly really surprised that we could forecast so well

4 terabits per square inch

The new record for data storage on a ferroelectric medium. The density is about eight times that of the most advanced magnetic hard drive, according to scientists at Tohoku University, in Japan.

a pressure differential around the tower, sending drafts ripping across floors when workers exercise their right to natural ventilation. "Sheets are blowing from the tables and the doors are smashing and the heat is going out," says Tom Geister, a senior architect with Berlin-based Sauerbruch Hutton, the firm that designed the Westarkade.

Sauerbruch Hutton worked with Stuttgart-based firm Transsolar KlimaEngineering to solve the problem. The firms installed 180 vertical ventilation flaps in the outer skin to manage air flows, creating what they call a pressure-ring facade. The building's control system takes constant feedback from a rooftop weather station and from 40 sensors deployed throughout the building that measure temperature, pressure, and sunlight. The system continually opens and closes individual flaps to maintain a ring of consistent positive pressure around the structure, preventing strong winds from entering.

That should keep windows from sabotaging the Westarkade's high-efficiency heating and cooling systems, which rely on such tricks as geothermal heat exchangers, heat captured from a basement data center, and heat recovered from vented air. Better still, in the fall and spring, air from the open windows should eliminate the need for mechanical ventilation altogether. Throughout the year, the control system will advise occupants via an LED panel in offices when open windows are a good idea, but it gives the occupant the last word.

SECOND SKIN: The Westarkade's control system manipulates ventilation flaps on the building facade to maintain a ring of air pressure around the building.
PHOTO: KFW BANKENGRUPPE

Of course, that's all theory. "We will see if it works," said Axel Hinterthan with a nervous laugh, as he led journalists around the nearly completed Westarkade a few months ago. Hinterthan is director of project management for KfW Bankengruppe, which commissioned the Westarkade as an expansion of its Frankfurt headquarters complex. He admits that KfW is taking a chance on new technology to further green-building design, which is an important role for the state-owned development bank. Created decades ago to implement the Marshall Plan, KfW now administers, among other things, low-interest federal loans for energy-efficiency upgrades.

Transsolar engineer Björn Röhle says his company is confident that the pressure-ring facade is the most efficient means of building windows into a tower. He says that a team at the University of Karlsruhe, in Germany, will monitor the Westarkade's energy consumption for two years to test whether this approach works.

Oregon architect Perepelitza expects that it will take two years just to tune the Westarkade's control systems for optimum energy performance. He cautions that the double-skin design was overhyped and that some similar early projects "didn't live up to the promise." But he is nevertheless bullish about the pressure ring's potential, which he says was extensively modeled by Transsolar and builds on the earlier designs. He thinks it could point the way forward for glass towers as natural ventilation and energy efficiency grow in importance. "This building represents a new generation," Perepelitza says.

—Peter Fairley

the prevalence of feather pecking," Roberts says.

What isn't clear yet is whether the method will provide an early enough warning of future problems, says animal behavior and welfare researcher Bas Rodenburg of Wageningen University, in the Netherlands. Fatalities in flocks seem to result from the tension between the way chickens are raised and some of their basic instincts. Chicks hatched into today's system are likely to be raised in large numbers, in close quarters, and with very little training in how to be hens, he says. Since they can eat their fill with little effort, their age-old instinct to forage and peck for food all day doesn't have an outlet. "It's really important to stimulate healthy foraging early on," Rodenburg warns, because birds who can't forage the normal way—by pecking the ground in search of food—are likely to peck at other things instead, including their neighbors.

In recognition of these problems, in 2012 the European Union will outlaw the smallest poultry cages in favor of cages with more room for chickens to wander and express their foraging instincts. But Rodenburg notes that the trend toward free-ranging flocks may enable the most deranged hens to harm more of their coop mates. Dawkins and Roberts, meanwhile, are making larger-scale versions of their system and aim to share future detectors with farmers and animal welfare agencies for real-time monitoring of other variables and other species. "It doesn't replace observant farmers," says animal scientist Blokhuis, "but it could focus the farmer's attention."

—Lucas Laursen