

# **A Survey on Fine Pointing and Steady Tapping for Motor Impaired Users**

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**ABSTRACT:** With the high popularity of touchscreen devices such as smartphones and tablets, it is important to find ways to limit the digital divide for people with motor impairments. Users with motor impairments interact with touchscreen devices differently than an average user, and “users with motor impairments” is a broad category. The current number of old age users is very less as they are not very familiar with smartphones. As the time passes by, the number of old age users will increase. These users can have varied disabilities ranging from minor hand tremors to missing limbs. This means solving common problems among these users can be difficult since solutions may need to be specific to the user’s abilities. This paper explores how motor-impaired users are interacting with touchscreens and how this interaction research can improve current assistive technology adoption rates. Finally, we will give an overview of new assistive programs: Touch Guard, Octopus Launcher, and Dowell.

**KEYWORDS:** Assistive technology, motor impairment, tremor, touch screen.

## **I. INTRODUCTION**

People get frustrated when their smart phones are not working and get even more frustrated when they are unable to use them properly due to their physical issues. Such users with motor impairment interact with touch screen devices differently and wish to use all the same tools as everyone else. Inability to use the devices properly is starting to divide the digital world. Digital divide is the difference in social or economic status between people who can and who cannot easily access to their smart devices. Users suffering from motor impairment are being helped by using various technologies such as assistive touch. There are a number of various advanced devices which are available in the market which can solve problems of many users affected by motor impairment but there is not a particular device which can be socially and economically be accepted by all such users. The current technologies available are too expensive or the users are notable to cope up with such advancements. Thus the adoption rates are very less, the number of such devices purchased is low and the rate of users using them in daily life is even more less.

By looking at various researches in interaction of motor impaired users with such smart devices we will be able to improve the current systems and invent new technologies to remove this digital divide. We are going to describe the various methods and techniques being used to help aid the motor impaired users.

## **II. RELATED WORK**

The assistive technologies Octopus launcher and Dowell are advanced solutions to help people with motor impairment to interact with touch screen devices. Statistics show that users prefer using Octopus launcher while Dowell has new features and ideas. In Dowell users can interchangeably use wheelchair’s joystick to control devices which in turn saves money as no additional HID has to be purchased. Moreover, users wish to work on all the

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common apps which normal people use. Both the technologies fulfil this demand, in Octopus Launcher there is a common framework which enhances interaction with applications while Dowell does the same in a better way as it's menus when are not being used remain hidden and provide with more space on the screen. Users also prefer to change any wrong selections done. In Octopus Launcher user can move back using the pop up menu with the help of joystick while in Dowell user can move towards left or right of the screen with the help of their HID to simply move back from Dwell selection or they can use the menu placed at the bottom to go back. Dowell may reduce the cost of assistive technologies to a bare minimum as it does not require any additional assistance devices.

## III. BACKGROUND

### 1. MOTOR IMPAIRMENT

To help aid users with motor impairment it is necessary to understand what motor impairment is. If we don't know the problem we would not be able to find the solution. Motor impairment refers to improper functioning of some body parts due to loss of limbs. It may lead to weakness in body, degradation of stamina, loss of muscle control and there can be adverse effects such as paralysis. There exist several impairments which affect normal functioning of a user in various different ways. The most common and basic type of motor impairment is tremor. Users suffering from tremors find difficulty in selecting crowded, small targets like options available on a touch screen. Tremors are rhythmic contraction and relaxation of limbs or hands. It involves involuntary movement of maybe one or more body parts. It is difficult for users suffering from tremors to perform gestures like swiping, sliding and gestures involving multiple fingers. Cerebral palsy is another motor impairment which affects users. In this situation due to neurological disorder in early childhood, body movement is affected and this situation persists for long life but does not deteriorate with time. Users affected by cerebral palsy are able to use devices such as joystick but face difficulty in it's movement. While using touch screen devices users feel difficulty in performing operations with gestures. One major motor impairment is loss of limbs. It is known as quadriplegia. Due to injury or illness, there is loss of control over limbs commonly known as paralysis. Users affected by quadriplegia need more assistance to have basic interaction with touch screen devices.

### 2. ASSISTIVE TECHNOLOGY

People affected by motor impairment depend on assistive technologies. Assistive technologies are defined as the substance, equipment, devices or some system which makes the user experience better and easy to use like any other normal user. The demand of assistive technology has increased significantly and platforms such as iOS and android have made this feature to assist users affected by motor impairment. Both the platforms provide an option to connect the user's switch with their devices and the user can customize the settings as per their ease. Assistive touch always stays on the screen and can be easily accessed whenever needed by the user. Assistive touch opens a menu which allows the user to set the device settings like gestures, sliding, swiping, swipe using multiple fingers. It also enables user to use all the physical buttons on the device without the need to physically press them. The user has option to the customizable touch settings which allow users to adjust aspects like dwell times, where the system should only initiate a tap if the user is touching the screen longer than x seconds. This helps to avoid accidental selection.

### 3. TOUCH SCREEN

The display that electronically determines the location of some contact made on its surface is known as touchscreen. Contact on touch screen can be made by fingers or hands and also with the help of smart pens known as styluses. In recent years, the use of touchscreen devices has risen drastically. Long ago, the use of touchscreen devices was limited to large industries as they were expensive. With the availability of new technology, the prices of touchscreen devices have fallen and the number of devices using touchscreen have increased. Nowadays, a large number of people have access to touchscreens and the issue related to them have increased.

## IV. PROBLEM SOLUTION

### 1. TOUCH GUARD

Touch guard is a new technology which can be easily used on smart phones and it is supported with all the installed applications. It provides motor impaired users with enhanced area touch that helps to acquire the desired target easily. Enhanced area touch increases the motor and visual space which removes the need of precise and fine pointing. It also decreases the difficulty faced by users to select crowded and small targets. It provides the user with a ball whose center is positioned at the point where the user's finger is placed on the screen and its size can be adjusted according to the user. When multiple targets intersect the ball, an additional menu is opened with enlarged options which can be easily chosen by user or else a list of targets is available.

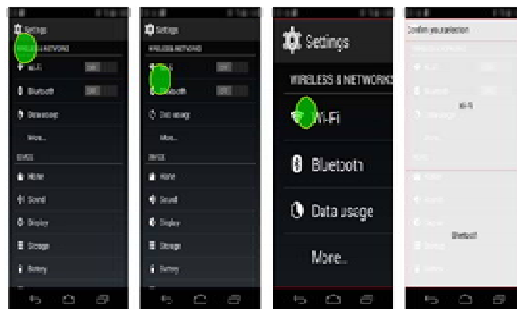


Fig. 1.Touch Guard

### 1.1. MAGNIFICATION

When phase of ambiguity is achieved, magnification is done. The area of touch screen which is active is magnified. Touch guard chooses the option closest to the center of the touch area instead of magnifying the area. The center of the view which is magnified shows the area of interest. It is made sure that the targets which are close to the edges of screen don't become hidden when magnification is done. User now can easily perform the desired selection in magnified view. If in the magnified screen multiple targets are captured then touch guard activates target which is close to the point that is touched. To help visually, magnified screen is animated. User is informed that touch guard is in phase of ambiguity removal with the help of red border.

### 1.2. TARGET LISTS MODE

Another way to remove ambiguity is called targets list mode which displays potential targets. On entering target list mode, touch guard gets titles of targets and forms a list covering the full screen then the user is asked for confirmation. To help user visually, Transparent background is made so that user can look through list underneath. The maximum number of targets on a page is four which can be scrolled down for more targets. There are as many targets available as required. The order of targets depends on the distance of target from center of area touched. Closest target acquires the topmost position of the list.

## 2. OCTOPUS LAUNCHER

It is an interaction framework created to interact with the smartphone with one touch interaction, researchers chose to implement a wheelchair joystick HID for the cursor interaction with the evolution box. The Evolution Box allows the user to toggle between the joystick's wheelchair control and Octopus Launcher control with a switch. This device contains a Bluetooth module, a joystick link, and a few other features which aid in the smartphone and joystick interaction. research has been made to modernize this joystick so that it can be exchanged with a joystick from a user's wheelchair or any other joystick. Initially the Octopus Launcher is displayed on the user's smartphone as a joystick with icons of eight commonly used applications surrounding it, such as menu, settings, email, etc. The eight options are

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mapped according to the eight possible directions that a joystick can move. To select an application, a user simply moves the joystick in the direction of the application to highlight it. Once highlighted, the user dwells for two seconds to initiate a selection of a target. This highlighting aspect was found to be important to help aid the user in mapping their joystick movement to what they were selecting on the screen. Inside of the application, the user can navigate using the joystick as the cursor interaction. If movement stops, after a slight delay, a sub menu appears with five interaction options; these can include going back, click, menu, scroll, or home.



Fig 2. Octopus Launcher

### 3. DOWELL

It is another software solution which allows any HID to connect to a smartphone using an inexpensive USB-OTG cable. This HID can be a user's joystick, but can also be an adaptive mouse, keyboards, or recognition software. For users who are already familiar with these devices, this software is easier to learn and use than other systems which may incorporate new assistive devices or controls. It makes use of guardrail UI which incorporates additional control options along the edges of smartphone screen to aid selection. In order to interact with a smartphone, user uses their HID as a cursor. To "tap" with the cursor the user simply dwells on the target for two seconds. This dwell time can be adjusted to the user's preference. The menu appears when a user dwells at the top of their screen, but is otherwise closed to allow more screen space. Since gestures are recognized with dwell interaction, there needs to be areas for a user to dwell when resting. These are located on the left and right sides of the screen. A user can also use these areas to cancel a dwell selection by moving left or right.

Besides the top menu for gestures, there is also a bottom menu for hardware keys. Like the top, a user dwells on the bottom of the screen to open the menu. This menu contains hardware keys such as menu, home, and back. There are additional hardware keys on the next page of this menu such as power, volume, and brightness. These gestures are one step and two-step gestures. The one step gestures include: tap, long tap, zoom-in, and zoom-out. These motions are simply dwell activated and do not need a specified direction or degree. The two-step gestures include only scroll and swipe. All of these gestures have unique cursors help a user know what gesture they are currently using.

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Fig 3. Dowell System

#### 4. FEEDBACK

A common problem faced by all the people suffering from tremors is that, because of tremor they do not know whether they have made contact with the touchscreen or not. Giving users feedback about the contact unintentional or intentional was made is a great mechanism that can be used. It is important to provide this feedback immediately especially because of the nature of tremor. Feedback mechanism can be provided as a visual, audio or haptic feedback. All these feedbacks have advantages and disadvantages.

Audio Feedback – Sound plays an excellent role in providing feedback that a touch has occurred but the age groups of people suffering from tremors have a high probability that they will be affected by hearing loss also. Thus audio feedback may not be perceived by the user.

Haptic Feedback – While using the touchscreen because of tremor the hand movement towards the target might accidentally touch the surface of touchscreen. The duration of such unintended contact is very short so the user might not be able to detect the fact such feedback has been initiated.

Visual Feedback – When the user touches the surface of the screen visual graphics can be displayed on the screen to denote that touch event has occurred. The user may get feedback from the buttons, changing colors, or text fields but not all UI elements.

#### 5. DISABLING THE INTERFACE LOCALLY

Tremors lead to oscillations in the users fingers due to which user performs an action multiple times even though they wished to perform it once. For example, while typing duplicated inputs are the most common error. A simple mechanism to remove duplicated or unwanted touches is disabling the UI element which was activated by touch temporarily. It will help in reducing the number of duplicated inputs on that element. On the basis of user testing where the test showed that the interval between the touches when multiple number of touches were encountered for a repeated action, disabling the UI element for a duration of 0.2 sec would be sufficient as the most repeated touches are performed within 0.2 sec. According to the nature of the tremor that makes accurate pointing not only the UI element that has been selected is to be disabled but the other UI elements near to the touch point are also needed to be disabled. To allow the user to perform gestures, the UI element must be disabled only when the touch event has been detected and the user has lifted his hand from the surface of the touchscreen.

#### 6. REMAP GESTURES

Results of sliding test show that the ease of movement different users experience differs from user to user and also from the direction the user is performing the sliding gesture towards. It is observed that movements away from the body are slower than the ones performed towards the body. The current gestures available for all users with tremors might not be adequate, some other gestures might be easier to perform for some users. Users should be allowed to input their own gestures if the gestures provided by the system.

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## 7. PREDICTIVE INTERFACE

The accuracy in the input of the persons that suffer from tremors is the biggest issue when they try to interact with touchscreen devices. We can increase their accuracy greatly if we can predict what their next action will be. Trying to determine the next action of the user is already deployed in user interface, the word user is typing is determined and alternative suggestions are given by the predictive text input system used in mobile phones. According to Fitts' law the bigger is the size of a target the easier it is to press on it but having the same UI element in with different sizes in the same interface disrupts the usability of the system. Increasing the size of the tappable area of the predicted UI element is a solution to this problem. This method will lower the error rates for inputs and at the same time keep the original appearance of the interface, so the same interface can be used for abled bodied users and also for users that suffer from tremor. Predictive interface is especially useful while text inputs are to be entered. Using prediction can be useful in filling forms where the field that follows the one you are currently editing has an increased tappable area.

## V. CONCLUSION

The research paper explored various new tactics and techniques which would help aid the users with motor impairment. The problems faced by people with motor impairment were listed. The research in this field to improve the user interaction with smart devices was taken into account. Measures to increase the adoption rate by motor impaired users were discussed. Brief discussion of the assistive technologies was done which is a cost effective and better solution for the problem.

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