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Introduction

Switch filtering is the process of removing, or not allowing, certain switch actions to take place because they are unintended. They may be caused by a variety of involuntary actions, or in some cases the absence of an action (such as the user failing to remove their hand from the switch in time to prevent a repeat action).

There are a large number of conditions which can benefit from switch filtering facilities including, but by no means limited to, tremors, ataxia, chorea, lack of forearm strength or any other motor deficit. This white paper does not seek to identify the particular conditions which may exhibit such deficits but instead confines itself to a discussion of how switch filtering may be used to good effect.

Whilst, at the time of writing, there are a few software titles that include some switch filtering features, there are no switches or switch interfaces currently on the market to address this need. This is regrettable since the switch hardware is the logical place to provide switch filtering so that its benefits can be gained irrespective of the software in use.

It was a great surprise to Pretorian that no such hardware existed when we conducted our initial research and this ultimately gave us the inspiration to create USB Switch with Switch Filtering.

USB Switch

USB Switch builds on the existing range of well proven and highly regarded switches from Pretorian Technologies. Both wired and wireless switches are available in a range of sizes and colours. All have a sloping profile and no surrounding flange which means that the switches may be used without the user putting their hand on the switch at all. Instead the user may rest their hand on the desk immediately in front of the switch with the slope of the switch towards the front. The user may simply 'roll' their hand towards the switch and in doing so will activate the switch along its front edge- see Figure 1. This has proven to be a great benefit to many users.



Figure 1. Making use of sloping profile of USB Switch

USB Switch takes this one stage further by providing the switch interface within the switch itself, meaning that it may be plugged directly into a USB socket, rendering switch interface boxes obsolete. The unit ships with a standard USB lead (often referred to as a camera cable) which allows it to be directly connected to a PC, Mac or Chromebook. Simply by changing the cable to one terminating in a USB-micro plug, it can also be used with many Android tablet computers. Users of Apple iDevices should purchase the very similar iSwitch from Pretorian Technologies.

As well as the main switch, a pair of 3.5mm sockets is also provided on the rear of USB Switch, allowing it to support three switches in all. Each of the three switches can be programmed to a different function using the intuitive display and programming buttons on the base of the unit. Any combination of mouse, keyboard and gamepad functions can be programmed, the precise list of 24 functions having been honed on the company's highly successful SimplyWorks wireless products over a number of years.

Typically, switches of this kind are used to access switch adapted software/apps and as such, functions such as *space*, *enter*, *left click* and *right click* are very popular. The unit also includes ~1 and ~3 to offer compatibility with some Android apps as well as a host of other functions.

Each of the three switches (one internal, up to two external) can benefit from the Switch Filtering features that are built in to USB Switch. Although all of these features are set to 'off' when shipped from our factory, they may easily be engaged at any point. The unit has an internal non-volatile memory to retain these settings even when it is unplugged or the computer powered down.

To gain access to these features, simply press and hold the 'Channel' button on the base of the unit and the user will be taken through a series of menus, allowing the current setting of each feature to be viewed and changes made as necessary.

The following sections take each switch filtering parameter in turn, describing how each works and giving example applications:

Switch Acceptance Delay

This is the minimum time for which the switch must be pressed, and remain pressed, before the switch action will be recognised as a valid press. If any single press lasts less than the selected period, the switch action is simply filtered out and no switch action passed to the host computer. Only if the switch press time exceeds the selected period will the switch action be passed to the computer.

Referring to Figure 2, the initial switch cycle is less than the chosen period and is ignored. Only the second cycle is greater than the chosen period and is passed on to the computer. Note that once the second switch press has been accepted, the switch action lasts for as long as the switch remains pressed.

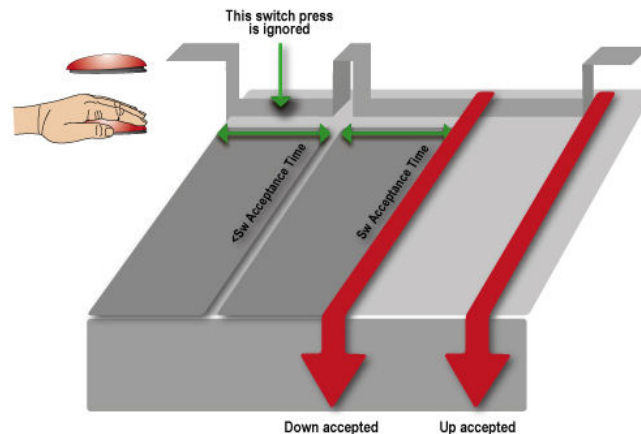


Figure 2. Effect of Switch Acceptance Delay

This feature has the effect of filtering out initial, unintentional switch presses so that the switch action is not passed to the computer until the user's hand has come to rest permanently on the switch top. This eliminates the chance of additional switch actions being recognised by the host computer.

Referring again to Figure 2, without switch filtering two separate switch actions would have taken place. This would have resulted in the user scanning on one place further than intended, which would inevitably lead to user frustration.

The Acceptance Delay can be set to zero (off), 0.1 sec, 0.2 sec, 0.5 sec, 1.0 sec, 1.5 sec or 2 sec, allowing it to be 'tuned' to the particular user's needs. It is advisable to start with relatively short delay periods initially, such as 0.2 sec and then adjust as the need arises.

There are a host of different conditions which can benefit from this particular setting, although it is important to note that the user should have relatively good aim to get maximum benefit. Users with poor aim would be unlikely to be able to press the switch for long enough to overcome the Acceptance Delay and therefore no switch actions would be recognised. Users with poor aim should instead make use of the Ignore After Release Time described in the next section of this document.

Ignore After Repeat Time

This is the time for which any subsequent switch activity is ignored after it is initially released. If one or more inadvertent switch cycles take place due to a tremor as the user removes his or her hand, these may be filtered out so that they do not have an unintended effect on the software that the user is running.

Figure 3 shows the effect. Following the initial switch release, two further switch cycles are shown. The first switch cycle falls within the Ignore After Release Time and are therefore filtered out- its action not being passed on to the host computer.

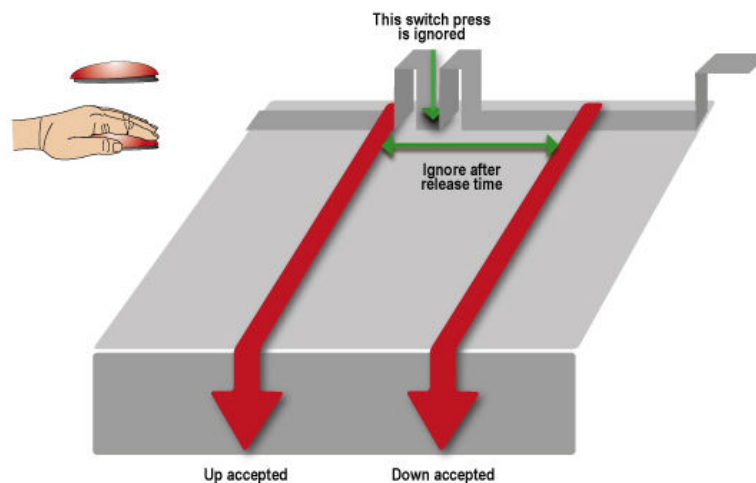


Figure 3. Effect of Ignore After Repeat Time

Conversely, the second switch cycle is outside of the Ignore After Release Time and therefore qualifies as a valid switch event, its action being passed on to the computer. It is important to note that this switch cycle itself, as a qualifying switch cycle, is *also* followed by an Ignore After Release period, and so on.

On the face of it, the Switch Acceptance Delay and the Ignore After Release Times are very similar. However, because one acts before the switch event is accepted and the other acts afterwards each is appropriate to a different set of circumstances. It is unlikely that both settings will ever be required.

Maximum Press Time

Users who have difficulty in removing their hand from the switch after a switch event, or those who have little forearm strength and tend to exert unintentional pressure on the switch due to the weight of their arm, will frequently benefit from the Maximum Press Time setting.

When set to a non-zero value, this feature passes to the computer a single switch event of a fixed duration no matter how long the switch is actually pressed for. Figure 4 shows the effect. Assuming no Switch Acceptance Delay is selected (recommended in most circumstances), the switch event occurs the moment the switch is first pressed and lasts for the duration given by the Maximum Press Time setting, i.e. 0.1 sec, 0.2 sec or 0.5 sec.

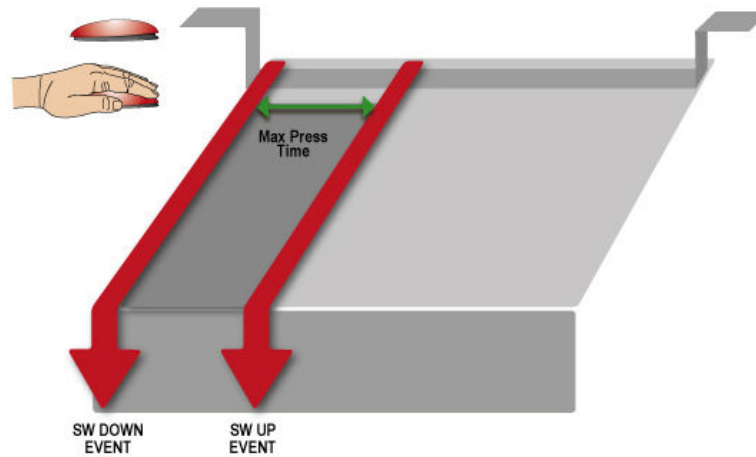


Figure 4. Effect of Maximum Press Time

If, for example, the switch is to be used to scan a number of items, the Maximum Press Time will ensure that each press of the switch will result in just a single step scan event irrespective of how long the switch is pressed for.

If there is a possibility of multiple switch events when the switch is released, due to laboured removal of the user's hand, then an amount of Ignore After Release Time is recommended.

The above discussion exemplifies a very important aspect of the multiple features that USB Switch offers- all of the key features can coexist. This allows almost infinite permutations of the features which can prove invaluable in setting up the switch to suit complex needs.

Auto-Repeat Setting

In some respects this setting is the opposite of the Maximum Press Time setting. Whereas the Maximum Press Time allows only one switch event to be sent to the computer per switch press, Auto-Repeat setting allows a single switch press to send multiple switch events, each equally spaced.

In instances where pressing the switch is so laboured that the user finds it difficult to make multiple presses- for example when scanning- this can lead to frustration and fatigue. Instead, if Auto-Repeat is enabled, the switch may be made to scan repeatedly for as long as it remains pressed. Now, a single switch press can take the place of multiple presses.

The duration of each event is the same as that selected in the Maximum Press Time setting and the period between each event is the sum of the Switch Acceptance and Ignore After Release times. Therefore, Auto-Repeat may only be enabled if Maximum Press Time is non-zero and Switch Acceptance and/or Ignore After Release are also non-zero. If these conditions do not hold true, the Auto-Repeat menu will not appear and its function will automatically be disabled.

At first sight this may appear rather complicated, but the simplest approach is to use the following settings:

- Switch Acceptance Delay = 0.
- Set Ignore After Release Time to the required time between switch events – e.g. 2 sec.
- Set Maximum Press Time to required switch event duration- e.g. 0.2 sec.
- Set Auto-Repeat to 'Y'.

This will allow the first switch event to take place immediately that the switch is first pressed, which is generally what is required. Figure 5 shows the effect.

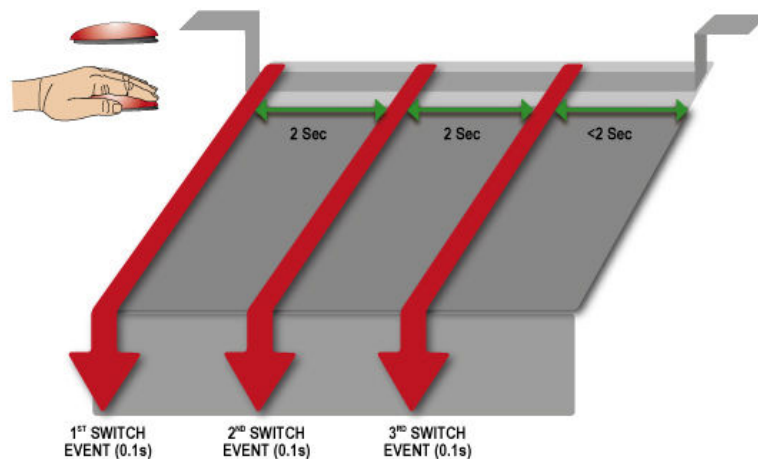


Figure 5. Effect of Auto-Repeat Settings (Switch Acceptance Delay=0)

The alternative configuration would be as follows:

- Ignore After Release Time = 0.
- Set Switch Acceptance Delay to the required time between switch events – e.g. 2 sec.
- Set Maximum Press Time to required switch event duration- e.g. 0.2 sec.
- Set Auto-Repeat to 'Y'.

This combination of settings creates a slightly different effect where the first switch event takes place after the Switch Acceptance Delay- see Figure 6. This may be of benefit in certain situations, for example where there is some tremor.

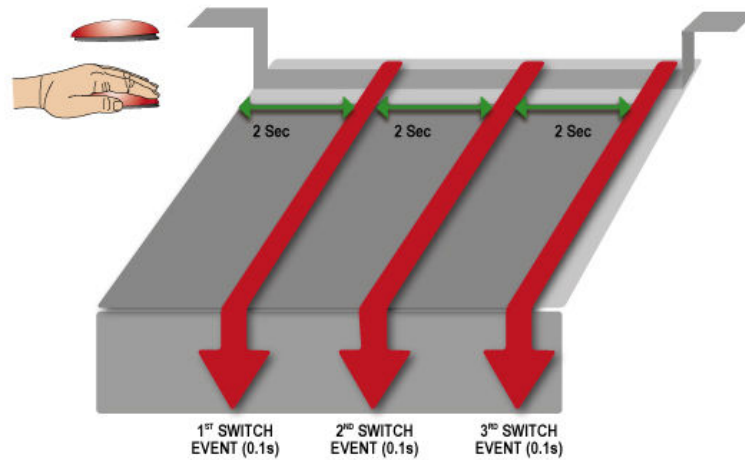


Figure 6. Effect of Auto-Repeat Settings (Ignore After Release Time=0)

Conclusion

USB Switch offers some unique features which allow users the freedom to use their chosen software effectively and without frustration. As with any product with multiple settings, a period of experimentation will quickly allow the occupational therapist to determine the optimum settings.

Pretorian Technologies takes great pride in designing products which benefit users with disabilities and we believe that USB Switch represents a considerable advancement in switch technology.

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