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NVDA: The Open-Source Screen Reader to Access Resources for the Visually Impaired

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Abstract:
This paper explores the architectural foundations and practical implications of screen readers, focusing particularly on NVDA (Non-Visual Desktop Access), in enhancing accessibility to digital resources for visually impaired users. Core architectural components such as APIs, ARIA, Alt Text, and keyboard navigation form the backbone of screen reader technology. APIs, built on SOAP and REST frameworks, facilitate interoperability across systems, enabling seamless data exchange and integration. ARIA (Accessible Rich Internet Applications), part of the WAI initiative, provides semantic structure for dynamic web content, enhancing accessibility where native HTML elements fall short. Alt Text supports non-text content accessibility by providing descriptive alternatives, while keyboard navigation is essential for content interaction and control without a mouse. The NVDA screen reader, an open-source, Windows-compatible tool, demonstrates advanced capabilities including multi-language support, Braille display integration, and customizable settings, making it a vital tool for inclusive education and information access. NVDA's functionality spans document navigation, form interaction, web browsing, and system-level access, with extensive keyboard shortcuts for efficient operation. Additionally, other screen readers like Apple's Voice Over, Linux-based ORCA and BRLTTY, and browser-based Web Anywhere offer alternative solutions, each with unique features and varying levels of affordability. The role of APIs in enabling this ecosystem is emphasized, as they support the sharing and interaction between software, systems, and services including mobile apps, cloud platforms, and IoT devices. Screen readers are not only assistive technologies but also integral tools in democratizing access to digital content.

Keywords: web accessibility, screen reader, API, ARIA, ALT TEXT, key board navigation, NVDA

Introduction:

Screen readers help in converted any documents into a braille display or voiceover on a desktop, laptop and also on mobile devices. The screen reader is an assistive technology that maximizes accessibility and interoperability for blind or low vision users by transforming content into a format that is appropriate for accessing resources. The operating system with accessibility at the end of the user interface, are Windows, Linux, Mac, Android, and others, can be integrated with screen readers. NVDA, Voice over, Dolphin Supernova, System Access to Go, Orca, are the screen readers help in converting any document into braille display and the use of keyboards and cursors to configure various keystrokes for text navigation with the speech synthesizer to read the text aloud. The NVDA screen reader is an open-source, Windows-compatible program with sophisticated features like multi-language support, braille display integration, and adjustable settings. API, ARIA, Alt Txt and Keyboard navigation are the

operational keys that acting behind the screen readers to make the web content fully accessible, especially role of API in accessing resources in sharable platform of interactive community. The guidelines of web content accessibility developed under the initiatives of WCAG at the end of 1990s. Recent advancements of this initiative also include the disabilities other than blindness to enhance the operability of the screen readers to its maximum level.

Objectives of the study:

- to highlight the basic applications and mechanism behind the functionality & web accessibility of screen reader
- to find out the important features and working principle of NVDA as a screen reader.

Literature Review:

Web content accessibility started with the WAI (Web Accessibility Initiatives) by the founding members of W3C (World Wide Web Consortium in the year of 1996. The first set of web accessibility guidelines (WCAG1.0) released on 1999 and the updated version WCAG 2.0 (2008) includes a wide range of variation in disability of visual, auditory, physical, speech disabilities, cognitive, language, learning and neurological disabilities. WCAG 2.0 aimed to apply "more broadly to different types of Web technologies and to more advanced technologies" and to be "more precisely testable with automated testing and human evaluation" (WAI, 2009). It includes "success criteria" with three conformance level A, AA and AAA. The level AAA highest level of conformance includes all the success criteria. WCAG 2.0 develop on the basis of the demand of various users' needs of the institutions and organizations. The layers of guidance consist of four founding principles of web accessibility that of perceivable, operable, understandable and robust, 12 guidelines, success criteria and sufficient & advisory techniques. These layers of guidance work together to meet the needs of disable user for accessibility of the web content at maximum level. IBM Screen Reader/2 developed over nine years which was released on 1988 built on accessing over OS/2, DOS and Windows operating system. The main features of this screen reader that it was based on 18 keypads and PAL programming languages for compilers and profiles. The user requests through the key pad are auto speak by the software screen reader.

The implications of architectural design behind the development of screen reader in accessing resources

The basics architecture that screen reader stands on are API, ARIA, ALTTEXT & KEY board navigation. API which is a set of rules, open standard and protocols (Application Programming Interface) as built on SOAP and REST technology of interoperability between application software without any direct code level integration for data and communication exchange allowing to operate on different system and services of web apps, cloud services, IoT devices etc.

API help screen reader in accessibility by sharing functionality of the applications of data as well as exchange of information. The architectural design of standardized schema or structure Common Data Model (CDM) acts as seamless integration of data by providing structure of data make it consistent and unified to enhance the interoperability between the system. API designed with SOAP (Simple Object Access Protocol) exchange messages through https and SMTP (Simple Mail Transfer Protocol) with XML data format of file. The standard that the web API deal with REST (Representational State Transfer) which is an architectural style of networking based on client server architecture of resource

sharing through https; statelessness; cacheability; layered system of additional features; code on demand and four facets of uniform interface while JSON is the representation of data format. OAuth is incorporated as a security protocol to provide security to authenticate and authorize the users in sharing protected resources.

ARIA (Accessible Rich Internet Applications) supplement of the assistive technology use in screen reader act as enhancing the accessibility and interoperability of the web content and its different applications in user interface in the case of lack of proper semantics in widget generation. ARIA is a technical specification of web ontology consists of roles, states and properties provides a structure in customization of widget and other web applications.

WAI ARIA (Web Accessibility Initiatives - Accessible Rich Internet Applications) having following properties to provide semantics of assistive technology for the improvement of accessibility of API.

Understanding roles of content

- Widget generation
- Interactive widget for navigation

Understanding state and properties of different attribute of elements

- Dynamic Interaction and manipulation for operating in user interface
- Value or operations of objects of widget

ALT TEXT:

Alt text which is the text alternative leads to access the non-text elements such as images, audio, video, animations and many other non-text elements for the disable users. The images would not be accessible without the ALT TEXT for the visual impairment users as it transcribes the types, purpose and meaning of the image and also its relation with the contents. The background color of a content, contrast of the images, logo, brand name, decoration etc. should be need major emphasize in the case of alt text as a part of assistive technology and a search engine maximizing tool of descriptive text substitute of non-text visual elements.

Key board navigation:

The most important features of the screen reader is to read out the text of the digital content by the different logical arrangement of keys in key boards; providing shortcut keys to operate and the navigational keys of moving around the texts from left to right and top to bottom and also display in braille.

Working mechanism of NVDA as screen reader:

NVDA developed by two blind person Michael Curran and James Teh and supported by the not-for-profit organization NV access in April 2006 under windows operating system. NVDA has free, open-source, multilingual speech synthesizer eSpeak NG, which has been developed over 55 languages. The open-source braille translator LibLouis is used by NVDA to convert text into braille sequences. Except for two specific circumstances, NVDA is distributed under the GNU General Public License version 2. The sections on "Non-GPL Components in Plugins and Drivers" and "Microsoft Distributable Code" in the license agreement list the exceptions. NVDA also uses and incorporates components that are released under various open source and free licenses.

Major highlighting features of NVDA:

- NVDA has compatibility with widely-used applications such as web browsers, email clients, instant messaging programs, and office suites
- The speech synthesizer of NVDA enabling over 55 languages
- The textual formatting when applicable, including font name, size, style, and spelling inaccuracies are reported by NVDA
- Text is automatically announced using mouse and the mouse position can optionally be indicated audibly.
- The capability to connect to and operate another computer running NVDA for remote assistance or cooperation;
- Support for numerous refreshable braille displays, including the capacity to recognize many of them automatically; and braille input on braille displays via a braille keyboard
- Easy-to-use talking installer that may be used exclusively from a USB flash drive or other portable media without the requirement for installation
- Support for modern Windows Operating Systems including both 32- and 64-bit variants
- Capacity to operate on secure screens, such as Windows sign-in
- Using touch movements to announce controls and text
- Supporting popular accessibility interfaces including UI Automation, Java Access Bridge, Microsoft Active Accessibility, and IAccessible2
- Support for console apps and the Windows Command Prompt
- Compatible with Windows accessibility technologies like Sticky Keys, Windows Voice Typing/Dictation, and Magnifier
- Capable of highlighting the system focus.
- Interact with touch screens while announcing controls and text.
- NVDA supports OCR built in to read PDF files and images that are inaccessible.
- An active community of add-on developers and a large selection of add-ons are features of the in-built DD-on Store.
- The well-known Python programming language is used to write the add-on.
- Additional features, such as remote access for assistance with RDP, Citrix or VMware, A.I. image description tools, and more, can be obtained through add-ons.

The operations of the screen reader NVDA depends on key board navigations and all the functions have separate arrangements of desktop key such as to start the software the use of desktop key is control +alt +n and while exit it is NVDA +q then enter. NVDA plus down arrow is used in reading text “say all” but “read current line” NVDA + up arrow is used. Pressing twice spells the line or any information while “read current line” or “read selection” of text accordingly. Pressing three times spells the line or selected text by using character descriptions. NVDA reports entire window or window title, window status bar, date and time, current control having focus, text formatting, link URL destination etc. In the case of reporting of windows title (NVDA+t) and Windows status bar (NVDA +end) pressing of key combinations twice will spell the information and three times will copy it to the clipboard. Pressing (NVDA+f12) for time and date once reports the current time, pressing twice reports the date. Report link destination (NVDA +k) once read out the destination URL of the link at the current caret or focus position and twice pressing shows it in a window for further review. There are separate key combinations controls when NVDA reads typed characters, typed words, typed non character keys and

enabling mouse physically moving around the text to read. NVDA is also accessible through Laptop combinations of keys. The setting of speech, voices, volumes of voices are also done by combinations of keys.

List of keys for web navigation

Command	Keystroke	Description
Heading	h	Move to the next heading
Heading level 1, 2, or 3	1, 2, 3	Move to the next heading at the specified level
Form field	f	Move to the next form field (edit box, button, etc.)
Link	k	Move to the next link
Landmark	d	Move to the next landmark
List	l	Move to the next list
Table	t	Move to the next table
Move backwards	Shift + letter	Press shift and any of the above letters to move to the previous element of that type
Elements list	NVDA+f7	Lists various types of elements, such as links and headings

Most NVDA functions can be enabled or changed via the NVDA settings. Settings, and other options, are available via NVDA's menu. To open NVDA's menu, press NVDA+ n. To open might NVDA's general settings dialog directly, press NVDA +control +g. Many settings screens have keystrokes to open them directly, such as NVDA +control+ s for synthesizer, or NVDA +control +v for other voice options.

Conclusion:

NVDA is a free, open-source program that works with the Windows operating system and offers universal access to synthetic speech that may be used immediately from USB flash drives or other portable media without the need for installation. It is especially helpful for students. The functionality of Microsoft Word, Excel, and PowerPoint is made possible via System Access To Go, which allows readers to navigate among tables, forms, headers, footers, footnotes, and text by moving by line and paragraph. The software works with Skype to communicate with other for free & it can also be used with the Internet Explorer browser. Web anywhere is another free, less expensive web-based software that can be downloaded and installed in a browser from any location with a computer. Apple Voice Over is built on the Mac operating system, giving users the freedom to switch between the system and customize speaking voice, speech rate, and voice over settings to suit their own needs. The Linux operating system is used in the development of ORCA and BRLTTY. BRLTTY offers full screen review and a braille display. Screen reader is one of the important tools to help the blind or low vision user to access the resources. The screen readers not only to read out the text but also having braille display allowing user to apply command navigating with keyboards or giving figure touch. The screen reader

can become an important tool to enlarge the search interface of any digital databases of accessing resources. Different screen reader having different utility and some additional features but cost could be one of the factors in affordability. The API working behind this accessibility of screen reader software providing gateway of collection, extraction and exchange of information with its private, partner and public licensing policies. API also work for the functionality of sharing between the different application, system and services of mobile app, web app, cloud services and IoT devices that help in integrating the software with different system.

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Important links:

1. https://www.redhat.com
2. https://www.nvaccess.org/
3. https://www.satogo.com
4. https://sci-hub-links.com/scihub/?q=screen+reader
5. https://pdfdrive.webs.nf/