Operators Manual

Mounted Art Instrument, Alternative Mouse Input Device & Game to Improve Name Recall

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**Game to Improve Name Recall**

**Important Safety Instructions**

When utilized properly the “Game to Improve Name Recall” should be operated on a computer with a microphone. The user will be able to run through the game commands with either a standard mouse and keyboard or oral communications.

- It is important to remember that when using this program a degree of moderation should be used. Prolonged period of staring at the computer screen can cause damage to the eyes.

- The CD should be handled with care, ensure that only the perimeter, not the optical part of the disk is touched. This will ensure the disk can be read and operated by the computer.

- Keep fluids away from the computer, microphone and other electrical components.

**Parts and Accessories**

1. Head mounted microphone
2. CD with name recall game

Features

The Game to Improve Name Recall offers a variety of useful features to assist users to increase cognitive abilities and improve face to name recognition.

Such features include:

- Easy to use CD ready game.
- Ability to load unlimited number of pictures and names.
- Multiple choice face recognition game.
- Innovative voice recognition technology.
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1. **Introduction**

1.1 **General Overview of Device**:

The game to improve name recall is a game that will assist people who have a hard time remembering peoples names. Many of these people experience frustration and embarrassment when relatives or friends come to visit them and they can not remember their names. Many neuroscientists have suggested that constant practice can slow or even stop the degradation of memory from these diseases.

The game allows a caretaker to upload pictures of loved ones which the user can then practice naming. Voice recognition software is included to allow ease of use for elderly people who may not be familiar or proficient with the standard keyboard and mouse interface.

The game is loaded onto a standard CD which can be put into a any compact disk play in a computer. However before using this device it is recommended to plug in the microphone that will be needed to operate the voice recognition software. The microphone provided should be plugged into a USB port on the computer as shown in Figure (1.0). Also ensure that the disk is cleaned so it can be read by the computer, although there should be issue with this when first receiving the CD.

![Figure (1.0)](image)

1.2 **How to Use Device**:

To start up the game insert the CD into CD-reading on your computer. Access your CD drive (which can be found under ‘my computer’) and open the .EXE file which the game is held on (figure 1.1).
After the executable file is opened it will bring up the main menu screen for the game. The main menu screen should look like figure (1.2)

The main menu access screen has several features. Firstly the user needs to input pictures into the program. This is done by the ‘Load Pictures’ button. This will allow you to go through your computer files and upload pictures then assign a name to them. The name you assign will be the name used in the game (figure 1.3).
Once you are satisfied with the pictures you have uploaded you may save them into a single file. This will make it easier to upload these pictures in the future. After pressing the ‘Done’ button, you will be given the option to save the file as a .txt file which can be uploaded in the future.

Files can be accessed through the ‘Load folder’ option on the main menu screen, in this way you can access previous files and get right to playing the recognition game. You do not have to upload each picture individually if you have saved them all into a file. After you upload your file (figure 1.4) you can get right to playing the game.
To access the main part of the game, push the ‘Start’ button on the main console window. If your picture/file is loaded the game should start and the user can then play the multiple choice game.

2. **Maintenance**

   Environmental: Certain precautions need to be observed to ensure that the game remains in useable conditions.

   - The CD for the game should be stored in a room temperature environment, where the chance of damage being done to the CD is minimal.
   - Like all CD’s this one should be handled with care.
   - After repeated use the disk may need some cleaning. If this ends up being the case you can purchase disk cleaning wipes at most computer stores.

   For example Radio-Shack has wipes that can clean the disk and increase the disks readability.
3. **Technical Description**

Most of the technical components of this project come in the computer code which was developed in Visual Basic. The game itself only takes up 377kbs, although this expands after loading picture into it. The game is meant to run on Windows XP, and can be run with almost any hardware configuration.

In this technical description will be bits of the code developed to make this game work. Keep in mind that far from all the code will be copied here because of its length and non-sensibility to the user. The goal is to help understand how important aspects of the voice recognition game is programmed.

The following code essentially sets up the Microsoft speech engine for use in our game. The speech engine uses command and control, meaning that with a given word database it will attempt to recognize words said by the user. In addition this piece of code will convert spoken words into text. This allows the voice recognition engine to compare pre-programmed words to the words that are being said and find the closest relationship.

```vbnet
Option Explicit

' declare all speech related variables
Const m_GrammarId = 10
Dim bSpeechInitialized As Boolean
Dim WithEvents RecoContext As SpSharedRecoContext
Dim Grammar As ISpeechRecoGrammar
Dim TopRule As ISpeechGrammarRule
Dim ListItemsRule As ISpeechGrammarRule

'Default Property Values:
```
Const m_def_PreCommandString = "Select"
Const m_def_SpeechEnabled = True

' Property Variables:
Dim m_PreCommandString As String
Dim m_SpeechEnabled As Boolean

In the game we have several buttons set up for example start game, load pictures, ect…
All of these buttons are ‘push-able’ through voice command. The following script sets up
commands for buttons. This allows user to command the buttons through a voice control
prompt.

Dim Text As String

Text = "Start Game"
ListItemsRule.InitialState.AddWordTransition Nothing, Text, " ", , Text, 0, 0

Text = "Statistics"
ListItemsRule.InitialState.AddWordTransition Nothing, Text, " ", , Text, 1, 1

Text = "Exit"
ListItemsRule.InitialState.AddWordTransition Nothing, Text, " ", , Text, 2, 2

Grammar.Rules.Commit
Exit Sub

The following script function runs when a word is recognized. When the voice
recognition system recognizes a word that has been said it will run this script. This script
will click the correct button based on what the user tells it too. This is important in the
game when doing the multiple choice and when trying to load pictures ect..

Dim index As Integer
Dim oItem As ISpeechPhraseProperty

Set oItem = Result.PhraseInfo.Properties(1).Children(0)
index = oItem.Id

If index = 0 Then
    Start_Click
End If

If index = 1 Then
    Stat_Click
End If

If index = 2 Then
The following script will take names from an array and recognize names. The names in the array are inputted when the users uploads the picture into the .txt folder. This script essentially will take names out of the array that most closely matches what name is said in the microphone and seed name into multiple choice game. This is done repeatedly after each screen is loaded.

' First, clear the rule
ListItemsRule.Clear

' Now, add all items to the rule
Dim i As Integer
For i = 0 To UBound(NameArray)
    Dim Text As String
    Text = NameArray(i)
    ListItemsRule.InitialState.AddWordTransition Nothing, Text, " ", , Text, i, i
Next

Grammar.Rules.Commit

Exit Sub

After saving various pictures into the game, you will automatically be prompted to save the pictures into a folder for easy access later. This code will take the pictures that you loaded up and save it into a single text file which can be easily loaded for repeated use. This code saves values for all the arrays into .txt file which can be opened up later by the user. This makes it easier to load up groups of pictures.

On Error GoTo ErrHandler

Dim Length As Integer
Dim n As Integer
Dim fso, txtfile
Dim Path As String

Length = UBound(PicPath)
If Length > 0 Then
    ReDim Preserve NameArray(Length - 1)
    ReDim Preserve PicBool(Length - 1)
    ReDim Preserve NameBool(Length - 1)
    ReDim Preserve PicPath(Length - 1)
End If

'Set properties and show the dialog
DialogOpen.FileName = "*.txt"
DialogOpen.Filter = "*.txt"
DialogOpen.ShowSave

Path = DialogOpen.FileName

Set fso = CreateObject("Scripting.FileSystemObject")
Set txtfile = fso.CreateTextFile(Path & ".txt", True)

For n = 0 To (ListNames.ListCount - 1)
    txtfile.WriteLine (ListNames.List(n))
Next

For n = 0 To (ListNames.ListCount - 1)
    txtfile.WriteLine (PicPath(n))
Next

txtfile.WriteLine "End"

txtfile.Close
4. **Trouble Shooting**

Problem 1: After inserting CD into driver cannot find game files.

**Possible Cause:** CD is dirty and cannot be read.
**Solution:** Use CD wipes to clean disk and try again.

Problem 2: Game is not recognizing when I speak

**Possible Cause:** Microphone is muted or has bad connection
**Solution 1:** Depress the ‘mute’ button and turn the volume wheel up.
**Solution 2:** Re-connect the microphone USB to ensure cable is connected.

Problem 3: When playing game pictures are too big or too small and do not fit into picture window.

**Possible Cause:** Picture resolution does not match the dimensions of the game.
**Solution:** Open up the problem picture and change picture dimensions.

Problem 4: When I try loading up picture I can’t find them.

**Possible Cause:** The load menu has a default folder which it opens to, your pictures are probably in a different folder
**Solution:** You can either make sure that you save your picture in the game default folder or remember where you saved your pictures so you can find them when you try to load them into the game.
Alternative Mouse Input Device

Important Safety Instructions

When correctly operated these devices can replace the mouse input for a computer system. It can reliably maneuver the cursor on the screen and additional games can provide a test system to improve the user’s cursor control.

- Do not tamper with wiring or electrical components, doing so may cause mouse quality to degrade.
- Do not have more than one mouse input plugged into the computer at one time, doing so may cause a decrease in cursor accuracy.
- Keep foods and fluids away from the mouse input device.
- Refrain from using excessive force when operating either mouse input device. Doing so may cause injury to the user and/or failure of the device.
- Keep fingers and other body parts away from moving parts during operation. Failure to do so may result in injury.

Parts and Accessories

1. Foot Pedals (2)
2. Strap-on foot mouse

3. Buttons (2)
4. 4-in diameter ball

5. Track Ball Housing

6. Mouse Ball Holster
7. CD with test games

Features

The alternative mouse input device offers a variety of useful features to assist users in utilizing a computer device.

Such features include:

- Easy to operate ball mouse.
  - 4-in diameter track ball for easy cursor maneuverability.
  - 2-in diameter buttons for easy mouse clicking.
  - Durable and mobile.

- Foot operated alternative mouse input
  - Two independent foot pedals.
  - Easy to maneuver strap on foot mouse.
  - Flexible design.
  - Durable and mobile

- Two innovative games to test control abilities.
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1. **Introduction**

1.1 **General Description**

The alternative mouse input devices will be used to help people with upper extremity disorders which limit fine motor control of their hands and arms. There are two devices that have been designing, one allows gross hand and arm movements to be transferred to smooth movement of the mouse on a computer screen. One of the devices is a foot operated so that a user can learn to use their feet to move the cursor on the screen. Two computer games will also be created to assess speed and accuracy to determine which device is best for different users.

The first of the two devices utilizes a track ball system. The track ball is mounted within a plastic box using ball bearings for a frictionless movement. By ‘rolling’ the track ball left/right or up/down the cursor on the computer screen will move relative to this motion. Two buttons are used for the left and right mouse clicks, which complete the total mouse control system.

The second mouse input devices is designed for use of the person feet. There are two foot pedals which will act as the left and right click buttons. These can be depressed with either of the users feet. There is a strap on foot mouse which the user can strap to either of his feet and control the cursor on the screen much in the same way a mouse does, except with the feet.

Two assisting games have been developed in order to test the users ability with these new mouse input systems. With practice the user should be able to master these new input systems and be able to complete these designed games. However before using these devices and games a few things need to be checked in order to ensure the safety of the user.

For the track ball mouse, ensure that the plastic covering for the box has not been broken, and that the track ball is sitting evenly in the encasing. If it is not please refer to the trouble-shooting section on how to fix it. The track ball system should look like figure 1.0. Plug in the USB cord coming out of the plastic encasement into the USB slot in your computer.
For the foot mouse, ensure that none of the wires to the foot pedals or the foot mouse have been compromised. There should be one set of wires from the foot pedals and foot mouse leading into the USB port the entire mechanism is seen in figure 1.1. If everything is alright plug the USB cord into the USB slot on your computer.
Figure 1.1

Insert the CD with the two test games on it. By bring up ‘my computer’ you should be able to access the DVD-rom device in your computer. After accessing this drive double check that you can see both test games (figure 1.2).

Figure 1.2

1.2  How to Use Device

The alternative mouse input device is easy to use and it can be used much like your average USB mouse input system. Essentially for both the ball mouse and the foot mouse there is a USB cable that will need to be plugged into the computer (figure 1.3), make sure that only one USB mouse is plugged into your computer at once. More than one input may result in the computer picking up multiple signals and not having accurate cursor control.

Figure 1.3

After having your alternative mouse plugged into the USB port it should be immediately operational. Check and make sure that both the cursor and buttons/foot-pedals are operational. If they do not work please check the troubleshooting manual. Additionally it is highly recommended that you turn down the cursor speed of the mouse input system. This can be done in Windows by clicking on the ‘start’ menu, then clicking on the ‘Control Panel’ option. This will bring up another window, select ‘mouse’ to bring up the
mouse options (figure 1.4). Move the slide bar for the ‘double click’ speed down to slow, then click ‘pointer options tab’ and move the cursor speed down to slow. Push apply and the mouse speed setting should be set up for perfect use, these are not mandatory options however in lab tests show that the cursor is easier to maneuver with these conditions.

With this your alternative mouse input should be set up and ready to use. If you wish to test your control of the alternative mouse input device with the games, insert the CD with both test games on it into the CD drive. Bring up the CD drive folder from ‘my computer’, two games should be found within the CD folder. You can then click on either of the .EXE files to open the game of your choice. Both games will pop up with a load window and then enter into the main menu. The main menu has two buttons, ‘Start’ and ‘Instructions’. Click on instructions if you want to know how to play, if you already know you may press start.

2. Maintenance

Environmental: Certain environmental considerations need to be considered to ensure that this device reaches its maximum lifespan and operates correctly.

- Make sure that the alternative mouse input system is stored at room temperature. This will ensure electrical components will not short circuit.

- The CD for the game should be stored in a room temperature environment, where the chance of damage being done to the CD is minimal.
Like all CD’s this one should be handled with care.

After repeated use the disk may need some cleaning. If this ends up being the case you can purchase disk cleaning wipes at most computer stores.

For example Radio-Shack has wipes that can clean the disk and increase the disks readability.


Mechanical: The alternative mouse input device is not built to withstand severe amounts of mechanical damage, to ensure that this does not happen please observe these maintenance precautions.

- The alternative foot mouse is designed to withstand a large amount of force, however not a person’s full body weight. Please operate this device while sitting down.

- Be careful not to ‘stamp’ your foot while operating the alternative foot mouse, doing so may cause permanent damage to the device.

- The alternative ball mouse is not built for high force situations. When operating do not apply excessive loads to the ball.

- The alternative ball mouse is meant for use on a horizontal surface; please ensure that it remains horizontal during use. Failure to do so may result in dislodging of internal ball bearings.

Electrical: There are several electrical components in alternative mouse system, to ensure that these keep working electrical maintenance procedures must be observed.

- Do not expose electrical components to liquid, doing so may cause the device to fail.
3. **Technical Description**

For this project, essentially we reverse engineered a standard hand operated optical mouse which can go into your computer via USB cable. Through this we were able to create two new mouse input devices. An optical foot mouse and a optical ball mouse, each that work without fine motor control from the users hand. Figure 3.1 shows what the mouse looked like before we performed changes to it.

![Figure 3.1](image)

The first alternative design is the optical foot mouse. This unit is comprised of an optical foot mouse with a Velcro strap and two pedal switches foot the clicking functions. The entire input system is mounted onto a black plexiglass sheet, which has a mouse pad mounted for easy movement of the foot mouse. The pedal switches are mounted next to one another on the left side of the base and are labeled.

An optical mouse was purchased to be used in the internal structure of the foot mouse. The optical mouse was machined to fit in accordance with the foot mouse design and was mounted on the base of the foot mouse. The housing of the foot mouse was constructed from ¼” thick white plexiglass that was in the senior design stockroom. The housing is elliptically shaped and encases the optical mouse and the internal wiring. The pedal
switches are wired to the foot mouse, and the entire unit uses the USB connection of the mouse to connect to the computer.

The second input device is the optical track ball. This unit is an Atari arcade track ball mounted inside a plastic encasing, with two buttons for the clicking functions. The plastic encasing houses a machined holster for the track ball to rest on. The holster is composed of a steel hollow cylinder with three washers holding ball bearings that the track ball rests on. Underneath the track ball is the optical foot mouse, mounted on the steel cylinder.

The ball bearings allow for a smooth rolling surface for the track ball. The track ball was painted blue with a dotted design of gray to represent the UConn colors. Painting the ball with the dotted design also improved the tracking ability of the foot mouse. The optical mouse is wired to the two buttons, which are mounted in front of the track ball. The track ball housing encases the internal structure and circuitry of the input system and is screwed tightly shut to allow for resistance to water and other damaging substances.

**Optical Foot Mouse**

The housing of the foot mouse is made from ¼” thick white plexiglass from the senior lab stockroom. The plexiglass was shaped using a heat gun from the machine shop, finally coming to an elliptical shape with the following dimensions:

\[ a = 4 \frac{7}{16} \text{ in.} \]
\[ b = 2 \frac{1}{16} \text{ in.} \]
\[ \text{Thickness} = 1 \frac{1}{8} \text{ in.} \]

Corresponding to the ellipse pictured below:

![Figure 3.2: Ellipse Example](image)

The housing is comprised of three separate parts, the side 1 1/8 inch thick strip and two identically shaped pieces for the base and top of the foot mouse. The side strip of the foot mouse was 23 ½ inches long and was wrapped around the base piece of the foot mouse and sealed using PVC clear cement. The side strip was also sealed using the PVC cement, as was the top of the foot mouse, which was placed on top of the side strip. The foot mouse structure is shown below, in pieces as it was constructed over time.
The top pictures were the first steps in the housing construction, in which the side strip and top and bottom pieces were made. The next step was to attach the base and side strip and position the optical mouse. The last step was to seal the optical mouse inside the housing, paint, sand, and attach the Velcro strap. Below is the machining done to slot the base of the foot mouse in order to make the optical mouse flush with the bottom of the housing.
After the housing was slotted, the optical mouse was trimmed and epoxy was used to attach the optical mouse to the base of the foot mouse housing. The base was then sanded and smoothed out allowing for a clean surface for sliding. Inside the foot mouse, the optical mouse was wired, using purchased USB extension, to the pedal switches purchased from Automation.com. Two wires were needed for each pedal input. The pedal switches closed the circuit, which allowed for the clicking function to be enabled. The connections for the wires for the pedals and the optical mouse are pictured above the foot mouse and wired pedal switches.
Figure 3.5: Wiring of Foot Mouse

The top of the foot mouse housing was then cemented to the unit, completing the housing construction. The entire housing was sanded and painted, adding a final touch of a UConn paw to the top of the foot mouse. A mouse pad cloth was attached to the base of the foot mouse unit to ensure proper optical detection by the mouse during use and the pedal switches were labeled “L” and “R” to guarantee no confusion with clicking functions. Also, the wires were shortened from the pedals to the foot mouse and clipped to the plexiglass base to eliminate and tangling that could occur. Below is the finished foot mouse design as it is to be shipped. The total dimensions of the foot mouse device are as follows:

Height: 3 ¾ in.
Width: 12 in.
Length: 23 ¾ in.
Weight: 7 lbs.

Figure 3.6: Completed Foot Mouse

Optical Track Ball Mouse

The track ball housing is a free sample box received from OK Enclosures online. The box is called a robust box and has the dimensions:

Height: 3 5/8 in.
Length: 9 ½ in.
Width: 6 ¼ in.

The internal structure of the track ball mouse is made from a steel cylinder. The cylinder was cut and filed to a height of 1 1/8 inches and has three 7/8 inch washers.
welded to the top of the cylinder. On top of the washers are three 3/8 inch diameter ball bearings. This entire structure allows for a smooth rolling surface for the track ball. Also, the height of the structure allows the track ball to protrude from the housing by 2 1/8 inches, which is just below the radius of the track ball. Below is the internal structure of the track ball mouse.

![Internal Track Ball Structure](image)

After the internal structure was machined and tested using the track ball, the outer housing was prepared. Two 2.5 cm holes were punched out of the top of the track ball box to allow the buttons to be placed inside them. These buttons are 1 inch button switches that will serve as the clicking functions of the track ball mouse. These buttons were obtained from Automation.com.

![Track Ball Housing with Buttons](image)
After the holes were punched into the housing, the optical mouse was mounted onto the base structure for the track ball. This was done by slotting the steel cylinder and cutting down the optical mouse base, just as was done for the foot mouse. The optical mouse was then placed in the cylinder and set in place using a high strength epoxy. The optical mouse was arranged to be flush with the surface of the track ball, so that the best optical scanning of the surface of the ball could be achieved.

When the internal structure of the track ball mouse was completed, the top of the box had to be machined in order for the track ball to protrude and be used as designed. A milling machine was used to slot the top of the housing enough for the track ball to just fit through the box while still remaining snug against the ball bearings on the base. After the top was milled out, the edges were cleaned using sand paper so that the track ball surface wasn’t scratched when in use.
The last step in the construction of the track ball mouse was the wiring of the buttons and optical mouse. The buttons were wired to the optical mouse that was mounted beneath the track ball on the steel cylinder using a purchased USB extension wire. After the buttons were wired to the optical mouse in the correct locations as previously stated for the foot mouse, the USB connection for the optical mouse was drawn through the front of the track ball housing via a drilled hole. The hole was plugged using a clear waterproofing sealant. When the wiring was complete, the track ball was painted blue and speckled with gray paint to provide a color contrast to ensure an optimal scanning surface. The track ball was also clear coated to protect the surface from water and other staining substances.
The wires that were wired from the mouse into the button were fairly simple. Wires were connect to metal connection points. When the mouse is pressed the contact points come together and activate the mouse button.

The last part of this project required the design and programming of two games that would be used with the alternative inputs to increase the speed and accuracy of the users over time. The two games designed and incorporated with the device inputs were made using a software program called Gamemaker. This program allowed us to
efficiently create an aesthetically pleasing game interface for the user. Also, this software was free and required no coding, as would C++ or Visual Basic. Therefore, the creation of these two games was easier than we had originally believed.

The first game designed was based on the simple hedgehog game seen in arcade arenas. The user uses the mouse cursor to click moving objects in a certain amount of time. A timer starts at the allotted time and counts down until either the user clicks all the objects or the time runs out. If the time runs out, the game is over and the user must restart. If the user clicks all the objects in time, they will proceed to the next level. In all, there are ten levels that increase in difficulty. The increase in difficulty is measured by the amount of object needed to be clicked, the speed the objects are moving at and the design of the gaming interface. The type of objects seen in this game include asteroids, balls, airplanes, and other various items that are typical in arcade games.
The second game is designed after a “brick breaker” arcade game. This game uses a paddle, a ball, and a series of bricks. The paddle and ball are located at the base of the interface screen, with the bricks stacked in various designs above the paddle and ball. The game starts with the user clicking the paddle, which launches the ball towards the bricks. The ball continues towards the bricks and upon contacting the brick, the brick explodes and disappears. The ball then ricochets off the brick and continues its path towards another brick, the walls of the interface, or down towards the base of the game. The user uses the mouse to move the paddle back and forth to bounce the ball back towards the bricks until all the bricks have been destroyed or the ball misses the paddle and then the game is over. As the bricks are destroyed, the users score increases. There are ten levels in all, with increasing difficulty. The difficulty is measured with the speed of the ball, the amount of balls in play, and the arrangement of the bricks. Also, hidden in the brick design are extra bonuses such as another ball being added into play.

Figure 3.15: Brick Breaker Game Interface
4. **Trouble Shooting**

Problem 1: When trying to operate my alternative mouse, the ‘double click’ does not work and/or my cursor speed is too fast.

**Possible Cause:** Due to the design, both the buttons and foot pedals have a slow reaction to ‘double clicking’, in addition the cursor speed tends to be faster than what people are accustomed to.

**Solution:** Make sure to set both the cursor speed and click speed to slow, following the directions in ‘How to Use Device’.

Problem 2: When trying to operate my ‘foot mouse’ the cursor gets ‘stuck’ or fails to move.

**Possible Cause:** The optical sensor is not making good contact with the moving surface.

**Solution 1:** For the foot mouse, if you are using anything other than the ‘provided’ surface mount please go back and try using the mousepad provided.

**Solution 2:** The optical sensor may be dirty; for the foot mouse the sensor can be found on the bottom. Wipe off any residue that may be found there.

Problem 3: When trying to operate my ‘ball mouse’ the cursor gets ‘stuck’ or fails to move.

**Possible Cause:** The optical sensor is not making good contact with the track ball.

**Solution:** First take off the top of the ball mouse housing. This is done by unscrewing the lid and removing it. The track ball is free moving and can be easily removed. Check to ensure that all 3 ball bearings are properly in place (Figure 4.1). Next wipe off the optical sensor gently and place the track ball back onto the holster. Re-Assemble the lid and try again.
Problem 4: After inserting CD into driver cannot find game files.

   **Possible Cause:** CD is dirty and cannot be read.

   **Solution:** Use CD wipes to clean disk and try again.

Problem 5: After plugging in the mouse input, nothing happens. The computer fails to recognize it is even plugged in.

   **Possible Cause:** Defect in the internal wiring of the mouse has occurred.

   **Solution:** Double check to make sure none of the soldered wires have detached. This is done by either opening the track ball or the foot mouse and making sure there are no loose wires. If there is, please see the technical description on how they should be.
Mounted Art Instrument

Important Safety Instructions

This system can reliably make lines and designed based on input from the user. Please read through the operators manual thoroughly before utilizing this device in order to ensure the owners safety.

- Do not tamper with electrical or mechanical parts, doing so may damage the integrity of the device.

- Be sure to keep fingers and other body parts away from moving mechanical parts. Failure to do so can result in injury.

- Keep loose articles of clothing or other miscellaneous items away from the moving mechanical parts.

- Keep fluids away from the electrical components.

- Do not apply excessive force to drawing board. It is not made to support body weight. Doing so may compromise the device and injure the operator.

- The drawing board is intended for use only on a flat horizontal surface.

- Always make sure the device is off when replacing drawing paper.

- When using the device be mindful of others in close proximity.
Parts and Accessories

1. Motors (2)

2. Wrist Strap and Accelerometer Encasement

3. Accelerometer
4. PCB circuit board and Encasement
5. Backboard

6. Worm Screw

7. Self – Manufactured Thread Screw
8. X-Y Grid rails

9. On – Off Switch
10. Micro-Switches

11. Power supply
Features

The Mounted Art Instrument offers a variety of useful features to assist users with limited motor skills to draw and express themselves artistically.

Such features include:

- Innovative accelerometer control device for complete user control.
- Unique X-Y track system for multiple directions of drawing.
- Reversible Motors.
- Durable design.
- Lightweight body attachment to cause minimal stress on user.
- Useable by a wide range of users.
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1. **Introduction**

1.1 **General Overview**

The mounted art instrument is a device which will assist people with limited motor and cognitive abilities achieve their full artistic potential. The mounted art instrument amplifies small tilt movements of the user into large art movements on an X-Y grid system. This device can be used by a wide variety of users, all that is required is minimal wrist movement to tilt an onboard accelerometer.

The machine was built with the users body in mind. This unique design puts very limited stress on the user and provides the user with full control of the art system. The total system consists of a wrist mount with an attached accelerometer encasement. This is what the user will use to control the device. Wires from the accelerometer is attached to a PCB board and PIC16F877A micro-chip. The PIC supplies voltage to relays with amplify the current and relay the current to the correct motors and make them spin in the correct direction.

Motors are mounted onto a innovative X-Y coordinate system. This system is driven by the motors and worm-screws. As the screws spin mounted holsters are propelled along the screws. A drawing utensil is attached to the holster and can draw based on input from the user.

Before utilizing the mounted ensure that everything is correctly connected and no wiring is loose. Firstly the system is powered through a 12v 7amp power supply. This should be plugged into a wall outlet upon during use as seen in figure (1.0). The power supply will be powering the system, so ensure that it is hooked up to the 12v motors and the black electrical box

Ensure that the accelerometer casing is secured to the mounted wrist strap. The accelerometer casing can be seen in figure (1.1). This is what the user will be directly utilizing to influence the movements of the art system.
Ensure wires from the accelerometer casing are securely connected to the black PCB box (figure (1.2)). The Black box is the electrical component which is the driving force for the track system. It is important that this is put in a safe spot before using this device.

The output wires from the PCB box should be fastened to the 12v motors on the X-Y coordinate system (figure 1.3). These motors are the driving force for the entire system it is important that the wires are attached to the correct leads. If these are swapped the motors will be rotating the opposite way than intended.
Make sure the motors and wires are securely fastened to the track before attempting to operate this device. It is essential that these are securely tightened because if they are not un-needed vibration will be caused, which can result in total failure of the art system. Secure attachment can be seen in figure (1.4). A quick overview of the X-Y track system is in order. Ensure that there are no obviously loose pieces and ensure that the utensil holster in the middle of the track system is secure (figure 1.4).
Another essential part is the micro-switches on each end of the X-Y tracks of the art system. These act as switches to stop the motors when they reach the end of the track. These should be wired directly into the Black PCB box. Make sure that all three leads to the micro-switches are wired to the box and that the micro-switches are attached to the X-Y track system (figure 1.5).
How to Use

First the art utensil which will be used to draw needs to be securely fastened into the holster as seen in figure and a fresh sheet of paper needs to be taped onto the back board of the system. Secure the wristband with the mounted accelerometer as shown in figure (1.6). Make sure that the wrist band is on securely with the accelerometer casing horizontal to the ground.

![Figure (1.6)](image)

Switch # 1 as shown in figure (1.7) will turn on the art system for use. Switching the switch in the opposite direction will cause the art system to turn off. This can be turned off any time during operation should the need arise.

![Figure (1.7)](image)
Tilting the wrist with the mounted accelerometer will result in rotation of the motors which will cause the art utensil to be propelled across the paper and draw. Tilting and motor motion can be seen in figure

2. Maintenance

Environmental:
Environmental considerations need to be considered when utilizing and storing this device.

- Do not expose the electrical components of this device to liquids. This device is not water-proof, liquids and moisture can ruin the circuitry.

- This back board for this device is not design to hold excessive weight, keep heavy objects off mechanical parts of this device.

Electrical:
This device depends on having electrical components working correctly. Correct maintenance of electrical components will help ensure continued used of this device.

- After use unplug power supply from the wall. Doing so will ensure that no electrical components will overheat and fail after long periods of use.

- Do not put unnecessary strain on any wires, this includes stretching or bending of wires or electrical components. This is applicable during storage and during usage.

Mechanical:

- This device is designed for using at room temperatures (60-80 degrees F), should this device be exposed to extreme temperatures the mechanical metal parts may shift in size and cause the device to fail. Electrical circuitry may also be damaged.

- After intermittent use of the device it is highly recommended to use oil lubricant on both worm screws and guide rails for the X-Y grid system. This will ensure that pieces move smoothly and that mechanical components are not compromised due to strain and vibration.

When applying lubrication to the X-Y coordinate system, only apply small amounts and continue to move the track system until the oil is worked in. After when there is no longer ‘catching’ in the mechanical components stop applying the lubricant.
3. Technical Description

The technical description will go through all of the electrical, mechanical and programming components which are involved for this project. The electrical circuit that directs the system is shown in figure 3.1. This shows all of the various components that are used in the circuit and also shows how they are connected together.

Figure 3.1

The above circuit diagram has several components, which will be clarified briefly.

Object J5 is the accelerometer which will be attached to the user wrist. It has four outputs; two outputs in the X-direction and two outputs in the Y-direction. RLY1-RLY4 are voltage relays, these take outputs from pins RC4-RC7 and sends current to the correct motors. Q3-Q6 increase the voltage to 12v which is used for the motors. One additional
things they are needed for is to reverse the direction of motor, for this 4 voltage relays are needed. One relay grounds the motor the other sends current to the other motor lead. This can be done either way based on commands from the PIC16F877A microcontroller. Q3-Q6 are voltage amplifiers. Given the 5v inputs these will amplify the voltage to 12v which are required for motors and the relays. At steady state all the voltages to the right of the PIC on the circuit-diagram should be zero. To the left voltages will depend on what tilt the accelerometer is, but it should be approximately 1v at the PIC input pins.

A pin diagram for the PIC16F877A microcontroller can be seen below in figure 3.2. Input pins are RA1 and RA3 which take inputs from the accelerometer. These inputs are voltage currents from 0-5v, and are interpreted by the PIC. The PIC converts inputs analog to digital and interprets it based on a certain threshold. If a given threshold in the program is surpassed then an associated output pin is powered; which will then drive the relays motors.

At steady state voltages at pins RA1 and RA3 should be approximately 1v based on tilt from accelerometer the voltages can vary between .6 and 1.4 volts. Accordingly when the accelerometer is horizontal the output pins have a voltage of zero. As there is shifting in the accelerometer the correct pin will out-put a correct voltage of 5v.

The accelerometer is a MEMSIC dual axis accelerometer from Radio Shack which would output a Pulse Width Modulation signal that changed based on the amount of acceleration.
each axis was feeling. At 0 g’s each axis would output a 50 percent duty cycle. As the acceleration increased the duty cycle being output from the axis would increase as well. When the acceleration decreased the duty cycle would also decrease. This would all happen in a linear fashion with the duty cycle linearly proportional to the amount of acceleration the axis was feeling. A picture of the MEMSIC Dual Axis accelerometer that we used for our project is shown below.

![Figure 3.3](image)

To turn the duty cycle output from the accelerometer into something that we could use easily with our PIC microcontroller we had to design a simple RC circuit that would output the average value of the duty cycle to the PIC microcontroller. Since we would be putting 5 volts into the accelerometer this means that the height of the pulses would be around 5 volts. When averaged by the RC circuit a 50 percent duty cycle would correspond to a 2.5 volt analog signal.

As the duty cycle increases the analog voltage will increase and when decreasing the analog voltage will decrease. After much testing we found that the best values for the resistor and the capacitor were 10k ohms with a 100 uF capacitor. We found that this gave us the smoothest DC value with a pretty quick and reliable time constant. This means that the capacitor does not take too long to discharge or charge as the voltage is changing.
Figure 3.4: RC Circuit

Once the DC value from the accelerometer is obtained we then need to input this value into the PIC microcontroller. We programmed the PIC using MPLAB ICD 2 with code that would read the analog voltage signal and convert this into a digital number which could be used for calculations. We decided to use an 8 bit binary number as we believed that an 8 bit number would give us the appropriate amount of resolution. Our accelerometer output was a maximum at 5 volts meaning that with an 8 bit digital conversion at 5 volts the number will be 256, at 0 volts the digital number will be 0. The 8 bit digital number will give us approximately 19 millivolts of resolution meaning that for every 19 millivolt increase or decrease the digital signal will increase or decrease by one bit accordingly.

We decided to use RA1 and RA3 as the two input pins that would be gathering the data from the accelerometer. We chose to use four pins as the output to our motors. Two pins for each motor, one pin per lead. This would give us the desired bidirectional capability that we would need in order for the art device to move in all four directions. The pins we chose as our outputs were RC4 through RC7 which would be output to a transistor circuit connected to a relay.

The computer code for the PIC16877A is shown below.

```c
#include <pic.h>
#include <stdlib.h>
#include <math.h>
#include "adc.h"
#include "delay.h"

__CONFIG(DEBUGEN & WDTDIS & LVPDIS & HS);
void main(void){

    unsigned int inputx;
    unsigned int inputy;
```
TRISC = 0; // c = output
PORTC = 0; // clear port c
ADRESH = 0;

#define outone RC7
#define outtwo RC6
#define outthree RC5
#define outfour RC4
outone = 0;
outtwo = 0;
outthree = 0;
outfour = 0;

for(;;)
{
    init_a2d();
    inputx = read_a2d(1);
    init_a2d();
    inputy = read_a2d(3);

    if (inputx >= 104)
    {
        outone = 1;
        outtwo = 0;
    }
    if (inputx <= 84)
    {
        outone = 0;
        outtwo = 1;
    }
    if (inputx > 84 && inputx < 104)
    {
        outone = 0;
        outtwo =0;
    } 

    if (inputy >= 104)
    {
        outthree = 1;
        outfour = 0;
    }
    if (inputy <= 70)
    {
outthree = 0;
outfour = 1;
}
if (inputy > 70 && inputy < 104)
{
  outthree = 0;
  outfour = 0;
}
}

As you can see we decided to set deadbands in the code so that when the user was holding the accelerometer level nothing would happen and the motors would not. Only when the feedback from the accelerometer reached an appropriate level would the motors be turned on. The output to the rest of the circuit from the PIC is just simply high and low. This means that when the output pin is set high it will output 5 volts and when the pin is set low it will output 0 volts.

The output from the PIC is connected to four transistor circuits which are connected across the coil of a relay. The relays used in this design are PC Relays rated at 10 amps. The nominal voltage to switch the relay is around 12 volts with 30 mA of current needed to switch the relay on. The PIC can only output up to 5 volts and can not deliver the current needed by the coil to switch the relay. This is why we needed a transistor circuit connected to a 12 volt power supply to deliver the appropriate voltage and current. The output from the PIC is fed into a 5k ohm resistor and then into the base of the transistor.

The resistor is used to limit the current being pulled from the PIC as well as limit the current going into the base of the transistor. The emitter of the transistor is connected to ground and the collector is connected to 12 volts through a diode. The diodes are used to protect against surges in current as the relay is switched on and off. This circuit has a gain of around 100 which is the beta of the transistor. This means that the sensitivity of the relay is increased by 100 and much less voltage and current is needed to switch it. The PIC can easily supply this voltage and current without a problem. A picture of this circuit is shown below.
The relay is connected to 12 volts and ground so that when the relay is not tripped the motor will only see ground and when it is tripped the relay will output 12 volts to the motor. A picture of the relay and transistor circuit is shown below.

The common pin connection on each relay is connected to one lead on the motor and will drive the motor in one direction when switched on. Our whole device is powered through an AC/DC adaptor capable of delivering 12 volts at 6.67 amps.
Since each motor is only drawing around 2.5 amps when running the power supply can deliver more than enough power for each motor to run at the same time as well as delivering power to the accelerometer, PIC, and transistor driven relays. All of our circuits will be made into a Printed Circuit Board and placed inside a plastic enclosure. The mechanical X-Y grid can be seen in figure 3.8. It takes the motor about 3.5 amps to drive the horizontal worm screw. The mechanical load is much higher than the vertical screw because it has to move the entire system. The motor driving the vertical self-made screw draws about 2 amps, meaning less force is required to move it. The motors are 1/35 horsepower motors which required a maximum of 12 volts to run. The maximum amount of current that each motor can draw is 3.8 amps of electricity. The maximum RPMs at 12 volts were rated at 2350 for each motor.

The motors that we decided to purchase were simple DC motors and were bidirectional. This was very important to our project in that the motors had to be able to reverse directions in order for the client to be able to draw in every direction that they wanted to. Each motor had two power leads and to switch the direction the polarity between the leads has to be switched. To attach the motors to the X-Y track, we purchased rubber connectors this reduced the load required to move the entire system and made the mechanical stresses much less. Based on these specs the motors are more than capable of driving the X-Y track system.
4. **Trouble Shooting**

Problem 1: Motors are trying to move the screws but are unable to do so.

**Possible Cause:** Screws and guide rails need lubrication or motors have been compromised.

**Solution 1:** Lubricate the screw rod and the guide rails with oil lubrication.

**Solution 2:** Purchase 12v DC which draw maximum of 4amps from www.grainger.com.

Problem 2: After turning the switch to on, nothing happens.

**Possible Cause:** Power-supply is not plugged in

**Solution:** Switch OFF power, plug in power supply then turn back on the system to see if it is operational.

Problem 3: Power is turned on but tilting the accelerometer doesn’t cause motors to work or try to move the system.

**Possible Cause:** PIC has been blown, or another piece of circuitry has been short circuited.

**Solution 1:** Open up the box to the PCB board by unscrewing the top and removing it. If the PIC needs to be replaced a new PIC16F877A will need to be bought and reprogrammed. The best solution is to contact the BME department at UCONN.

**Solution 2:** Soldering of wires has come loose and needs to be redone. Inspect the PCB board and the wires, compare to the circuit diagram provided in the technical description. If there are loose wires they will need to be soldered back into the appropriate places.

Problem 4: Accelerometer is not staying horizontal on wrist and reading when I’m not moving.

**Possible Cause:** The wrist band has not been tightened enough

**Solution:** Tighten the wrist band and make sure that the accelerometer casing is securely fastened to the wrist band

Problem 5: Motor is not reversing direction
Possible cause: PIC has been blown, or another piece of circuitry has been shorted.

Solution: See problem #3