Virtual Drums

http://www.virtual-drums.com

From Real

To Virtual !

The Technology Involved

A Brief History

- Created by Matthieu Aubry and his 2 friends from INSA Lyon, France, while trying to find a possible use for the a real-time stereovision 3 dimensions tracking system they had created.

- No, the idea didn't strike them in a "garage".

Basic Principles Involved

- Image detection using the Frozen Chameleon algorithm
  (see website www.virtual-drums.com/frozen-cameleon.php)

- 3-Dimensional Motion Capture

- Pre-sampled Audio Programming

The Recipe

- A Personal Computer with the Virtual Drums software installed.
- Two web-cams (30 Hz sampling rate)
- Two tailor-made drumsticks (with strong LEDs at its heads. Different colors for distinguishing the drumsticks.)
- A video-game pedal (for the bass drum)
- A Passion for both Drums and Technology!

How it works…

A 7 Step Process!

Step 1: Swing the Sticks!

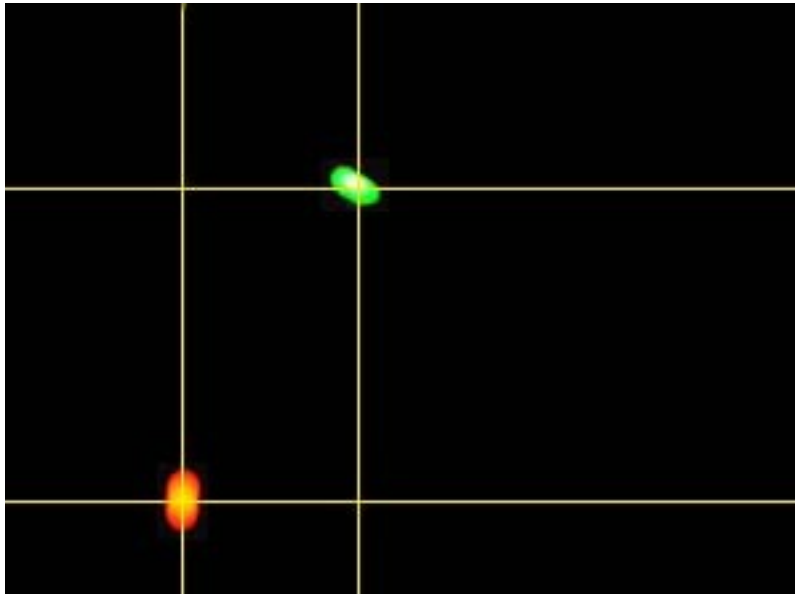
- Drummer swings the specially designed drumsticks (with two strong LEDs – one green and the other red – at their tips) in the air.
- Here we see our good friend Matthieu doing the chores!

Step 2: Adjust to the Surroundings

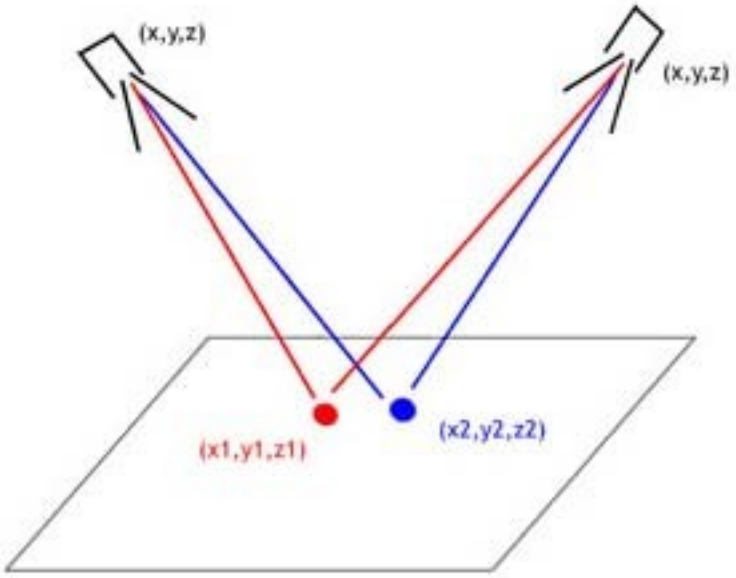
- Adjust the gain, saturation, balances, exposure-time of the cameras so that the LEDs can be observed distinctively.
- Depends on the environment in which it's being played.

Step 3: Catch the LEDs

- Detect the movement of the drumsticks (LEDs) in 2-D space with the help of algorithms for determining form and color.
- At this stage, it is necessary to get rid of unwanted noise and store only the relevant information.



Step 4: Locate the LEDs



- Knowing the 3D positions of the 2 cameras in the absolute reference mark, we determine the 3D position of the drumstick LEDs via with simple triangulation calculations.
- The error due to geometrical deformations of the lenses of the cameras are accounted for.

Step 5: Use DSP to make sense

Once the rods are detected, we carry out the calculation their speed as well as other interesting information, such as

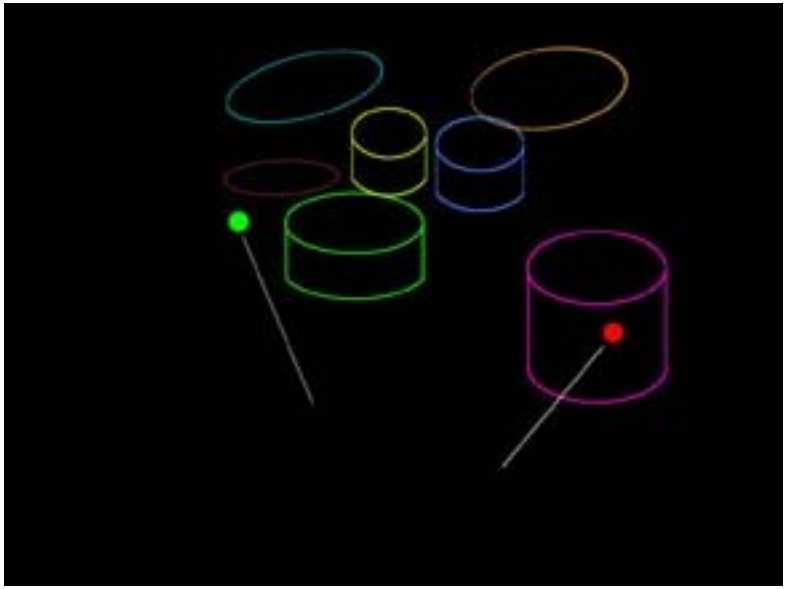
- frequency of appearance
- lifespan of the object
- resemblance to the ideal model

Speed = 0.83 m.s^{-1}

Position = (1.2; 0.25; 0.78)

Detection rate = 93%

Step 6: Make a Decision…



- Via an algorithm of analysis of movements and positioning, we determine if the rod is in collision with one of the virtual drums.
- The calculation of the spatialization in 3D is then carried out, allowing one to make a "faithful and realistic" sound reproduction.
- Sound (pre-sampled) depends on velocity of the strike also!

Step 7: Play the Drums!

- The 3D interface posts in real time the position of the sticks (LEDs) w.r.t. the virtual drum-kit setup.
- The drums are activated in the 3D interface in the event of collision.
- The drums start making sound. Yippee!!

How to detect the sticks..

The

Frozen Chameleon

Algorithm!

Frozen Chameleon :What is it ??

- A software for capturing motion of colored objects on the screen

- Developed by Matthieu Aubry and his friends (Julien Rouvière, Xavier Maurice) at INSA Lyon, France.

How does it do that ??

- First, they convert the RGB (Red, Green and Blue) frame into HSV (Hue, Saturation and Value) color space.

- Then they specify a certain "central" color with thresholds on Hue (+5 to -5, say) and Saturation.

How does it do that ??

- Then, you map the RGB plane onto a List which determines whether a certain color has been mapped or not.

- To reduce memory requirements and increase processing speed, number of colors in reduced from 24 million to 4096.

How does it do that ??

- Then, you use the Blob algorithm to find the regions with the maximum collection of such colored points. You ignore the rest.

How does it do that ??

- Then, for example, you try to figure out how close the ratio of the area of those figures are (compared to the area of the smallest encompassing square) to $\pi/4$.

- The figures are enumerated. The one resembling the circle the most (using many different criteria) is taken to be the LED head of the drumstick

Once the head is detected distinctively, it's motion can be tracked easily!!

How do you get the Sounds?

- Pre-Sample the sounds of an actual Drum-Kit – each of it's different instruments (Snare, High-hat etc), for different strike powers and store them in the program.
- Play the corresponding sound-file depending on the position and velocity of the strike on the Virtual Drum-kit.

Advantages over "Real" Drums?

Lots of them, but mainly…

- The Cost Advantage
- The Sound Advantage
- The Size Advantage

The 'Cost' Advantage

- Much cheaper
- A decent "entry-level" drumset costs around $350 (around $1200 in France).
- Virtual Drums: 2 Webcams x $50 each, two sticks x $10 each, A video game pedal x $10..so (assuming user already *has* a computer), total cost comes to..

$150 only!!

The 'Size' Advantage

- Big Drum kit => Big hassles, almost impossible to carry around everywhere you go.
- The entire Virtual Drums setup fits into a 50cmx10cm box!!
- And finally, the Drummer too can be seen by the hot chicks in the first row of a rock concert!! Move aside, bulky view-blocking drum-sets!

The 'Sound' Advantage

- Can program in lotsa different kind-of sounds, which can be changed during playtime at the flick of a button, e.g switching over from Techno to African Percussions over the same kit.
- Simulating famous drummer's drum-kits!
- Using effects like Chorus, Echo etc.
- No sound when u don't need it…can use headphones .. so no nasty neighbors either!
- Training-mode with pre-loaded rhythms. Learn faster!

"Imagination is the only limit to the Evolution"

Matthieu Aubry
Creator, Virtual Drums

Thank You!

Presentation made by Suryadeep Das
during the presentation of the Virtual Drums software
at a Workshop during Shaastra festival
in October 2006, IIT Madras, Chennai, India