Mt. Lebanon
Virtual Pet

Project Documentation 9-25-2019

Summary

The school is a community of practice in which learning, experimentation, and the opportunity for reflection are the norm. It is with this mindset that we embark on this collaborative project attempting to enhance the student experience in our middle school. Our goal is to envision, create, and put into place a product that will use artificial intelligence to make a positive impact on our school climate. We will create a "virtual team pet" that will "live" within our four 8th grade Iron Brigade team classrooms. This pet will embody three pillars: CASEL's five components of SEL, AMLE's 16 Characteristics of Successful Schools, and scientifically proven benefits of pet therapy. Middle level students make multiple transitions between our classrooms each day. Relationships are at the core of our student-centered practices and can increase students' feeling of connectedness to school. Computer-based applications can support real-time assessments that can aid in both implementation and program evaluation efforts. As new technological innovations appear, so will ideas about how they can be used most effectively in SEL programming. This collaboration between an interdisciplinary middle level team, private industry, and an institution of higher learning is an attempt to combine current best practices in SEL, middle level education, pet therapy, and emerging AI technology to enhance student experiences within our "Schools to Watch" middle school.

Rationale

Relationships and emotions affect how we learn and how we use what we learn. While emotions can generate an active interest in learning and sustain our engagement in it, unmanaged stress and poor regulation of impulses interfere with attention and memory and contribute to behaviors disruptive to learning. Furthermore, learning is intrinsically a social and interactive process. It takes place in collaboration with one's teachers, in the company of one's peers, and with the support of the school climate. Relationships are the engine of learning. Current best practice guidelines for middle level education recognize the diverse developmental needs of this age group and the importance of promoting both academic and personal development, including social and emotional competence. SEL knowledge, skills, and attitudes are especially relevant during adolescence because youth at this stage are going through rapid physical, emotional, and cognitive changes. These changes create unique opportunities for middle schools. At the classroom level, the quality of teacher-student interactions is one of the most important predictors of student academic performance and adjustment. Interpersonal and organizational factors at the school level also influence students' academic performance and adjustment, in part through their effect on school climate. Students who perceive a positive climate in their school demonstrate higher levels of social competence and report fewer personal problems. In schools characterized by supportive relationships, common goals and norms, and a sense of collaboration, students perform better academically and have fewer behavior problems. In short, quality relationships are important dimensions of school climate

Partner Organizations

Carnegie Mellon University Entertainment Technology Center (https://www.etc.cmu.edu/)
The ETC is the premiere professional graduate program for interactive entertainment as it's applied across a variety of fields, exploring transformational games, innovation by design and interactive storytelling. The ETC excels at creating an educational environment in which interdisciplinary students acquire collaboration, creativity and communication expertise while applying their artistic and technical skills through design-based research projects.

Mt. Lebanon School District (https://mms.mtlsd.org/)
The public school system in Allegheny County for residents of Mt. Lebanon, Pennsylvania, a suburb of Pittsburgh, Pennsylvania. The district has won multiple National Blue Ribbon School awards.
[7] The high school was rated as one of the Top 500 high schools in the United States by *Newsweek* in 2000 and 1st in Western Pennsylvania by the *Pittsburgh Business Times* in 2005.[8]

Automadable (https://automadable.com/)
Your friendly, neighborhood automation company. Automadable is a small business automation company. We specialize in rapid prototyping technology solutions across the entertainment, education, and hospitality industries.

Credits

Jeffrey Halliday
Interdisciplinary Teacher @ Mellon Middle School / Mt. Lebanon School District

John Balash
Director of Educational Engagement at CMU Entertainment Technology Center.

John Choi
CEO of Automadable and Lead Software Developer

Hardware

Looking Glass Holographic Display

The Looking Glass® is the first desktop holographic display designed for 3D creators. Create, view, and share in true 3D - no VR or AR headsets required. Studies show that across all age groups and subjects, student recall is much stronger when curriculum leverages three-dimensional content. 3D is just more real and therefore more engaging. With the Looking Glass, we can create full-on '3D classrooms' without the needing 3D glasses or VR/AR headgear. With the Looking Glass, multiple students can interact with one system. For our Virtual Pet, this is the star of the show, and it can be purchased here: **https://lookingglassfactory.com/products/the-looking-glass/**

Leap Motion Gesture Controller

The Leap Motion Controller senses your hands and fingers and follows their every move. With infrared cameras and highly complex mathematical algorithms to translate hand and finger movements into 3D input, it lets your hands move in all that wide-open space between you and your computer. The Leap Motion Controller can track your movements at a rate of over 200 frames per second in a super-wide 150° field of view and a 1.5ft Z-axis for depth. At just 3 inches long, the Leap Motion Controller transforms the space above into a 3D interface for your hands, working alongside a keyboard, mouse, stylus, and/or trackpad for a richer and more natural 3D computing experience. It can be purchased together with the Looking Glass as a bundle, or separately here: https://www.adafruit.com/product/2106

Intel NUC NUC7i5BNK Mini PC/HTPC

We need a Windows 10 machine with enough graphical computing power to run the Looking Glass holographic display, Leap Motion hand tracker, and simple computer vision algorithms simultaneously at a playable frame rate (24-30 frames per second minimum at 2560x1600 resolution). For this, the minimum recommended specs are computer with at least 128GB storage memory, minimum 3.0GHz processor speed, 8GB RAM memory, and 4K resolution display output. We also need a portable small form factor so that the computer can be wall mounted anywhere in a classroom.

At these specifications, we recommend the **Intel NUC NUC7i5BNK Mini PC/HTPC:**
- 7th Generation Intel Dual-Core i5-7260U 2.2GHz With Turbo Boost Upto 3.4GHz, 4MB Cache
- 8GB DDR4 2133MHz, 128GB Solid State Drive m.2 SATA
- Intel Iris Plus Graphics 640 with 4K Support
- Wifi, Bluetooth 4.2, Gigabit Ethernet, Card Reader, Dual Monitor Capable
- Windows 10 64Bit, 1x Thunderbolt 3, 4x USB 3.0, 1x HDMI, 1x Audio Jack

This Intel NUC model computer can be purchased here:
https://www.amazon.com/NUC7i5BNK-Dual-Core-i5-7260U-Bluetooth-Thunderbolt/dp/B0751RJDRV/

Logitech HD Pro Webcam C920

For computer vision emotion tracking, we need a webcam. While it does not necessarily have to be this model, we do want a webcam with decent contrast and resolution and is easily mountable. For this, we choose the Logitech HD Pro Webcam C920, which can be purchased here:
https://www.amazon.com/Logitech-C920S-Webcam-Privacy-Shutter/dp/B006JH8T3S/

Sabrent 4-Port Powered USB 3.0 Hub with 5V/2.5A Power Adapter

As there are many accessories connected to the Intel NUC Mini PC, we need another small USB hub to extend the number of ports and help regulate the flow electricity with another power adapter. We recommend purchasing this one: https://www.amazon.com/Sabrent-Individual-Switches-Included-HB-UMP3/dp/B00TPMEOYM/

Sanyun SW102 Computer Speakers

A standard set of USB powered speakers with 3.5mm audio jack. These were chosen for their cute cylindrical form factor. This set of speakers can be purchased here: https://www.amazon.com/Sanyun-Computer-speakers-Diaphragm-USB-Powered/dp/B075CRYDC5/

Logitech Bluetooth Multi-Device Keyboard K480

A standard wireless bluetooth keyboard will allow the user to discretely control the virtual pet. A full list of keyboard commands can be found in the shortcut section of this guide. Although it can be any wireless keyboard for remote control, we recommend purchasing this one as it connects with a bluetooth chip (and not a wireless USB dongle, which can be easily lost):
https://www.amazon.com/Logitech-Bluetooth-Multi-Device-Keyboard-K480/dp/B00MUTWLW4/

Standard Monitor with HDMI Input

While the Virtual Pet does not require an additional monitor when in use, it is exceedingly useful to have an additional monitor to setup and configure the Intel NUC Windows 10 Mini PC. While the Looking Glass is recognized as a standard HDMI screen, the screen size is very small and the refractive elements of the 3D glass screen make it hard to read small text and icons, which is necessary for set up. While any screen with an HDMI input works, one can be purchased here:
https://www.amazon.com/Elecrow-Raspberry-1920X1080p-Resolution-Speakers/dp/B076GZVCP2

LAN Network Router

A standard wireless local area network router is needed for strong wireless communications between the player computers. This does not need to be connected to the internet, and only serves as a base platform to create a local wireless area network *(note that internet is required however for speech recognition though)*. Most standard commercial wireless routers will work. The router used and tested for this project is the **Tenda N300 Wireless Wi-Fi Router with High Power 5dBi Antennas** (it can be purchased here: https://www.amazon.com/Tenda-Wireless-Router-Antennas-F3/dp/B01CA5SN1K)

Custom Enclosure

Purchasing notes: one of each of the following items (with the exception of the router) is required for each instance of the Virtual Pet in the classroom. It is recommended and encouraged to allow students to create a custom laser cut or 3D printed enclosure for a unique and unified custom constructed cage to house the Virtual Pet. Here is an example of how this can be done: https://www.instructables.com/id/Mini-Pi-Powered-Arcade-Machine/

Software

Initial Configuration:

There is a process to maximize utility of the hardware and software of the virtual pet to ensure it works as optimally as possible. Please follow the following steps to ensure everything works correctly:

(This is a one-time step, for first installation and configuration:)

1. Connect the Intel NUC Mini PC to a standard monitor, speakers, USB mouse and keyboard.
2. If Windows 10 has not been gone through the initial setup process, do so now.
3. Once Windows 10 has been installed correctly, please install <u>Google Chrome</u>, and change it to the <u>default browser</u>.
4. Connect the Intel NUC to the <u>Logitech Bluetooth Keyboard for remote control.</u>
5. Change the <u>Power and Sleep Settings</u> to "Never" and "Never" for both Screen and Sleep.
6. Plug in the Leap Motion Controller and install <u>Leap Motion SDK and Drivers.</u>
7. Plug in the Logitech Webcam and install <u>Logitech Webcam Drivers</u> if needed.
8. Download both the Mt. Lebanon Virtual Pet app and create a shortcut to the desktop.
9. Download the ChromeSpeechProxy and create a shortcut to the desktop.
10. Change the <u>Windows 10 Custom Display Scaling Size</u> to 300%.
11. Plug in both the HDMI and USB ports of the Looking Glass onto the Intel NUC.

Running the App:

After completing the one-time initial configuration, you can now run the virtual pet software.

1. Keep the Logitech Webcam plugged in.
2. Unplug the Leap Motion Controller.
3. Start the ChromeSpeechProxy app and start Speech Recognition with a Chrome tab (this requires internet to work!).
4. If you are using the Looking Glass, run the Virtual Pet app in 3D mode. If you are using a standard monitor, run the Virtual Pet app in 2D mode. *(Note that the 3D Virtual Pet app requires significantly more graphical computing power than the 2D version!)*
5. Say something like *"Hello Rufus!"* to make sure the speech recognition is working.
6. Make sure that the webcam and face tracking is working by looking at the camera.
7. If it is working, plug in the Leap Motion Controller, and then test to see if it can track your hand. (Note that the Intel NUC has a weird USB initialization problem that requires that the webcam is connected first, and then the Leap Motion, otherwise the webcam won't load properly.)
8. The app is ready to use continuously over the course of the day!

3D Display Mode

This is the full setup including all hardware ingredients: the Intel NUC, the Logitech Webcam, the USB Speakers, and the Leap Motion Controller. The Looking Glass is shown below with its full 4x6-inch 3D holographic glory. To use the 3D hologram effect, use the Virtual Pet app in 3D mode.

2D Display Mode

The Virtual Pet can be run standalone on a standard monitor as well if the Looking Glass is not available, or if the 3D hologram rendering requirements is running too slowly on the installed machine. Use the Virtual Pet app in 2D mode if this is the case:

Note: You can switch between 2D and 3D modes at any time by pressing the **[Space]** *key.*

Leap Motion Gestures

The virtual pet can be interacted with your hands using the Leap Motion Controller. Up to two hands can be tracked simultaneously. Try waving, petting, and fist bumping virtual pet!

	Toy Ball *Grab and release this item to toss a toy ball for the virtual pet to chase and play with. There are 4 different random ball types it can randomly spawn.*
	Water Bottle *When the virtual pet gets dirty or thirsty, grab and shake the water bottle up side down to pour a stream of water on the virtual pet.*
	Food *Grab and release this item to feed the virtual pet with a snack for when the virtual pet gets hungry. There are 18 different random food types it can randomly spawn.*
	Cleaning Brush *When the virtual pet gets dirty or thirsty, grab and shake the cleaning brush add soap and scrub the virtual pet. The pet will get dirty every couple of hours, and will begin to glow a greenish hue.*

Face Tracking

On the upper right corner of the screen is a face tracker. If the face is being tracked, a green box will be rendered on the position of the face. Every time a new face is tracked, the dragon will be happy to see a fresh face. Note that the face tracker does not do face recognition, only positional and rotational tracking, so it will not be able to distinguish between faces.
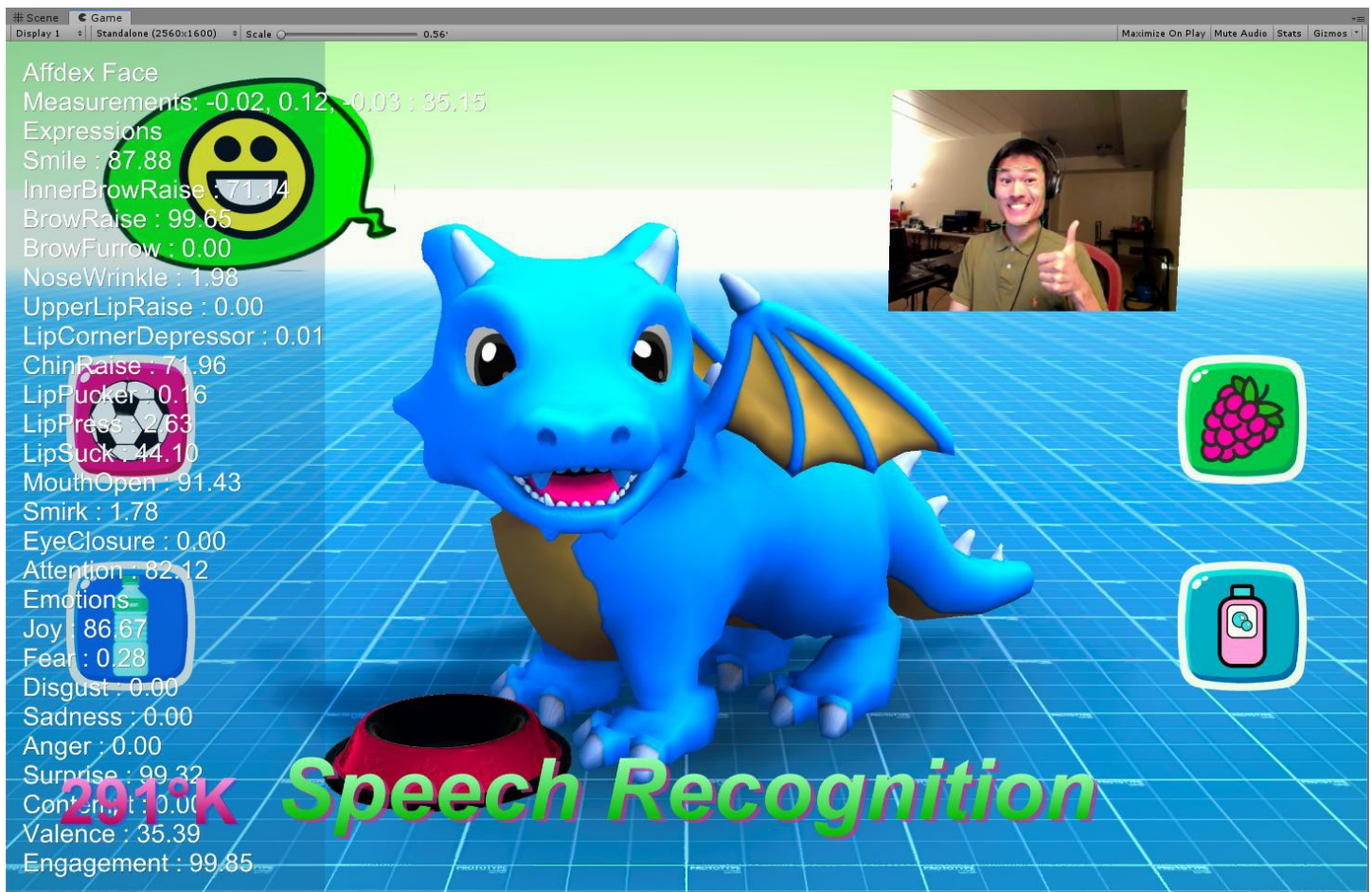
The face tracker is able to calculate and estimate the user's emotions based 36 different "key face marker points", which are not rendered on the screen. These emotions are *Joy, Fear, Sadness, Anger, Surprise, Contempt, Valence, and Engagement.*

Press **[Tab]** on your keyboard at any time to show/hide emotions being estimated.

Every time a face is lost, it will save anonymous average emotion data it recorded to this directory:
Virtual Pet Folder\Mt Lebanon Virtual Pet_Data\TrackedEmotions

It will be saved in the following format as "TrackedEmotions_yyyy-mm-dd.csv":

Timestamp	Duration	Joy	Fear	Sadness	Anger	Surprise	Contempt	Valence	Engagement
2019-09-25 12:39:17PM EST	0.03	0.001813622	0.004578852	0.02386333	0.004499251	0.1953716	0.1932959	-0.0220871	0.08087896
2019-09-25 12:39:18PM EST	0.08	0.001816534	0.005492403	0.03599431	0.004136006	0.234007	0.1978965	-3.254198	0.1124773
2019-09-25 12:39:27PM EST	3.24	0.001196914	0.1116991	0.1015504	0.06681074	9.028331	0.2557696	-21.12615	26.70152
2019-09-25 12:39:28PM EST	0.19	0.0003038146	0.4607611	1.697974	0.0004880813	37.41269	0.1943084	-47.85707	53.74357
2019-09-25 12:39:49PM EST	6.67	0.001612496	0.06869087	0.2345432	0.151656	5.036182	0.4249129	-14.02263	10.49218

Social-Emotional Learning Games

SEL is the process through which children and adults understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions. SEL skills are critical to being a good student, citizen, and worker, and many risky behaviors can be prevented or reduced. SEL is a way students and adults interact both in the classroom and out of it, and helps provide children with equitable, supportive, and welcoming learning environments.

We assign keyboard mappings to allow the virtual pet to participate in a selected excerpt of SEL games from *"Mindful Games Activity Cards: 55 Fun Ways to Share Mindfulness with Kids and Teens"* by Susan Kaiser Greenland. They are as follows:

[1] Fading Tone *We listen closely to the sound of a tone as it fades away to help us relax and focus.*
[2] Feeling My Feet *We pay attention to the feeling of the bottoms of our feet to relax, concentrate, and become aware of what's happening at this moment.*
[3] Resting and Noticing *While relaxing and paying attention to the sensation of breathing, we note when thoughts and emotions distract us by silently saying the word thinking.*
[4] Pinky Pointing *We point a pinky finger – up, down, and to the side – to help us notice how we're feeling and communicate it to others.*
[5] Mindful Waiting *While we're waiting, we choose a nearby object (a potted plant, a coffeepot, a tree) to focus on. We gently gaze at the object to relax and notice what's happening within and around us.*
[6] Mindful Listening *There are always sounds around us even when a room seems quiet. We listen carefully to sounds to become more aware of our experience in the present.*

Speech Recognition and Keyboard Animation Commands

By running the Chrome Speech Proxy, it is possible to allow the virtual pet to hear and understand a few simple pre-trained phrases with advanced real-time speech recognition technology (this requires an internet connection. The virtual pet does not collect and store any recognized speech locally.)
Use either speech or a key press to activate the following animation commands:

[Q] **"Jump"** makes the virtual pet jump.
[W] **"Bite"** makes the virtual pet bite forward.
[E] **"Five"** make the virtual pet do a high five.
[R] **"Bark"** makes the virtual pet bark.
[T] **"Sleep"** makes the virtual pet sleep.
[Y] **"Dead"** makes the virtual pet play dead.
[U] **"Eat"** makes the virtual pet eat.
[I] **"Stay"** makes the virtual pet lay down.
[O] **"Sit"** makes the virtual pet sit down.
[P] **"Fly"** makes the virtual pet fly.
[Esc] **"Stop"** stops the current animation.

Multiplayer

If there are multiple machines set up to run the virtual pet, It is possible to have the virtual pet share multiple different locations to traverse around, so that the pet can move from class to class to class. To do this, make sure all machines running the virtual pet software are connected to the same local area network, and make sure the Virtual Pet app is allowed through the Windows firewall.

Designate one of the computers as the Host. Run this machine's Virtual Pet app first, and note the machine's local IP address (*192.168.1.2 in the image below*). Click on the **Start LAN Host!** button.

When starting the other instances of the virtual pet, enter the host machine's local IP address in the **Join Game** field, and then click on the Join Game button to join the host machine's virtual pet.
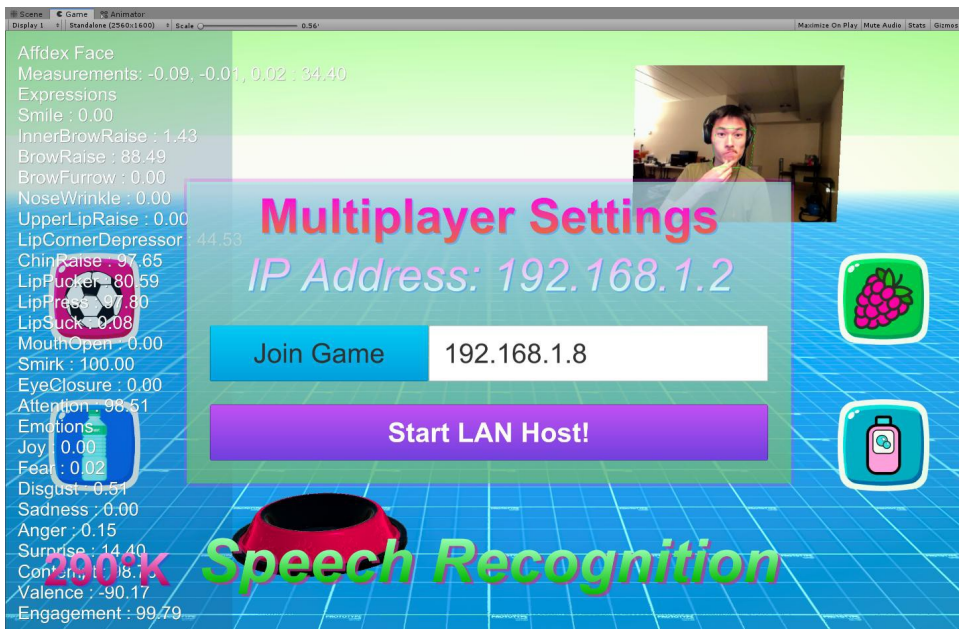
Then all instances of these machines will share the same Virtual Pet across several classrooms!

Press the **[Enter]** key to teleport the Virtual Pet to your machine's instance.
Press the **[Backspace]** key to teleport the Virtual Pet away from your machine.

Keyboard Mappings Index

[Space] to switch between 2D and 3D modes.
[Tab] to show/hide emotion recognition user interface
[Enter] key to teleport the Virtual Pet to your machine's instance.
[Backspace] key to teleport the Virtual Pet away from your machine.

[1] Fading Tone SEL game on listening.
[2] Feeling My Feet SEL game on feet nerves.
[3] Resting and Noticing SEL game on meditation.
[4] Pinky Pointing SEL game on emotions and moods.
[5] Mindful Waiting SEL game on patience and meditation.
[6] Mindful Listening SEL game on listening, time, patience and feeling.

[Q] "Jump" makes the virtual pet jump.
[W] "Bite" makes the virtual pet bite forward.
[E] "Five" make the virtual pet do a high five.
[R] "Bark" makes the virtual pet bark.
[T] "Sleep" makes the virtual pet sleep.
[Y] "Dead" makes the virtual pet play dead.
[U] "Eat" makes the virtual pet eat.
[I] "Stay" makes the virtual pet lay down.
[O] "Sit" makes the virtual pet sit down.
[P] "Fly" makes the virtual pet fly.
[Esc] "Stop" stops the current animation.