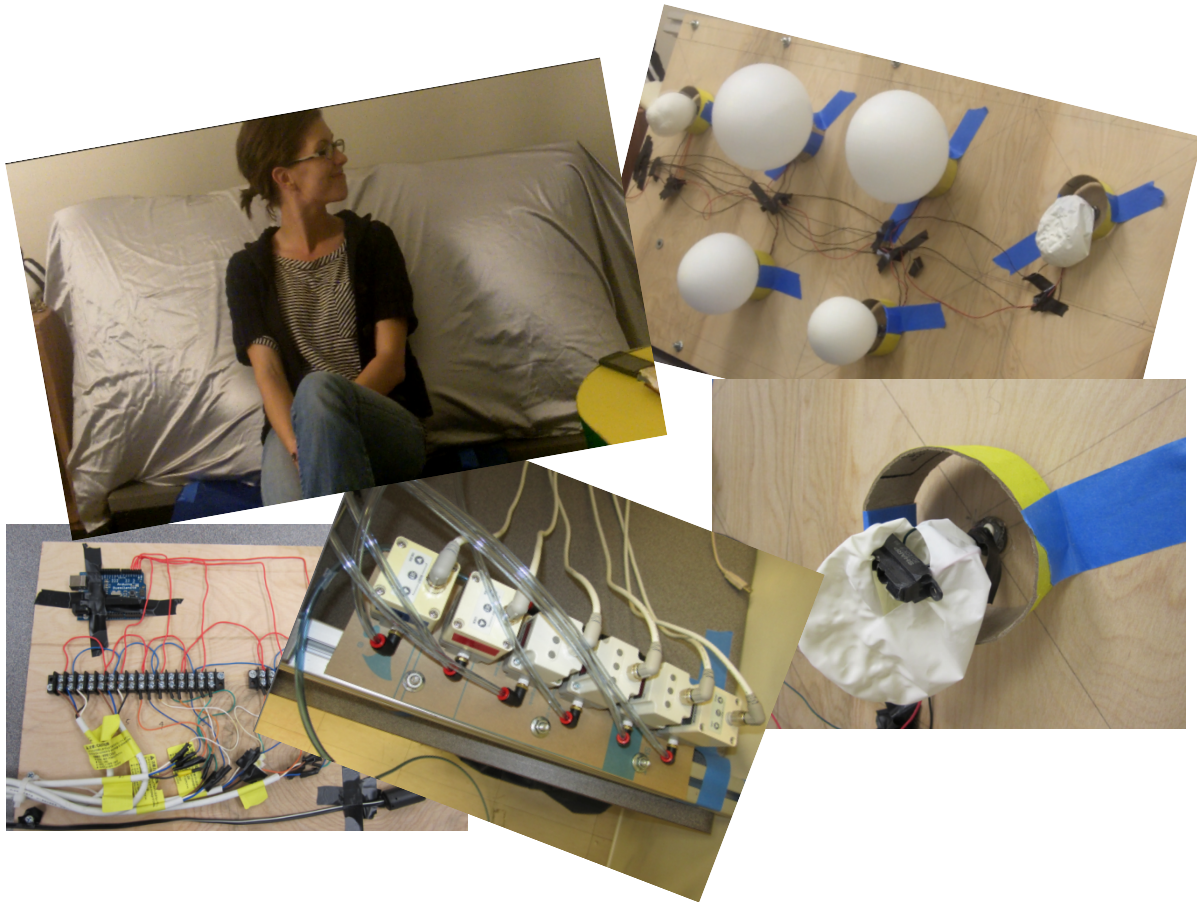


The Animated Headboard



YouTube Video:

http://www.youtube.com/watch?v=tkA_GTxojiM

Abstract

The animated headboard is an innovation in furniture that satisfies both utilitarian and aesthetician. Headboard is a piece of furniture attached to the head of bed, located usually between the bed and the wall. It was originally used to keep sleeper warm during night time by isolating cold stone wall and redirecting air drafts from the sleeper's head. However, with air conditioner entering homes and increasingly stricter building code, the bedroom is quite warm even during a harshest winter night. Hence, the head board is now purely a decoration. In many cases, it is omitted or simplified to be a thin piece of wood.

At the meantime, people are complaining about comfortless when sitting on the bed watching TV, reading books or surfing Internet on portable devices. A common solution is to pile several pillows

against the headboard to provide back support. However, this temporary solution often suffers from lacking of support and needing of regularly re-organizing of pillows.

We reinvented the headboard and made it a piece of dream furniture. The six pneumatic actuators in the headboard will be adjusted as needed and give you the most comfort support when you are leaning towards the headboard watching your favorite talk show, reading the latest bestseller or checking friends Facebook updates. I can also massage your tired back. A pure luxury enjoyment!

Scenario

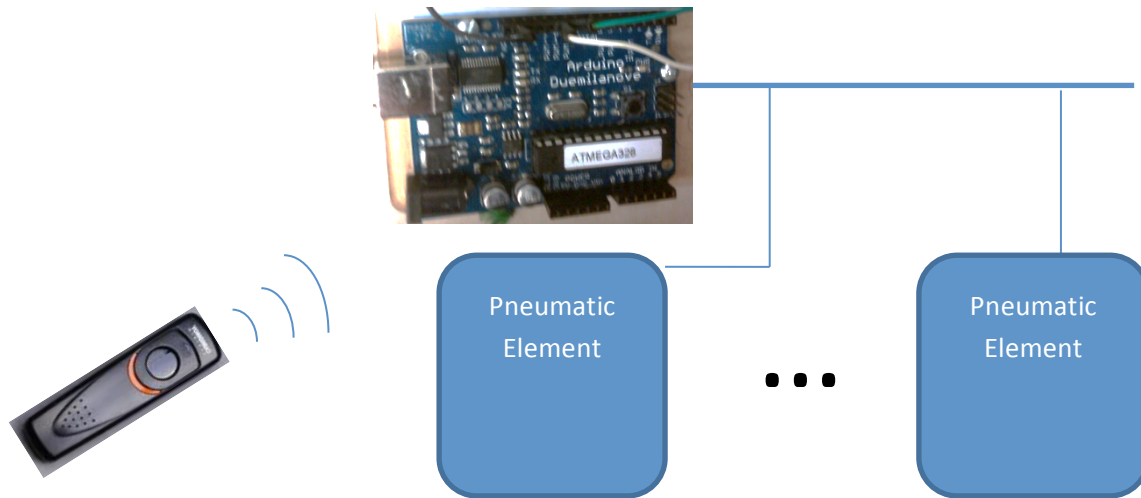
- A. Matthew, 29, was on a business trip to Dallas. One night, he was watching his favorite David Letterman show in the bed in the hotel. He leaned against the headboard and felt it uncomfortable due to the decorated rough surface. He put several pillows between his back and the headboard. It was less painful with this ghetto solution. However, he had to adjust the pillows from time to time because they tended to slip out of the gap. He was so upset that he missed a lot of fun moment when busy fixing his pillow back support. The next day, he checked into a different hotel. The manager recommended him the newly installed animated headboard system. He tried it and it surprised him. He not only finished the whole talk show without turning back adjusting pillows but also enjoyed a soft massage from the headboard after shower to relief stress from work.
- B. Joyce, 57, lost her husband in a workplace accident six years ago. After that she was suffering serious insomnia and as long as she close her eye lid, image of her passed away husband shows up in her mind. Lacking of sleep, she fall down in the stair case the day before yesterday and broke her left arm. During her stay in hospital, she was watching a novel before sleep. Suddenly, the story in the novel together with loneliness reminded her husband, and she cannot help to cry. She leaned towards the headboard helplessly with tears on her face. She saw a small remoter was attached to the headboard and recalled the nurse mentioned this new equipment called animated headboard. She quickly got though the intuitive interface and enabled a comfort setting. Then she just leans sideway and felt being hugged in by the shaped headboard. She felt much better after that.
- C. Jerry, 17, got both legs serious injured two weeks ago when he was running across the street and hit by a taxi. The doctor said he will be OK to walk in another month. However, sitting on the bed all day would be a really boring experience. Luckily, his best buddy let him use his PSP. He finished two games in a row but felt his back suffers. He talked with his parents, and they agreed to move him into a new animated headboard enabled room. The room is slightly more expensive but worth the money. Jerry never felt back pain anymore and the doctor said he recovered faster than expected, which is probably due to Jerry's good attitude.

Structure

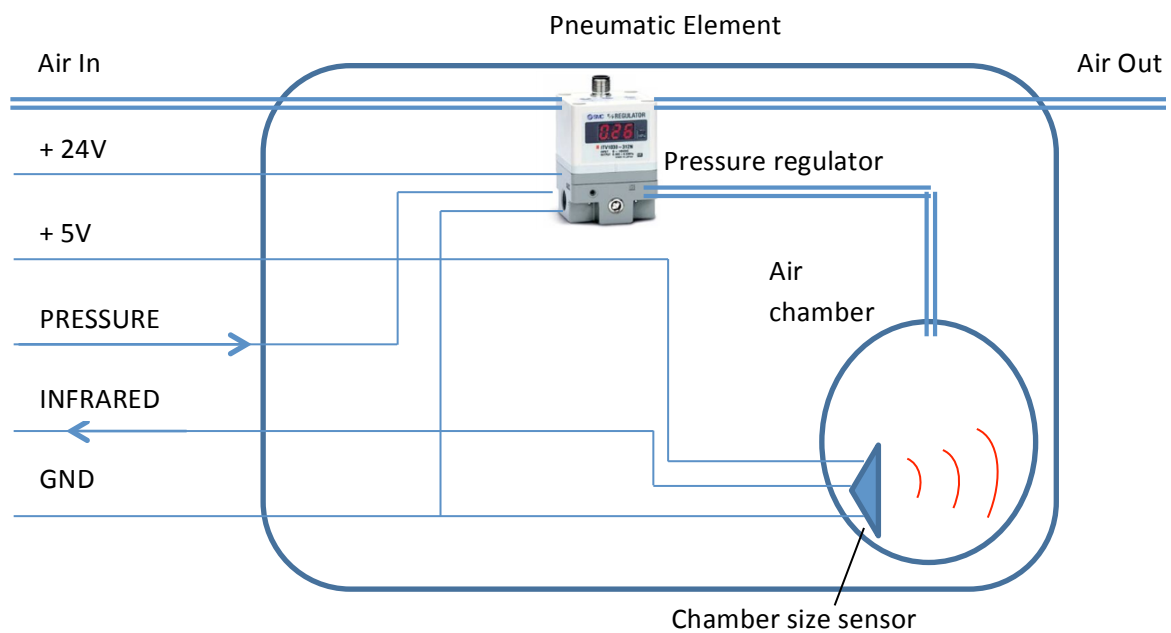
The animated headboard is consists of six pneumatic elements and a central controller. Each element is independently actuated by a pressure regular to maintain a specified size. One element is consists of an air chamber, which serves as a human compliant actuator; a pressure regulator and an infrared chamber

size sensor. The central controller is connected to each element and form close-loop control for individual element. Central controller also accepts user command from remoter.

Below is a system diagram:

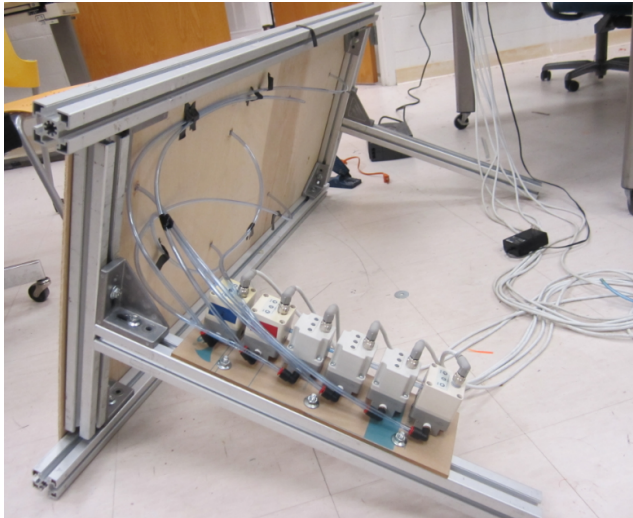


The mechanism of individual element is shown as below:

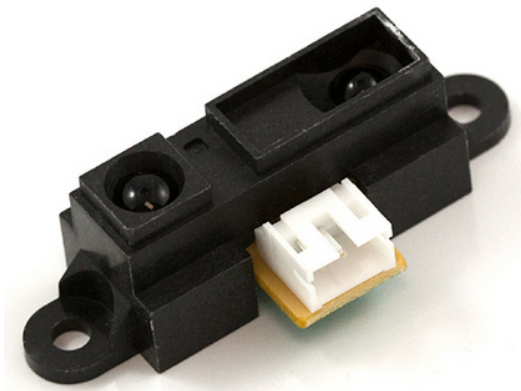


Equipment

- Animated headboard hardware structure (built by Peng Xu and George Shafer)



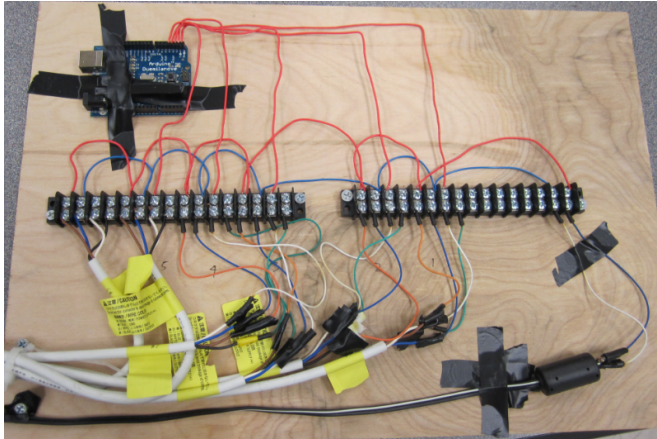
- Sharp infra-red range sensor X 6



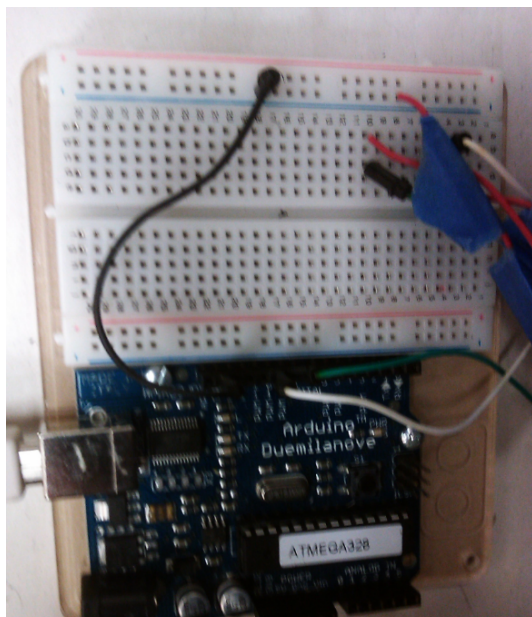
- SMC Pressure Regulator X 6



- Circuit connection panel (build by Peng Xu)



- One Arduino board



- One 24V power supply



Appendix: Arduino Code

```
#include <Servo.h>
#include <Stdio.h>

/*
 * Animated Headboard Arduino Code
 *
 */

#define MAX_NDEVICE 8
#define NDEVICE 6

int OUT_LUT[NDEVICE+1]; // 0 is not used
int IN_LUT[NDEVICE+1]; // 0 is not used

void secure_down()
{
  int i;
  for (i = 1; i <= NDEVICE; i++)
  {
    digitalWrite( OUT_LUT[i], LOW );
  }
}

void setup() // run once, when the sketch starts
{
  int i;
  Serial.begin(9600); // set up Serial library at 9600 bps
  Serial.println("Ready!"); // prints hello with ending line break

  // setup look up table
  for (i = 1; i <= NDEVICE; i++)
  {
    OUT_LUT[i] = i+1; // start from port 2
    pinMode(OUT_LUT[i], OUTPUT);
    IN_LUT[i] = i-1; // start from port 0
  }

  // initialize output
  secure_down();
}

// once go in, never come out
void halt()
{
  secure_down(); // secure things down
  while(1)
  {
    Serial.println("HALT");
    delay(1000);
  }
}

const char * strSW(int o)
{
  return o?"ON":"OFF";
}

int convert_level(int id)
{
  return 280-id*10;
}

int convert_back(float value)
{
  return (280-int(value))/10;
}
```

```

void loop()                                     // run over and over again
{
  unsigned beginbyte, m[5], stopbyte;
  char buffer[100];
  char setlevels[NDEVICE+1];
  char inlevels[NDEVICE+1];
  char linebuf[100];
  float filtered[NDEVICE+1];
  char hyster[NDEVICE+1];
  char lastone;

  int autocontrol;                             // do nothing!

  int i;

  for (i=1;i<NDEVICE;i++)
  {
    filtered[i]=0.0;
  }
  autocontrol=0;
  lastone = 0x90;

  while(1)
  {
    //filter update
    for (i=1;i<=NDEVICE;i++)
    {
      filtered[i]=filtered[i]*0.95+analogRead(i-1)*0.05;
    }

    beginbyte = Serial.read();
    while(beginbyte!=0xFA)
    {
      beginbyte = Serial.read();
    }
    Serial.println("Synced");
    m[0] = Serial.read();
    m[1] = Serial.read();
    m[2] = Serial.read();
    m[3] = Serial.read();
    stopbyte=Serial.read();

    if (stopbyte ==0xFF) //&& m1<181 && m1>=0 && m2<181 && m2>=0
    {
      if (m[0] == 0xA0)
      {
        autocontrol=1;
        setlevels[1]=m[1]&0x0f;
        setlevels[2]=m[1]>>4;
        setlevels[3]=m[2]&0x0f;
        setlevels[4]=m[2]>>4;
        setlevels[5]=m[3]&0x0f;
        setlevels[6]=m[3]>>4;

        if (lastone == 0x90)
        {
          for (i = 1; i <= NDEVICE; i++)
          {
            if ( convert_level(setlevels[i]) <filtered[i] )
            {
              hyster[i] = HIGH;
            }else
            {
              hyster[i] = LOW;
            }
          }
        }

        sprintf(linebuf, "VAL %d %d %d %d %d %d", setlevels[1],
          setlevels[2], setlevels[3], setlevels[4], setlevels[5], setlevels[6]);

```

```

    Serial.println(linebuf);
    lastone = 0xA0;

}else if (m[0] == 0x90)
{
    autocontrol=0;

    digitalWrite(2, (m[1]==1) ?HIGH:LOW);
    digitalWrite(3, (m[1]==2) ?HIGH:LOW);
    digitalWrite(4, (m[1]==4) ?HIGH:LOW);
    digitalWrite(5, (m[1]==8) ?HIGH:LOW);
    digitalWrite(6, (m[1]==16) ?HIGH:LOW);
    digitalWrite(7, (m[1]==32) ?HIGH:LOW);
    sprintf(linebuf, "VAL %d ", int(filtered[2]));
    Serial.println(linebuf);
}else {
    //
    sprintf(buffer,"Roger! M0=%u M1=%u, M2=%u, M3=%u, M4=%u",m[0], m[1],m[2],m[3],m[4]);
    Serial.println(buffer);
}

lastone = 0x90;
}else{
    Serial.println("bad pack!");
}

if (autocontrol)
{
    for (i=2;i<=5;i++)
    {
        if ( convert_level(setlevels[i]) <filtered[i]-5 && hyster[i] == LOW)
        {
            digitalWrite(i+1, HIGH);
            hyster[i] = HIGH;
        }
        else if ( convert_level(setlevels[i]) >filtered[i]+5 && hyster[i] == HIGH)
        {
            digitalWrite(i+1, LOW);
            hyster[i] = LOW;
        }
        else
        {
            digitalWrite(i+1, hyster[i]);
        }
    }
    sprintf(linebuf, "CUR %d %d %d %d", convert_back(filtered[2]),
        convert_back(filtered[3]),
        convert_back(filtered[4]),
        convert_back(filtered[5] ));

    Serial.println(linebuf);
}

delay(10);
}
}

```