Turtles make the right moves via remote control (w/ Video)

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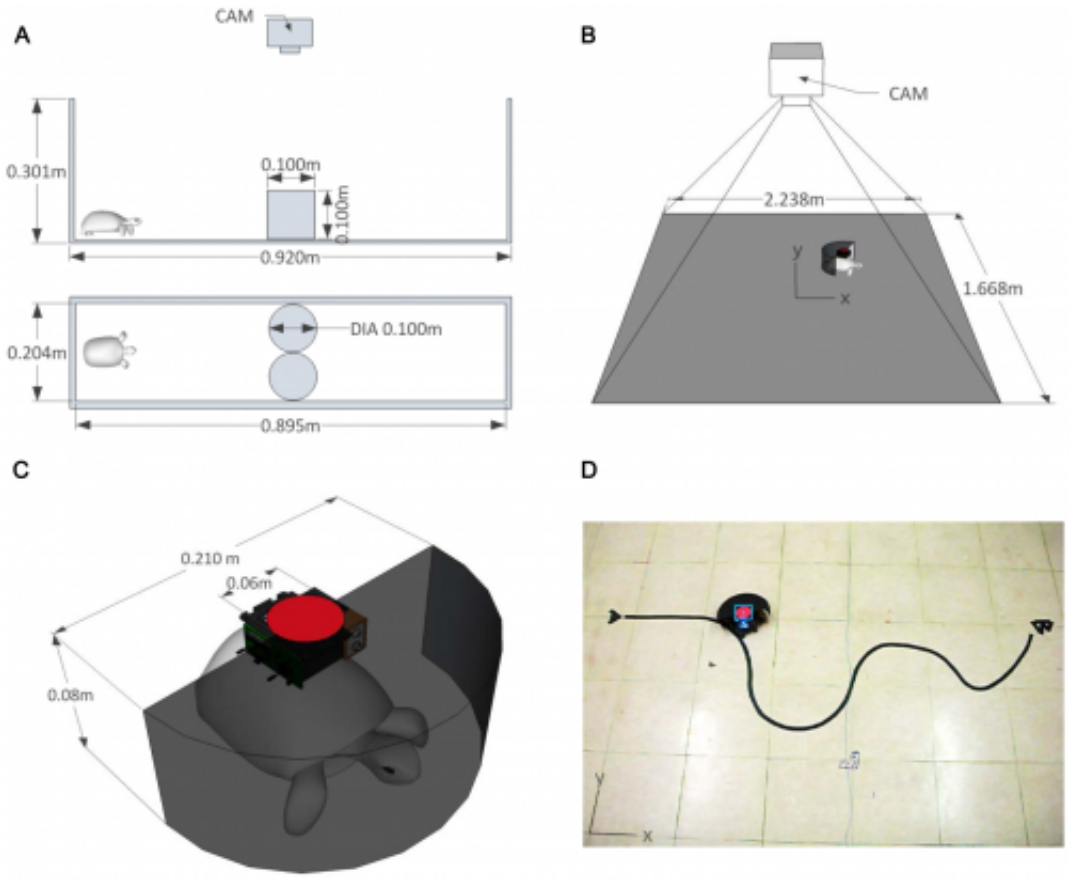

Depiction of experimental remote-controlled visual stimulus delivery and tracking systems. (A) To examine the turtle's visual obstacle recognition, an experimental arena was equipped with a camera and two movable cylinders as obstacles (shown from the side view and from above). The dimensions of the arena, surrounding walls, and obstacles are indicated. (B) Experiments performed on the laboratory floor area (with the dimensions indicated) are shown in the drawing. The placements of the turtle, obstacle, and tracking system are shown. (C) The embedded control system to block the turtle's view is shown

in the drawing. The servo motor controls the positioning of the semi-cylinder obstacle (in the image, it is positioned directly in front of the turtle). The red circle on the controller tracked by the simple tracking algorithm was regarded as the location of the turtle. (D) The turtle was remotely controlled to follow the desired path by alternating the visual angle of the obstacle between ±180 (no stimulus) and ±90 degrees. Credit: doi:10.1371/journal.pone.0061798.g001

(Phys.org) —Your typical robot story tends to be about robotics teams finding clever ways to make their mechanical devices mimic real animals in shape and movement. A study coming out of South Korea has a twist. Researchers there are working with live animals subjected to remote control. Their study subjects are being described by bloggers as cyborg creatures or remote-control pets. The team from the Korea Advanced Institute of Science and Technology have shown how a live turtle can be made to follow a winding path through special apparatus that is used as a "noninvasive" steering system. Their study, titled "Remote Guidance of Untrained Turtles by Controlling Voluntary Instinct Behavior," describes their work and their results in taking "red-eared sliders" (*Trachemys scripta elegans*). and placing an attachment to the shells, a half-cylinder remotely rotated with a servo.

Rotating the half-cylinder gave the turtles the message that there was an obstacle on one side or another. The turtles followed suit, taking whatever direction meant being able to avoid the obstacle. According to the team's paper, the materials they used for steering and tracking the turtles included an embedded control module mounted on the turtle's upper shell with a circular color patch for tracking. A black semi-cylinder was used to block the turtle's view. A micro controller unit, ARM Cortex-M3, STM32F101V8T6, received an angular value, they wrote, to control the servo motor, which could rotate the black semi-cylinder within ±180 degrees, from a PC control software written in C#

via Bluetooth communication.

Four turtles for the study were grown indoors in labs at the authors' institute (KAIST). The turtles were housed in a water-filled glass tub fitted with a water filter and had a dry platform for basking. The turtles were sunbathed six to seven hours under a UV lamp. They were fed commercial pellets four times a week. After six hours without feeding in the tank, said the researchers, they were moved to the floor or the experimental table for experiments. As each experiment was repeated, the turtles became sluggish from fatigue; different turtles were used for experiments every ten minutes.

The team showed that by tapping into the animals' instinctive behavior of obstacle avoidance, they achieved control. They devised an apparatus that allowed them to rule over the turtles' movements, just by drawing on the turtles' instinct to avoid obstacles. So what?

The authors readily answered that question in the paper: "All animals, including humans, usually act by reaction to stimuli. In particular, a reactive behavior connected with bodily protection is essential and must occur quickly, and it must be evoked, mediated, and directed in a consistent manner by a stimulus. From these studies in turtles, we have observed a consistent pattern of control of an animal's movement trajectory utilizing the innate instinctive behavior of obstacle avoidance, and we propose this as a novel behavior control scheme. Using this non-invasive scheme, our system of animal behavior control can be more stable and adoptable. The system is suitable for application in tasks traditionally carried out by mobile robots, such as surveillance and reconnaissance, exploration and navigation, as well as other missions dangerous for humans."

Also, they intend to expand their research using other animals. In future works, they want to apply their framework to other animals "with

excellent vision."

They see hawks, cats, and lizards as good candidates, strong enough to carry larger devices. As for fish: "Through our on-going research, we already found that the same framework can be employed to control fish." While the study of turtles was controlled in a well-prepared experimental setup, they recognize there would be further challenges ahead—e.g., waterproofing, telecommunication, and navigation. Nonetheless, in facing the challenges, the technology may be used in deep sea exploration, they wrote, "and could replace our dependence on robotic probes."

More information: Lee S, Kim C-H, Kim D-G, Kim H-G, Lee P-S, et al. (2013) Remote Guidance of Untrained Turtles by Controlling Voluntary Instinct Behavior. *PLoS ONE* 8(4): e61798. doi:10.1371/journal.pone.0061798

Abstract

Recently, several studies have been carried out on the direct control of behavior in insects and other lower animals in order to apply these behaviors to the performance of specialized tasks in an attempt to find more efficient means of carrying out these tasks than artificial intelligence agents. While most of the current methods cause involuntary behavior in animals by electronically stimulating the corresponding brain area or muscle, we show that, in turtles, it is also possible to control certain types of behavior, such as movement trajectory, by evoking an appropriate voluntary instinctive behavior. We have found that causing a particular behavior, such as obstacle avoidance, by providing a specific visual stimulus results in effective control of the turtle's movement. We propose that this principle may be adapted and expanded into a general framework to control any animal behavior as an alternative to robotic probes.