Omega Vest

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PROBLEM STATEMENT AND OBJECTIVE

Current "4-D" technologies are only available in large theaters and theme parks.

Our objective is to design a portable, wearable system that can deliver "4-D" experiences to the users wherever they go.

DESIGN CONCEPT

Our design concept included the following key elements:

- It will support the following Windows operating systems: Vista, 7, and 8, for both x86 and x64 architectures.
- It will have a user-friendly video player that will be able to play major video file formats, such as MPEG, MOV, AVI, and WMV.
- The video player will be able to play videos between 24 and 30 frames per second.
- The video player will be able to send signals serially to a microcontroller that will turn on or off the components.
- The "4-D" effects that the vest will emulate are vibrations, air, and scent.
- The air and scent effects will be actuated by servos.
- The system will have small motors and larger motors to apply vibrations to the chest and abdominals.

DESIGN APPROACH

- Create an application compatible with Windows computers using .NET framework. The application has playback capabilities and sends signals to the microcontroller every 50 milliseconds.
- Use an Arduino Uno microcontroller to receive the signals sent by the video player and control the effects of the vest.
- Use 4 24-mm motors to provide vibrations to the chest and abdominals.
- Use 4 7-mm motors to provide vibrations close to the neck.
- Use a servo that provides a 3.2 Kg-cm torque to actuate the air valve and press the button of the scent can.
- The components of the system are powered by a 6V AC/DC adapter.

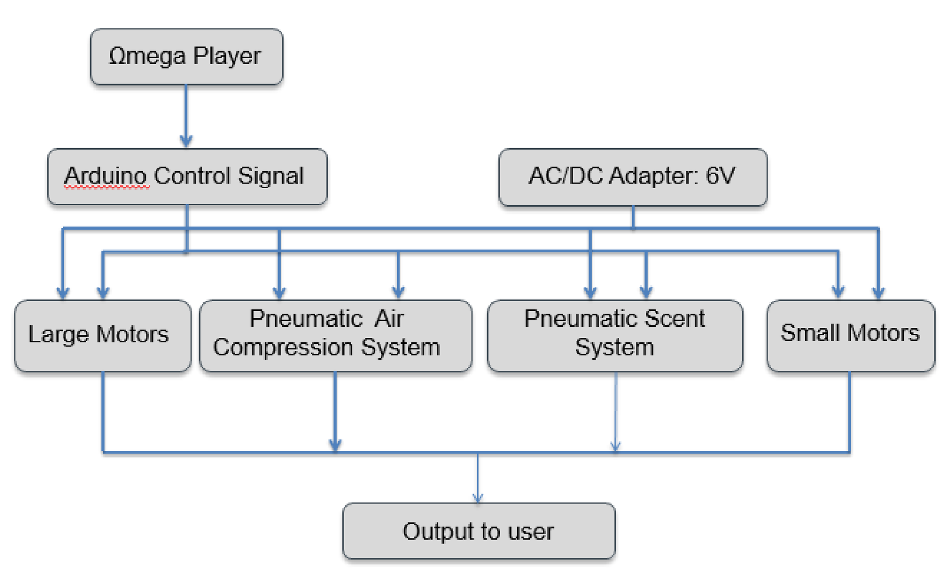

Fig. 1: Block Diagram

TEST PROCEDURE

Our testing procedure consisted of three phases.

Phase I: Software testing

- Test compatibility with Windows operating systems.
- Test playback capabilities with .MOV, .WMV, .MPEG, and .AVI video files.
- Test detection of multiple Arduinos.
- Test period of time required for a cycle of 6 string serial messages sent.

Phase II: Circuit and vibration motors testing

- Design and simulate motor switching circuits.
- Implement preliminary circuit board and final prototype circuit board.
- Simulate the transient response (settling time) of the vibration motors.
- Design 3D enclosures for the components
- Test if 3D prints interfere with operation of the motors.

Phase III: Pneumatic systems and load testing

- Test angles of rotation for pneumatic scent and compression systems.
- Perform an overall load test.

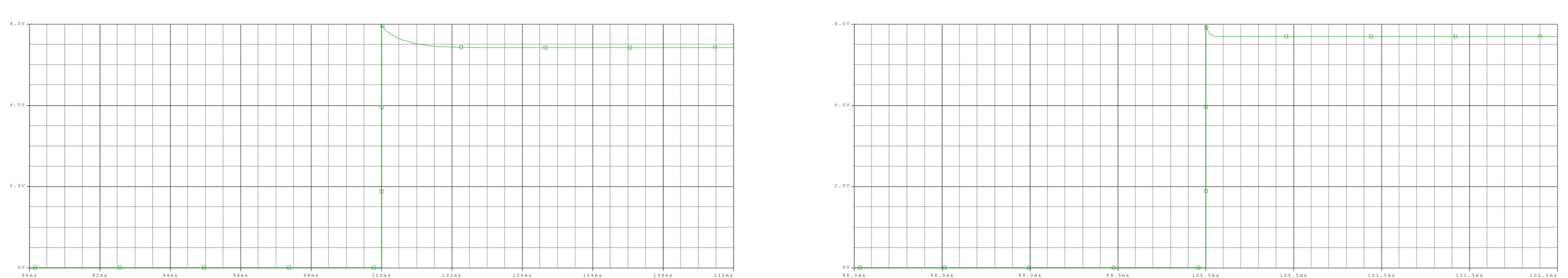

Fig 2: Step response of 24-mm motor (left) and Step response of 7-mm motor (right)

IMPLEMENTATION

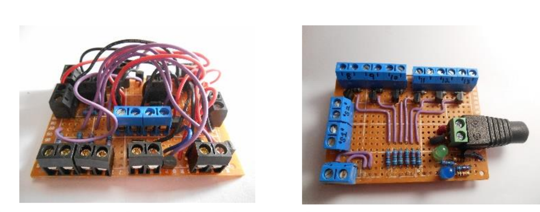

Fig 3: Initial (left) and current (right) circuit boards

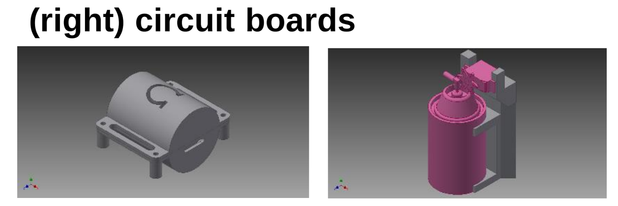

Fig 4: Motor Housing (left) scent canister holder (right)

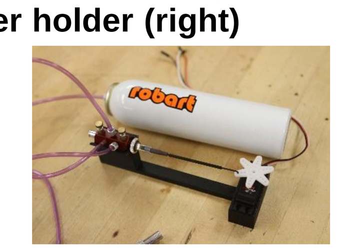

Fig 5: Complete pneumatic compression system: valve, tank, servo, tubes, and 3d-printed holder

Figure 6: Omega Vest System

COST ANALYSIS

Component	Unit Cost	Units Used	Mass Production
Microcontroller	$26.00	1	$3.00
Servo	$16.99	2	$6.45
24-mm Motors	$5.00	4	$0.14
7-mm Motors	$1.00	4	$0.08
Scent Canister	$6.49	1	$1.23
Vest	$30	1	$14.00
6V AC/DC	$6.59	1	$2.37
Air tank/Valve	$40.98	1	$23.86
Miscellaneous	$30.00	1	$10.00
Total		$198.04	$68.24

Table 1: Estimated development and production costs

Table 1 shows a summary of the development costs and an estimation of the production costs. The cost for developing a proper prototype of the Omega Vest was $198.04 and our estimations indicate that the production costs would shrink to $68.24, which is 34.45% the original cost. Below are some of the reasons for such a drastic drop:

- Current microcontroller is an Arduino. For production, we would use an ARM processor, which is significantly cheaper, especially when over 1000 units are bought.
- Cost of vibration motors is reduced considerably if over 1000 units are ordered.
- Similarly, the servos, air tank, vest, AC/DC adapter, etc. would lower their costs if bought en masse from overseas.
- The cost for miscellaneous, which includes resistors, wires, and 3D-printed housings would be much lower for companies owning a manufacturing facility or fabrication lab.

CONCLUSIONS AND FUTURE WORK

We conclude that our project has been completed successfully. All components function as desired and are within expected electrical behavior. Omega Player software works efficiently and is free of bugs. Movie clips can be encoded and watched through the Omega player and responses are felt from the vest. Many different additions can be made to make the Omega Vest better. To start with, it could be made wireless by adding a Bluetooth module or RF module. Also, its functionalities can be expanded by adding more motors to different regions of the vest, or allowing for more scent canisters. Lastly, the Omega Vest could be paired up with augmented or virtual reality devices, such as the Google Glass or Oculus Rift respectively, to make the experience even more immersive.

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