DeskPal

An interactive and persuasive companion on your desk :)

Making Things Interactive Final Project

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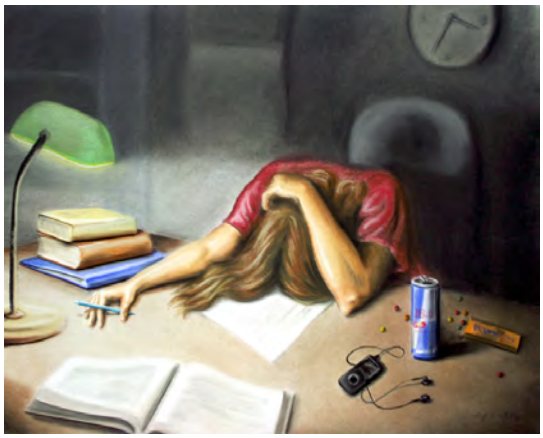
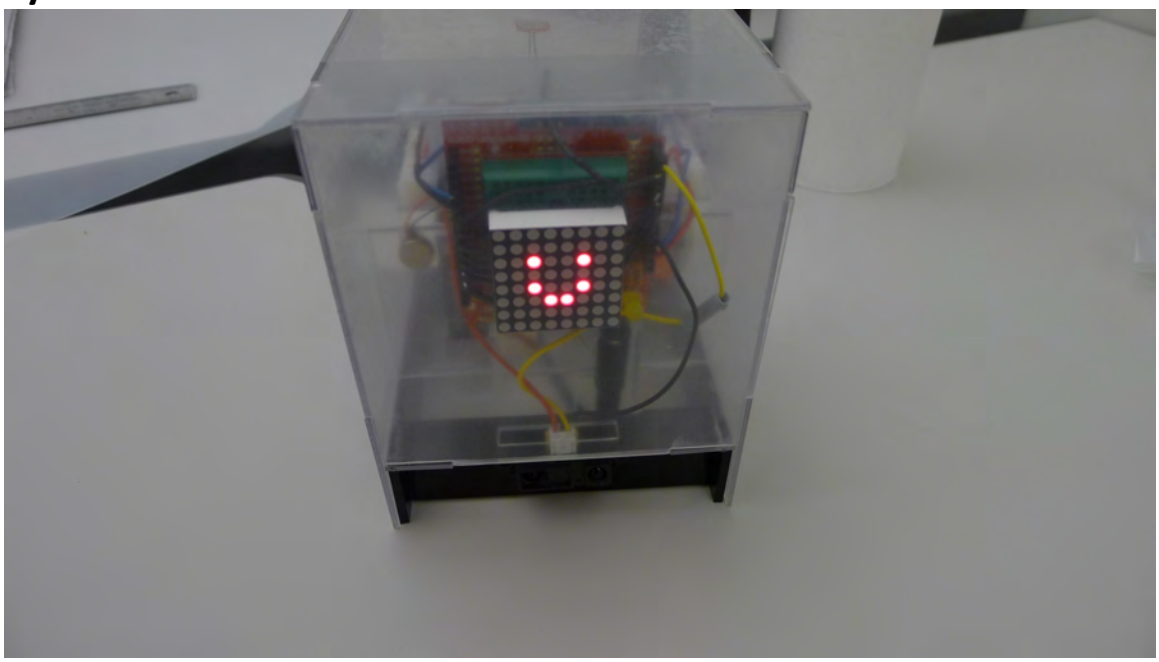
The Idea



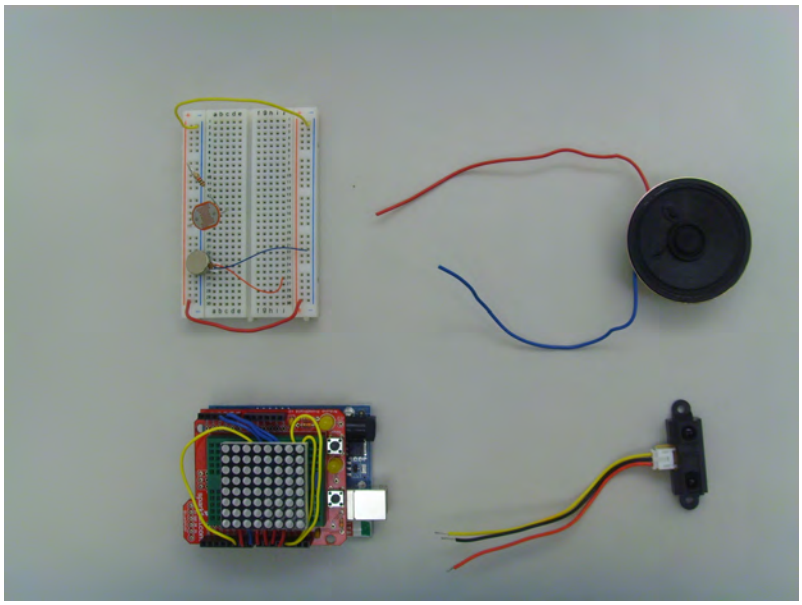
As a graduate student, you've probably been spending most of your days sitting on a desk. Over time, we eventually develop a lot of bad habits without knowing! Such as bad sitting postures, falling asleep doing work, simply just being extremely exhausted. Persuasive technology have a huge potential in addressing these types of problems we face everyday. DeskPal is a persuasive companion aiming to improve these common behaviors and making the desktop workspace a more fun place to work.

System Overview



DeskPal communicates with the user mainly through different "emotional states", the transitions between the states are determined by the current sensor inputs and different states have different actions associated. An example scenario might be when DeskPal senses the user is in a bad sitting posture, it starts to vibrate with an angry face, and it'll only stop when the user touches it and corrects their posture (DeskPal will then put on a smiley face and stop vibrating). A 2nd scenario is when the room temperature starts to get cold, DeskPal turns blue and starts vibrating in a certain way, the user noticed it and puts on some clothes, then touches DeskPal to calm it down.

What you need



8X8 LED matrix (1)
Vibration Motor (1)
Speaker (1)

Photoresister (1)
Infrared Proximity Sensor (1)
1K Ohm Resistor (2)

Acrylic boards to laser-cut

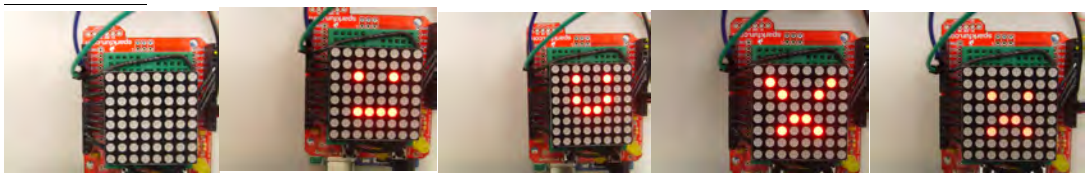
Arduino ProtoShield Kit with mounted breadboard (1) – optional

Construction

Testing Things Out

The initial step is to test out every input and output components work individually. The first obstacle I ran into was working with the LED matrix.

LED Matrix



The face expressing emotions on DeskPal was first drawn on paper to visualize and then implemented. Matching the correct pins were straightforward referencing the schematics. The harder part lies in the software implementation of setting up the structure and the draw function.

IR Proximity Sensor

The proximity sensor was pretty sensitive on the readings and sometimes jumps. Originally I had bad posture detection based on a single if statement, resulting in a overly sensitive response making DeskPal angry all the time. Thus, I improved it by simply set a integer that counts the number of loops with bad posture reading. Letting it react only when it senses 5 consecutive counts makes it more reasonable and stable.

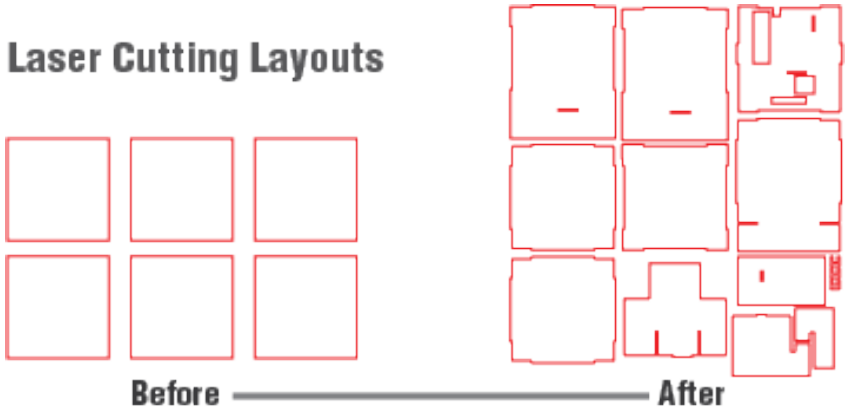
Others

The speaker and the vibration motor are quite straightforward with simple connections to an output pin, power and ground. In the process I only encountered minor signal

interference on the speaker pin (PWM pin), producing unwanted beeping sounds. This was fixed by using strictly anologWrite on the speaker pin.

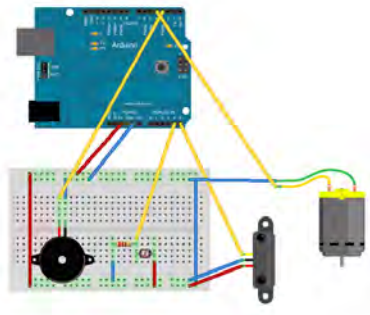
Designing Physical Structure

In the beginning the idea of putting everything in a hollow cube seemed pretty easy. What can go wrong with cutting 6 squares and gluing it together? The more I dwelled into the project, the more I realized the need for a robust structure to hold everything in one place, and that was hard! The structure was designed from the concept of toys that have pieces snapping together. In the process there were major tradeoffs between flexibility and precision. The more parts you want to have it "snap in" the more precise you have to be. Layout was done in illustrator and cut with 0.2 cm PETG board.

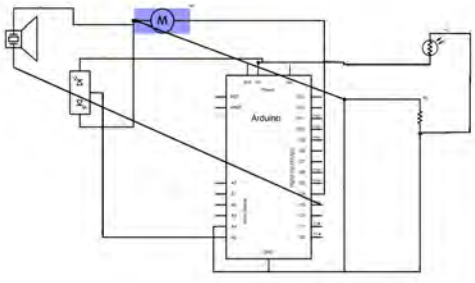


Wiring and Circuit

For the ease of readability, the LED matrix was omitted from the diagram. It is very straightforward to connect



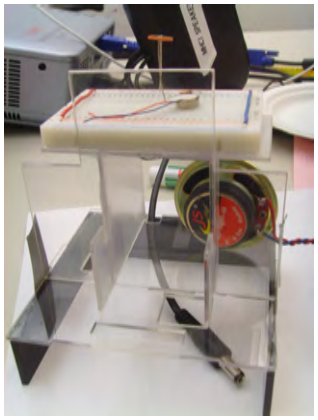
Breadboard view

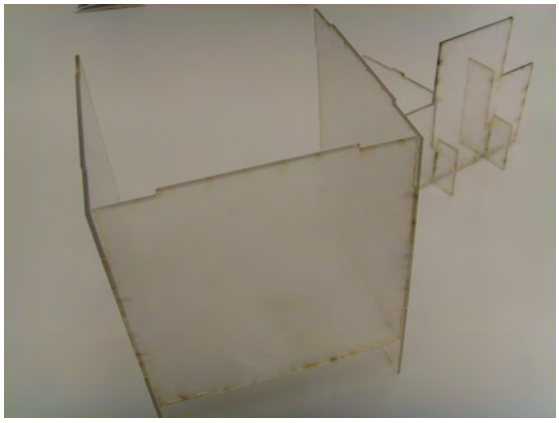


Schematic view

Digital pin 5 to 13 and analog pins 0 to 2 (a total of 12 pins) were used to control the 6X6 LED matrix. Because the one I got were multi-color, I had to look up the specs of the matrix and get the correct pins.

Building and Wrecking it





After all the pieces were cut out from the board, I discovered that they didn't "snap together" as I had predicted. This was mainly due to the laser width (around 0.5 mm) that wasn't taken into account. Thus I had to use a lot of glues to stick it together. The process of gluing it was a challenge on its own, the fact that I used a rather thing plastic made it hard to hold when I added the weight of the actual component. So often times I went back and forth of gluing and breaking things at the same time.

Also there were minor burnt marks on the edge of the pieces cut out due to oversetting the power of the laser. So be sure to always test cut a few pieces first.

Sensing

Sitting postures – With consideration of incorporating all the sensors onto the Deskpal itself, I decided to simplify the definition of a bad posture as the distance from the user's upper body to DeskPal. This way I can achieve the sensing by simply mounting an infrared proximity in the bottom of DeskPal aiming 30 degree upwards. Then setting a threshold and a response time for emotion state jump. As the reading from the proximity sensor goes above the threshold for 10 cycles, the system determines it as bad posture (IR sensor readings increases with the decrease of distance).

Touch – Given that DeskPal will be placed on the desk where the user studies, the context environment will have sufficient and stable lighting. Thus, touch interaction can be simulated cheaply and effectively by a photo-resistor. The threshold is determined as half of the current light value. The threshold is adaptively changing in every loop cycle, and triggers touch interaction whenever a lower value is sensed.

Output

The decision on the forms of output came from the observation of current pet-like toys available on the market. DeskPal is design to interact with the user in a less obtrusive

and a rather passive manner. Visual, vibration, and audio are the 3 aspects of output I focused on. With visual as the most important aspect and audio as the least important.

Emotions

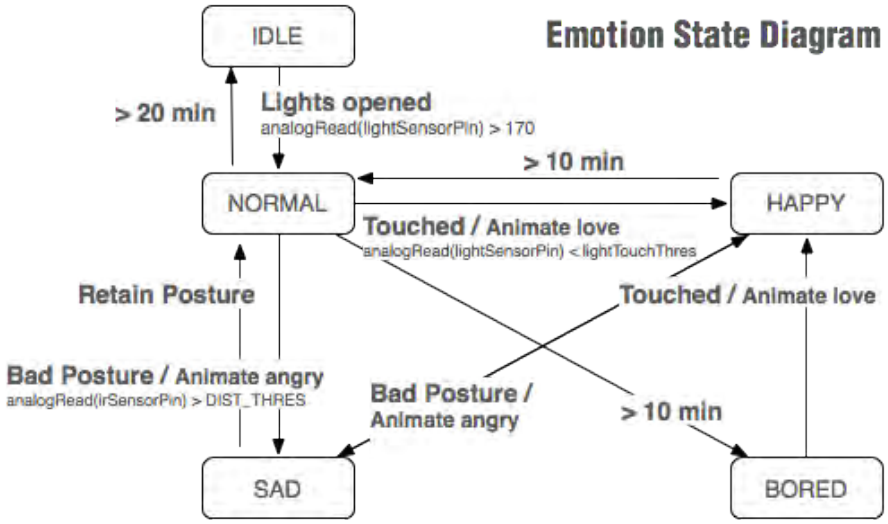
Out of the 8X8 LED matrix module, I only used 6X6 to display the "face" of DeskPal, which only requires only 12 pins (compared to 16), and was tested sufficient for the purpose.

Emotion State	Display	Description
IDLE		The initial state of DeskPal, where the four dots are displayed in a consecutive sequence. Jumps to NORMAL state if it senses presence of light.
NORMAL		This is the standby state where it checks sensor inputs to make necessary transitions. Animation programmed here is left and right movement.
HAPPY		State of DeskPal happy upon detecting touch. Up and down animation programmed.
BORED		The state reached after having no transitions for 10 minutes in the NORMAL state. No animation in this state.
SAD		This state is reached after bad posture has been detected. DeskPal makes an angry transition (described below) then jumps to this state. No animation in this state.

2 transitions are annotated with display to make it more apparent.

Transition	Display	Description
ANY to SAD		Upon detecting bad posture, I thought it would make it more interesting for DeskPal to get mad first and then be sad afterwards.
ANY to HAPPY		Upon detecting touch from the user, DeskPal expresses love first and then jumps to HAPPY state.

The animation displayed on the matrix depends on the emotional state of DeskPal. Implementation is basically that of a state machine where the transitions are sensor inputs and timer; Actions incorporated into each state are the functions displaying or animating different emotions. (see diagram below)



Tactile Feedback

A vibration motor is mounted in the interior to give user tactile feedback when they touch DeskPal, activated the same instance as the transition from any state to HAPPY. Vibration is also used when it gets mad, providing a much more subtle feedback that is appropriate with the context of studying.

Audio Feedback

Given its purpose of serving as a study companion, the amount of audio feedback should be minimized to avoid interfering with user studying. However, it might be a good to have the functionality there for expanding the context of use. DeskPal only gives a tiny beep on transitions.

Summary

In the future, I would explore a richer feedback possibility with the LED matrix, such as dealing with the constraint of pin numbers and use incorporate multi-color on it. Also, microphone can be used to have DeskPal reacted on speech input, and other different sensors can also be used to extend the context of use of DeskPal. Besides the problems mentioned in the previous sections, I also had problems finding the desire material for the actual box to have a half-transparent presentation. Another thing was that the vibration motor was a bit too strong, making the vibration a distraction instead of a subtle reminder.

The process of putting sensors together and making something useful is truly an exciting process! Also, the initial thought process and project planning also gave me a lot about actually starting and carrying out a project, when dream big, when to reasonably scale it back, etc.