Gesture Based control of Snake robot.

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1. Abstract

In this paper we present a new gesture based control for snake robot using a custom developed accelerometer based data glove. This Snake robot which was biologically inspired was developed for the purpose of search and rescue and serve as a research platform for its locomotion analysis. The locomotion of Snakes is because a differential curve traveling in its body from the head to the tail and the traction it generates from the surface because of such a traveling wave. This has several controllable parameters like amplitude, frequency, phase difference, angular velocity etc. By changing these parameters the Snake robot can change from sidewinding (as used by the desert snakes), crawling (like caterpillars) or even lift its hood up to look behind an obstacle like a king cobra.

2. Introduction

In a previous work [6] a caterpillar based legged robot was developed which could be controlled from the laptop using USB-RF modems but the Snake version of the same still functioning in a stand alone gait execution mode. Also we developed an API for the integrated physics simulation and CAD design environment of google sketchup with sketchy physics. To improve the interactivity and control of the Snake we developed a data glove with accelerometers. The main accelerometer is on the users palm which is used for sensing tilt and the direction of Snake’s motion. The second accelerometer rests on the users fingers.

Previously control of the Snake robots has been through control of cumber-some GUIs with sliders and checkboxes to set the appropriate parameters or through hand held remotes and joysticks which offered a slightly better control for controlling the gait. The directionality of the Snakes gait be wheeled or non-wheeled can be achieved by introducing an offset in the differential curves which turn biases the gait towards the desired direction. Gaming devices like the Microsoft’s wheel became popular because it feels like driving a real car by using a steering wheel and this is more natural than a handheld joystick. Even the game of tennis played with a Nintendo Wii-mote where the user swings his hand as if he is holding a shuttle racket is more intuitive and fun to use. So computer interface devices which are more natural, intuitive and relate to the real world metaphors of the task being performed offer a greater ease of use, faster learning curve and users can easily adapt to such devices. With the same understanding this data-glove was developed for the Snake.

3. Embedded Architecture

We used two accelerometers (ADLX330 and MMA7660FC) one is less sensitive than the other. The MMA7660FC is a less sensitive I2C accelerometer which is generally used in cell phones to detect tap or shake. The MMA7660FC was used to identify the rotation of the fingers (middle and indexed fingers). A more sensitive analog accelerometer was used to sense the rotation of the hand. The raising of the Snake’s hood was detected my measuring the acceleration about X axis and the acceleration value from the MMA7660 FC was used for identifying head roll and head retract. Also the motion of the data glove along a mutually perpendicular axis (Y) can be used for guiding the Snake. A voice assistive output has also been provided which indicates the mode and the change.

We were able to identify the following actions:

1) Hood lift: Just as the real Snake lifts its head to strike or look behind an obstacle we were also able to identify the same. This action was also translated to the simulated model in google sketchup. This data glove can also be used in games to identify gestures with animated Snakes or animals like giraffes, squirrels which have a long head lift action. Here we implemented it for Snooping operation where the Snake robot has a camera and can look behind obstacles like rocks, tall grass, into holes etc.

2) Head Roll and Retract: After the Snake lift’s its neck the head can be rolled and retracted to change the angle at which the Snake’s camera is looking. Also this secondary action can be used in games for changing the camera’s view.

3) Normal mode: The Snake can be brought where it crawls like a caterpillar by keeping the hand horizontal.

4) Gait change mode: This gesture has been inspired from the metaphor of grasping a clutch on a bike to change gear. Here curling the fingers towards the palm and retracting them quickly back to the normal position will cycle through the available modes of locomotion thus changing the Snake’s gait. For example in video games if the terrain changes from grass to sand one can change from Side-winding to crawling. So based on the terrain on can switch to better gait patterns.

4. Simulated gait

Snakes have not been much adapted in games. Even a few Snake’s shown in the game have only a single convention

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motion the serpenoid gait. Unlike a natural Snake where the gait is limited by its kind the animated and animatronic / robotics Snakes have the capability to show more than a single gait. This can be used in simulation and gaming where a different gait is chosen based on the terrain the Snake can adapt in a best way possible or on real robots for search and rescue where challenging terrain not traversable by legged or wheeled robots can be used. The 3D snake game in Nokia phones can be made more interesting by adding more gaits and introducing different terrains like water, grass, logs or steps, rocks etc. We were successfully able to get the following gaits in the Snake robot: side-winding, concertina, rolling, caterpillar gait or vertical undulation, serpenoid gait or horizontal undulation, flapping, turning 360 degree in place. These gaits were generated as a combination of vertical and horizontal differential sine waves passing through the chain like structure of a Snake’s body. These simulations can be adopted to bio-inspired games as well for example the Snake’s found in Nokia’s phone can include more advanced maneuvers as the above gaits.

Demo video of the Snake here:  

4. Acknowledgements:

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3. References:

[1] Snake robots by Dr. Gavin Miller: http://snakerobots.com