

Accessible Switch

User Manual

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Abstract

Technology is growing at a rapid pace, and society's dependence on it will only keep growing. Desktops and laptops have always been commonly used by mice and keyboards, but not everyone can use them. Many users with dexterity problems are unable to utilize technology because of the form factors that machines have taken. Users with dexterity disabilities require another form of input to the computer. Devices with many types of sensory information (e.g. breathing, pressure, blinking.) have been commonly used, but are often expensive and may require a tough learning curve. Furthermore, there is a lack of affordable software that can transform a switch into a computer input device. This is why we have developed this accessible switch that comes with free software for users with dexterity problems. It does not need the range of motion of a mouse or keyboard. It is simple to use and only requires a simple press of a button with anything. The software is user-friendly and allows the user to adapt to their preferences, which are also saved on the computer for later use.

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INTRODUCTION

Technology has been growing at a rapid pace and has led to the point where society depends on technology for almost everything in their daily lives. Notably, computers have been increasing in popularity and demand because of their abilities to store large amounts of data, increase productivity, access to powerful applications, and most importantly, access to the internet. The computer is most often used with a mouse and keyboard. However, not all users can utilize them because of their form factor and their complexity. People with dexterity issues are generally the ones who are unable to use computers because of this. About 3.5% of Canadians aged 15 or older have dexterity disabilities (Government of Canada, 2017). The accessible switch is aimed to give users who need a simple way to use a computer without a mouse and keyboard. This switch is lightweight and is compatible with the most popular operating system, Windows. Furthermore, it is very cheap as the switch is affordable compared to other similar devices. Also, the software is free, unlike some of the other software online.

PRODUCT FEATURES

The product consists of both a physical switch and a software program to connect to it. The switch has one button and is connected to the computer with a Mini USB to USB-A cable. The switch then interfaces with an Arduino and C# program that controls the functions of the switch. It will detect button presses and execute the necessary functions, based on a cycling instruction list. Additionally, users can customize settings using the program to change cursor speed, input delay, and a delay between each instruction.

HARDWARE BUILD

The switch was built using an Arduino Nano board, connected to a circuit with a 10K Ω resistor, a push button, and wires. The circuit was wired with an external pull-down resistor, with the button input and GND wires connected to the Arduino. A 3D printed enclosure was designed and built to house the circuit. It consisted of a case on the bottom, a raised platform inside with the push button attached to it, a cover with a hole, and the button is glued to the button cap with a stem that inserts through the hole to make contact with the button. There is also a cutout on the side of the case, where a USB cable can be inserted to connect with the Arduino nano.

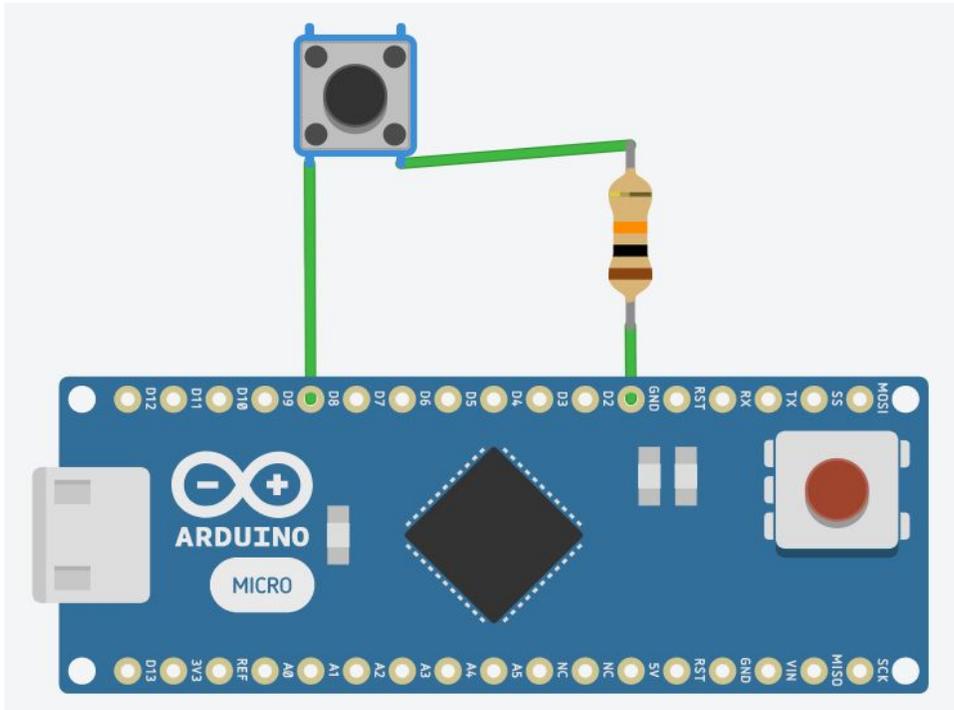


Fig 1. Circuit diagram of the switch

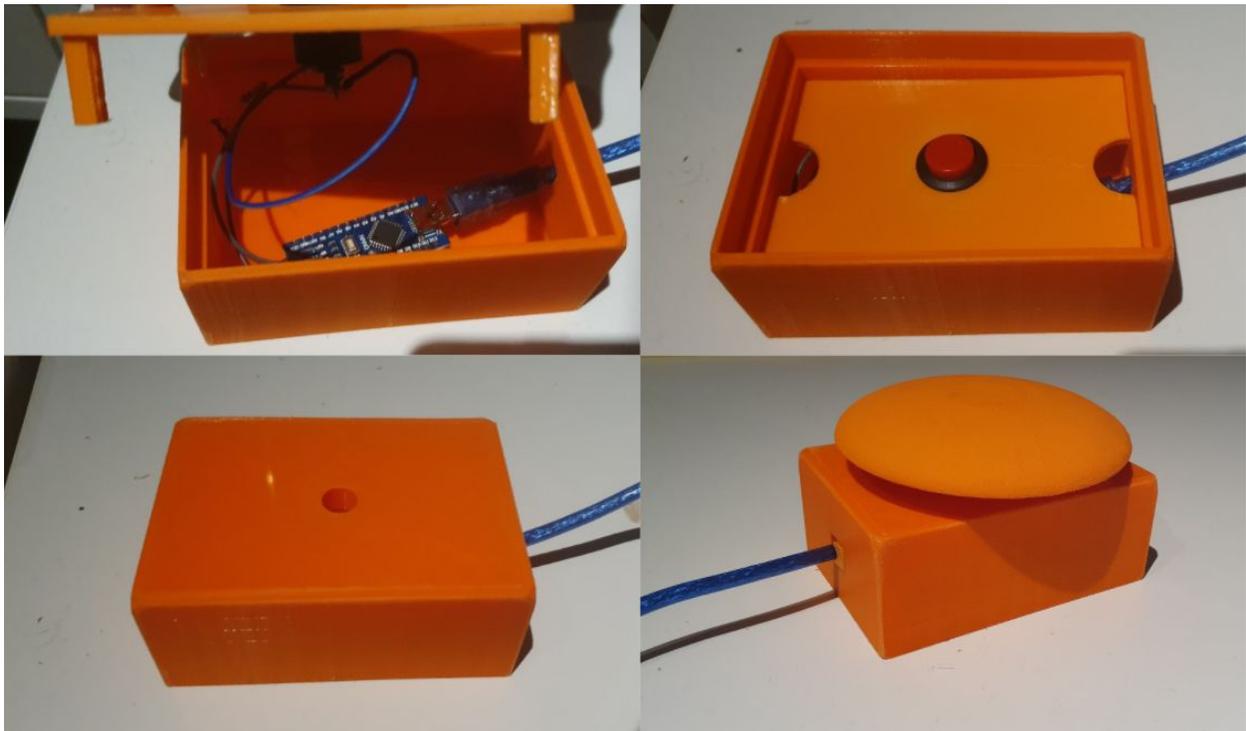


Fig 2. Components of the hardware case

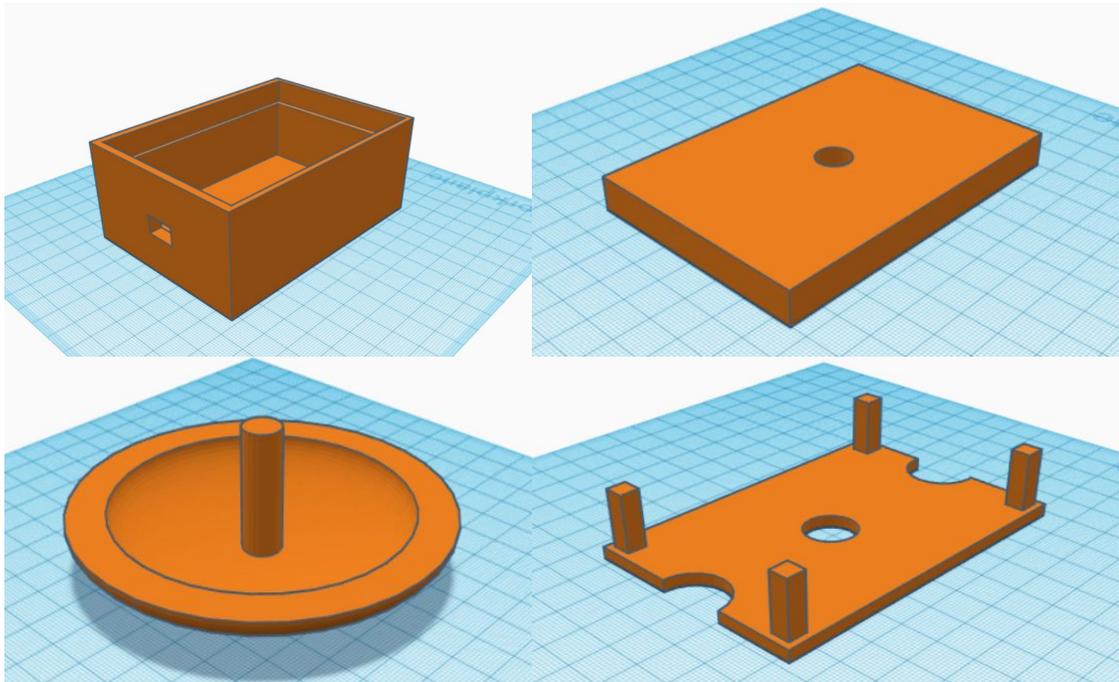


Fig 3. CAD Design files for the case

SOFTWARE BUILD

The software development of this product is based on two programming languages, C++ language for the Arduino program, and C# for the User Interface and the application's functionality. Most of the program is written in the C# program and it communicates with the Arduino IDE through serial communications. The serial communication drivers for the Arduino device can be found on (<https://sparks.gogo.co.nz/ch340.html>). The Arduino IDE is used to set up the inputs and outputs of the switch. The user interface has two visual parts, the application with the "Next Action" option, will visualize several of the different actions that the user can choose from, and they are:

-  : to move to the right of the screen.
-  : to move to the left of the screen
-  : to move to the top of the screen

-  : to move down to the screen.
-  : to perform a left click with the switch.
-  : to perform the right click

And the second application is the adjustment options, and these options are:

- 
Mouse speed: this will determine how fast the cursor will move, the range of speed is between 50% and 300%, where 50% is the slowest and 300% is the fastest.
- 
Delay Input: the input delay is the amount of time that passes between sending an electrical signal and the occurrence of the corresponding action.
- 
Cycle Frequency: this will determine how many seconds will the appearance of the “Next action” lasts.

C# Program Specification

The C# application was developed with Windows Forms. There are two Windows forms “Form1” and “Form2”. “Form1” is the main application and contains the settings for the switch and software. The UI elements were developed with the Windows toolbox and the images were stock images found on the internet. The application ends when the settings form (“Form1”) is closed.

The settings form (“Form1”) is a Windows Form that has buttons, images, and text. Also, it contains the main code that controls the windows cursor/pointer actions. The buttons have on-click functions that adjust the settings of the switch when triggered. The speed function modifies the number of pixels the cursor can travel. The input delay function modifies the delay in the Arduino switch by sending information to the Arduino. The cycle frequency function adjusts the time before the next move and sends information to the next move indicator form (“Form2”).

The next move indicator form (“Form2”) receives updates from the settings form

when the user decides to go through the cycle of the next action to do. The next action is determined with a simple switch case statement then displayed as a symbol on the form.

The current settings of the settings program are loaded from the “settings.txt” file whenever the application is launched from the Form1_Load function. The “settings.txt” file should be in the same folder as the executable (.exe). If the application cannot find the settings, it will create a new “settings.txt” with default settings. When the application closes, the Form1_Closing function will save all the settings and override any settings in the “settings.txt” file. The settings.txt can be modified directly without the program.

```
#include "Mouse.h"

// pins of the switch
const int mouseButton = 8;

int clickState = digitalRead(mouseButton);

int d = 50;

// variables will change:or reading the pushbutton status

void setup() {
  Serial.begin(9600);
  pinMode(mouseButton);
}

void loop() {

  clickState = digitalRead(mouseButton);

  if(clickState == LOW) {
    Serial.write("switch");
    delay(100);
  }

  delay(d);
}
```

Fig 4. Arduino code

TROUBLESHOOTING

How to open the application

After extracting the Zip files provided for this project, Double click on the main folder **GNG2101AccessibleSwitches-main→CursorMovement→ bin→Release** then open the **CursorMovment.exe** file, (Optional: you can make a shortcut with a right-click on the .exe file and dragging it to the desktop so that the access is easier to the app)

The computer is unable to detect the switch

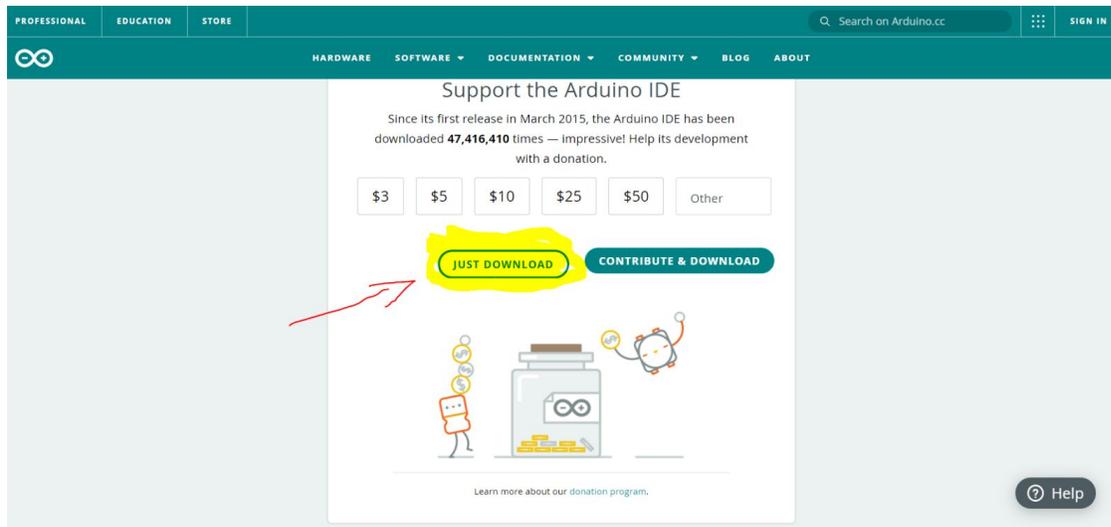
Make sure that:

- The USB connection is firm and stable in the button and the computer
- The USB connection wire is functional
- The computer is running on Windows 10
- The Arduino nano (CH340) drivers are installed on the computer

If all of these solutions did not work, it might be the problem of the drivers, that your computer did not install them properly, the solution could be “installing Arduino IDE” for your computer, visit this link: <https://www.arduino.cc/en/software> and choose “Windows” in the Download Options, then, choose “Just download” :

The screenshot shows the Arduino IDE 1.8.13 download page. The page has a teal header with navigation links: PROFESSIONAL, EDUCATION, STORE, and a search bar. Below the header is a navigation menu with links: HARDWARE, SOFTWARE (highlighted), DOCUMENTATION, COMMUNITY, BLOG, and ABOUT. The main content area is titled 'Downloads' and features the Arduino logo and the text 'Arduino IDE 1.8.13'. The description states: 'The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. This software can be used with any Arduino board. Refer to the Getting Started page for installation instructions.' Below this is a 'SOURCE CODE' section with a link to GitHub. On the right, there is a 'DOWNLOAD OPTIONS' section with a list of operating systems and bit architectures. A red arrow points to the 'Windows Win 7 and newer' option. Below the options is a 'Help' button.

DOWNLOAD OPTIONS	
Windows	Win 7 and newer
Windows	ZIP file
Windows app	Win 8.1 or 10 Get it
Linux	32 bits
Linux	64 bits
Linux	ARM 32 bits
Linux	ARM 64 bits
Mac OS X	10.10 or newer



After this step, the Arduino IDE will start downloading, after it's done, click on it and start the installation process, and keep clicking "Next", the app will ask you to install the drivers (usually 3 drivers), choose "Install" each time, and the installation will finish.

The next-move indicator is hidden

Make sure that:

- No fullscreen applications are running
- To open the next move indicator again, click on the "Open next move indicator" on the settings

If the application cannot open

Make sure that:

- The button is the only Arduino device connected to the computer
 - If any other devices need to be connected with a COM port, then reconnect them after the switch has been connected
- The computer is running on Windows 10
- The Arduino nano (CH340) drivers are installed on the computer

The cursor moves erratically when on a second screen

The program is only limited to the primary screen of the computer.

Typing

Open the Windows On-screen keyboard application and use the cursor to select the letters to type.

Where to find the settings outside of the application

The settings can be found in the same folder as the .exe file.

CONCLUSION

From this prototype, we have learned that it is very important to coordinate hardware and software development and keep constant communication between members. Furthermore, it is also noteworthy to assign a leader/manager when working on a project to focus on goals and have better time management and efficiency. Also, plan early on tasks to give room for any unexpected problems.

Room for improvement on this prototype can be done using Visual Code as the IDE for the C# programming language. For collaboration on code, Github is highly suggested as a repository for the code. For hardware development, the use of an Arduino nano is suitable for all the tasks handled by this switch. A 3D printer is suggested for building a robust housing for the button switch. The button switches, circuitry, USB cable, and the Arduino nano can be all found on online distributors.

BIBLIOGRAPHY

1. Government of Canada, S. C. (2017, February 15). *A profile of persons with disabilities among Canadians aged 15 years or older, 2012.*
<https://www150.statcan.gc.ca/n1/pub/89-654-x/89-654-x2015001-eng.htm>.

APPENDICES

Links to Project Files

This project can be accessed at:

<https://makerepo.com/victorc/gng2101a14accessible-switches>

Demo of the Switch

Youtube Link:

<https://youtu.be/fZNMPq9oneo>

Arduino Drivers Link

<https://sparks.gogo.co.nz/ch340.html>

Bill of Materials

Material	Cost	Link (Amazon)
Arduino	\$13.99	https://tinyurl.com/y6akl4m5
Buttons	\$8.11	https://tinyurl.com/y2un99vg
Jumper wires	\$9.99	https://tinyurl.com/yydr1899
Resistor	\$8.50	https://tinyurl.com/yxalh9o7
Total	\$40.59	