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Electronic system with a rollable display and a keyboard that are utilized to imitate a typewriter

Abstract

An electronic device, method, and computer program product imitate a typewriter. A top horizontal row of a virtual typing sheet is presented on an upper portion of an extendable display. Keystrokes received by a text input device are monitored and corresponding characters are presented across the top horizontal row of virtual typing sheet. In response to a next line transitioning condition (e.g., reaching an end of a current row or detection of a return keystroke received via the text input device), the extendable display is triggered to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of the characters associated with the top horizontal row. Presentation of the virtual typing sheet and the top horizontal row at the corresponding line spacing are upwardly adjusted to insert a new lateral row for presenting keystrokes.

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Background/Summary

BACKGROUND

1. Technical Field

(1) The present disclosure relates generally to electronic systems having a display and input mechanism for generating text presented on the display, and more particularly to electronic systems having the input mechanism and a display that extends and retracts to change presentation size of the display.

2. Description of the Related Art

(2) Portable electronic communication devices, such as smartphones, tablets, and laptop devices, have become ubiquitous. People all over the world use such devices to stay connected, to retrieve and consume information, and to complete tasks, such as generation of textual, graphical, and numerical based content using integrated and/or connected input devices. These devices have been designed in various mechanical configurations. Conventionally, these electronic devices each have a rigid display disposed along a major face of the electronic device. More recently, rollable flexible displays have been introduced for smaller handheld mobile devices, such as smartphones, where the displays extend or retract via a telescoping device housing or via a sliding blade that either rolls the flexible display onto a back of the device housing or extends the flexible display from a front side of the device housing. Rollable displays are being introduced to larger electronic devices such as laptops and monitors.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

(1) The description of the illustrative embodiments can be read in conjunction with the accompanying figures. It will be appreciated that for simplicity and clarity of illustration, elements illustrated in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements are exaggerated relative to other elements. Embodiments incorporating teachings of the present disclosure are shown and described with respect to the figures presented herein, in which:

(2) FIG. **1** presents a simplified functional block diagram of an electronic system that includes an electronic device that imitates a typewriter based on keystrokes received from a text input device and presented on an extendable display, according to the one or more embodiments;

(3) FIG. **2** depicts a functional block diagram of a communication environment including a communication device that is an implementation of the electronic device of FIG. **1**, according to one or more embodiments;

(4) FIG. **3** depicts a three-dimensional view of an example electronic system for imitating a typewriter that includes the communication device, an extendable display in a retracted position, and a keyboard with a user positioned at the keyboard, according to one or more embodiments;

(5) FIG. **4** depicts a front view of the extendable display of FIG. **3** in a retracted position presenting an initial position of a virtual typing sheet, according to one or more embodiments;

(6) FIG. **5** depicts a three-dimensional view of the example electronic system of FIG. **3** having the extendable display in an at least partially extended position, according to one or more embodiments;

(7) FIG. **6** depicts a front view of the extendable display of FIG. **5** in the at least partially extended position presenting the virtual typing sheet having the characters inputted as keystrokes on the keyboard, presented on an extended upper portion of the display, according to one or more embodiments;

(8) FIG. **7**A depicts a front view of an example system implemented as an electronic device in a laptop design form having an extendable display in a retracted position and that communicates with a printing device, according to one or more embodiments;

(9) FIG. **7**B depicts a front view of the example system of FIG. **7**A with the extendable display in an at least partially extended position, according to one or more embodiments;
(10) FIG. **8**A depicts a side view of an example extendable display implemented as a blade assembly in a retracted position on both a front side and back side a device housing, according to one or more embodiments;
(11) FIG. **8**B depicts a side view of the extendable display of FIG. **8**A with the blade assembly in an extended position rolled onto and extending beyond the front side of the device housing, according to one or more embodiments;
(12) FIG. **9** depicts an exploded view of the blade assembly of FIGS. **8**A-**8**B, according to one or more embodiments;
(13) FIG. **10**A depicts a side view of another example extendable display having a telescoping device housing in a retracted position and with an excess portion of a flexible display not needed to cover a front side rolled onto a back side of the device housing, according to one or more embodiments;
(14) FIG. **10**B depicts a side view of the extendable display of FIG. **10**A in an at least partially extended position, according to one or more embodiments;
(15) FIG. **11**A depicts a side view of an additional example extendable display having a telescoping device housing in a retracted position and with an excess portion of a flexible display not needed to cover a front side scrolled within the device housing, according to one or more embodiments;
(16) FIG. **11**B depicts a side view of the extendable display of FIG. **11**A in an at least partially extended position, according to one or more embodiments; and
(17) FIGS. **12**A-**12**B (collectively "FIG. **12**") are a flow diagram of a method of imitating operation of a typewriter by an electronic system having an extendable display and a text input device, according to one or more embodiments.

DETAILED DESCRIPTION

(18) According to aspects of the present disclosure, an electronic device, a method, and a computer program product imitate operation of a typewriter. The electronic device includes a memory that stores a typewriter imitation application. A controller of the electronic device is communicatively connected to a text input device, an extendable display, and the memory. The controller executes the typewriter imitation application, which presents, on an upper portion of the extendable display, a top horizontal row of a virtual typing sheet. The controller monitors keystrokes received by the text input device. The controller presents characters corresponding to the keystrokes across the top horizontal row of virtual typing sheet. The controller monitors occurrences of a next line transitioning condition from among a last character reaching an end of a current row of the virtual typing sheet and detection of a return keystroke received via the text input device. In response to identifying an occurrence of the next line transitioning condition, the controller triggers the extendable display to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of the characters associated with the top horizontal row. The controller upwardly adjusts presentation of the virtual typing sheet and the top horizontal row at the corresponding line spacing to insert a new lateral row for presenting characters corresponding to received/detected keystrokes.
(19) In the following detailed description of exemplary embodiments of the disclosure, specific exemplary embodiments in which the various aspects of the disclosure may be practiced are described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that logical, architectural, programmatic, mechanical, electrical, and other changes may be made without departing from the spirit or scope of the present disclosure. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present disclosure is defined by the appended claims and equivalents thereof. Within the descriptions of the different views of the figures, similar elements are provided similar names and reference numerals as those of the previous figure(s). The

specific numerals assigned to the elements are provided solely to aid in the description and are not meant to imply any limitations (structural or functional or otherwise) on the described embodiment. It will be appreciated that for simplicity and clarity of illustration, elements illustrated in the figures have not necessarily been drawn to scale. For example, the dimensions of some of the elements are exaggerated relative to other elements.

(20) It is understood that the use of specific component, device and/or parameter names, such as those of the executing utility, logic, and/or firmware described herein, are for example only and not meant to imply any limitations on the described embodiments. The embodiments may thus be described with different nomenclature and/or terminology utilized to describe the components, devices, parameters, methods and/or functions herein, without limitation. References to any specific protocol or proprietary name in describing one or more elements, features or concepts of the embodiments are provided solely as examples of one implementation, and such references do not limit the extension of the claimed embodiments to embodiments in which different element, feature, protocol, or concept names are utilized. Thus, each term utilized herein is to be given its broadest interpretation given the context in which that term is utilized.

(21) As further described below, implementation of the functional features of the disclosure described herein is provided within processing devices and/or structures and can involve use of a combination of hardware, firmware, as well as several software-level constructs (e.g., program code and/or program instructions and/or pseudo-code) that execute to provide a specific utility for the device or a specific functional logic. The presented figures illustrate both hardware components and software and/or logic components.

(22) Those of ordinary skill in the art will appreciate that the hardware components and basic configurations depicted in the figures may vary. The illustrative components are not intended to be exhaustive, but rather are representative to highlight essential components that are utilized to implement aspects of the described embodiments. For example, other devices/components may be used in addition to or in place of the hardware and/or firmware depicted. The depicted example is not meant to imply architectural or other limitations with respect to the presently described embodiments and/or the general invention. The description of the illustrative embodiments can be read in conjunction with the accompanying figures. Embodiments incorporating teachings of the present disclosure are shown and described with respect to the figures presented herein.

(23) FIG. **1** presents electronic system **100** in which electronic device **101** imitates a typewriter based on keystrokes **102** that are received from text input device **104**. The keystrokes **102** originate from user **106**, and the corresponding characters are presented on extendable display **108**. Electronic device **101** can be one of a host of different types of devices, including but not limited to, a laptop, a netbook, an ultra-book. In an example, controller **110** of electronic device **101** monitors keystrokes **102** received by text input device **104**, such as keyboard **112**, as manually input **114** by user **106**. In another example, controller **110** monitors keystrokes **102** provided by text input device **104** that is dictation system **116** that interprets audio input **117** spoken by user **106** and received by microphone **118**. Dictation system **116** is communicatively coupled to microphone **118** to convert words and symbols recognized in audio input **117** to microphone **118** into keystrokes **102** and corresponding characters **132**, such as text.

(24) Electronic device **101** includes memory **120** that stores typewriter imitation application **122**. At **123***a*, extendable display **108** is depicted at a first time “TO”. Controller **110** executes typewriter imitation application **124**, which presents, on upper portion **126** of extendable display **108**, top horizontal row **128** of virtual typing sheet **130**. Controller **110** presents characters **132** corresponding to keystrokes **102** across top horizontal row **128** of virtual typing sheet **130**. Controller **110** monitors for an occurrence of a next line transitioning condition from among: (i) a last character reaching an end of a current row of the virtual typing sheet; and (ii) detection of a return keystroke received via text input device **104**.

(25) At **123***b*, extendable display **108** is depicted at a second time “T1”. Controller **110** triggers the

extension mechanism of extendable display **108** to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of characters **132** associated with top horizontal row **128**. Controller **110** upwardly adjusts presentation at of virtual typing sheet **130** and top horizontal row **128** at the corresponding line spacing to insert new lateral row **133** for presenting characters **132** corresponding to received/detected keystrokes **102**.
(26) Electronic system **100** imitates a typewriter by having upper portion **126** of extendable display **108** automatically extend upwardly like a physical sheet of typing paper. Electronic system **100** resets extendable display **108** in preparation for imitating a new sheet of typing paper. Examples of extendable displays **108** are described below, such as a telescoping frame with a rollable or scrollable flexible display or an extendable blade assembly of a rollable display.
(27) In one or more embodiments, in response to the occurrence of the next line transitioning condition, controller **110** determines whether extendable display **108** is fully extended. In response to determining that extendable display **108** is fully extended, controller **110** at least partially retracts extendable display **108**. Controller **110** resets virtual typing sheet **130** by presenting, on upper portion **126** of extendable display **108**, top horizontal row **128** that is empty of characters **132**.
(28) In one embodiment, in response to the occurrence of the next line transitioning condition, controller **110** determines whether the virtual typing sheet has reached vertical threshold **134** stored in memory **120**. In response to determining that the virtual typing sheet has reached a vertical threshold **134**, controller **110** at least partially retracts extendable display **108**. Controller **110** presents, on upper portion **126** of extendable display **108**, top horizontal row **128** of reset virtual typing sheet **130** that is empty of characters **132**.
(29) In one or embodiment, in response to determining at least one of that extendable display **108** is fully extended or virtual typing sheet **130** has reached vertical threshold **134**, controller **110** stores virtual typing sheet **130** in memory **120** and presents an indication of storing virtual typing sheet **130** that was previously presented.
(30) In one or more embodiments, electronic device **101** is communicatively coupled to text input device **104** and extendable display **108** of electronic system **100** via communications subsystem **136**. In one or more embodiments, electronic device **101** is communicatively connectable to printing device **138** via communications subsystem **136**. Controller **110** communicates virtual typing sheet **130**, via communications subsystem **136**, to printing device **138** to print in response to determining that virtual typing sheet **130** is complete based on at least one of: (i) identifying a new page input; (ii) determining that extendable display **108** is fully extended; and (iii) determining that virtual typing sheet **130** has reached vertical threshold **134**.
(31) FIG. **2** depicts a functional block diagram of communication environment **200** including communication device **201** that is an implementation of electronic device **101** of FIG. **1**. Communication device **201** includes additional optional features to support wireless network communication. Communication device **201** can be one of a host of different types of devices, including but not limited to, a mobile cellular phone, satellite phone, or smart phone, a networked smartwatch or networked sports/exercise watch, and/or a tablet computing device or similar device that can include wireless communication functionality. As a device supporting wireless communication, communication device **201** can be utilized as, and also be referred to as, a system, device, subscriber unit, subscriber station, mobile station (MS), mobile, mobile device, remote station, remote terminal, user terminal, terminal, user agent, user device, a Session Initiation Protocol (SIP) phone, a wireless local loop (WLL) station, a personal digital assistant (PDA), computer workstation, a handheld device having wireless connection capability, a computing device, or other processing devices connected to a wireless modem.
(32) Communication device **201** may include controller **210**, communications subsystem **212**, data storage subsystem **214**, memory subsystem **216**, and input/output (I/O) subsystem **218**. To enable management by controller **210**, system interlink **219** communicatively connects controller **210** with communications subsystem **212**, data storage subsystem **214**, memory subsystem **216**, and I/O

subsystem **218**. Communication device **101** may include physical sensors **220** that are communicatively connected to controller **110**, either directly or indirectly via system interlink **219**. System interlink **219** represents internal components that facilitate internal communication by way of one or more shared or dedicated internal communication links, such as internal serial or parallel buses. As utilized herein, the term "communicatively coupled" means that information signals are transmissible through various interconnections, including wired and/or wireless links, between the components. The interconnections between the components can be direct interconnections that include conductive transmission media or may be indirect interconnections that include one or more intermediate electrical components. Although certain direct interconnections (i.e., system interlink **219**) are illustrated in FIG. **2**, it is to be understood that more, fewer, or different interconnections may be present in other embodiments.

(33) In one or more embodiments, communications subsystem **212** may include one or more network interfaces **222**, such as local wireless communication module **224** and local wired communication module **226**, to communicatively couple communication device **201** respectively via wireless connection **228** or network cable **230** to external networks **232**. Communication device **201**, via external networks **232**, may connect to network storage devices **234** that store computer data and to network server devices **236** that facilitate access to network storage devices **234**. Network server devices **236** may have identical or similar components and functionality as described above for communication device **201**. Communication device **201** may communicate with second communication devices **238** via external networks **232** or via communication networks **240** that are supported by core networks **242**. Network interface(s) **222** may include a network interface controller (NIC) and support one or more network communication protocols. External networks **232** can include a local area network (LAN), a campus area network (CAN), a metropolitan area network (MAN), or a wide area network (WAN). For example, wireless connection **228** and network cable **230** can be an Ethernet connection/cable.

(34) In one or more embodiments, communications subsystem **212** may include additional functionality for communicating, using a cellular connection, with network node(s) **244** of external communications system **245** and for communicating, using a wireless connection, with wireless access point **246** or local wireless devices **247** of local communications system **248**. Examples of local wireless devices **247** may include printing device **249**, external monitor **250** having extendable display **251**, and wireless keyboard **252**. Communications subsystem **212** includes antenna subsystem **254**. Communications subsystem **212** includes radio frequency (RF) front end **255** and RF communication module **256** having baseband processor **257**. RF front end **255** includes transceiver(s) **258**, which includes transmitter(s) **259** and receiver(s) **260**. RF front end **255** further includes modem(s) **261**. Baseband processor **257** of RF communication module **256** communicates with controller **210** and RF front end **255**. Baseband processor **257** operates in a baseband frequency range to encode data for transmission and decode received data, according to a communication protocol. Modem(s) **261** modulates baseband encoded data from RF communication module **256** onto a carrier signal to provide a transmit signal that is amplified by transmitter(s) **259**. Modem(s) **261** demodulates each signal received using antenna subsystem **254** from external communications system **245** or local communications system **248**. The received signal is amplified and filtered by receiver(s) **260**, which demodulates received encoded data from a received carrier signal.

(35) In one or more embodiments, controller **210**, via communications subsystem **212**, performs multiple types of cellular over-the-air (OTA) or wireless communication with local communications system **248**. Communications subsystem **212** can communicate via an OTA connection **262** with local wireless devices **247**. In an example, OTA connection **262** is a Bluetooth connection, or other personal access network (PAN) connection. In one or more embodiments, communications subsystem **212** communicates with one or more locally networked devices via a wireless local area network (WLAN) link **263** supported by access point **246**. In one or more

embodiments, access point **246** supports communication using one or more IEEE 802.11 WLAN protocols. Access point **246** is connected to communication networks **240** via a cellular or wired connection. In one or more embodiments, communications subsystem **212** receives downlink channels **264** from GPS satellites **265** to obtain geospatial location information. Communications subsystem **212** can communicate via an over-the-air (OTA) cellular connection **266** with network node(s) **244**.

(36) Controller **210** includes processor subsystem **267**, which includes one or more central processing units (CPUs), depicted as data processor **268**. Processor subsystem **267** can include one or more digital signal processors **269** that can be integrated with data processor **268**. Processor subsystem **267** can include other processors that are communicatively coupled to data processor **268**, such as baseband processors **257** of communication module **256**. In another example, auxiliary processors **270** may act as a low power consumption, always-on sensor hub for physical sensors **220**. In one or more embodiments that are not depicted, controller **210** can further include distributed processing and control components that are external to housing **272** or grouped with other components, such as I/O subsystem **218**. Controller **210** manages, and in some instances directly controls, the various functions and/or operations of communication device **201**. These functions and/or operations include, but are not limited to including, application data processing, communication with second communication devices, navigation tasks, image processing, and signal processing. In one or more alternate embodiments, communication device **201** may use hardware component equivalents for application data processing and signal processing. For example, communication device **201** may use special purpose hardware, dedicated processors, general purpose computers, microprocessor-based computers, micro-controllers, optical computers, analog computers, dedicated processors and/or dedicated hard-wired logic.

(37) Memory subsystem **216** stores program code **273** for execution by processor subsystem **267** to provide the functionality described herein. Program code **273** includes applications such as communication application **274** and typewriter imitation application **275** that may be software or firmware that controls operation of extended display **251** to imitate operation of a typewriter as keystrokes are received by keyboard **252**. Program code **273** may include other applications **276**. In one or more embodiments, several of the described aspects of the present disclosure are provided via executable program code of applications executed by controller **210**. In one or more embodiments, program code **273** may be integrated into a distinct chipset or hardware module as firmware that operates separately from executable program code. Portions of program code **273** may be incorporated into different hardware components that operate in a distributed or collaborative manner. Implementation of program code **273** may use any known mechanism or process for doing so using integrated hardware and/or software, as known by those skilled in the art. Program code **273** may access, use, generate, modify, store, or communicate computer data **277**, such as display configuration data **278**.

(38) Computer data **277** may incorporate "data" that originated as raw, real-world "analog" information that consists of basic facts and figures. Computer data **277** includes different forms of data, such as numerical data, images, coding, notes, and financial data. Computer data **277** may originate at communication device **201** or be retrieved by communication device **201**. Communication device **201** may store, modify, present, or transmit computer data **277**. Computer data **277** may be organized in one of a number of different data structures. Common examples of computer data **277** include video, graphics, text, and images as discussed herein. Computer data **277** can also be in other forms of flat files, databases, and other data structures.

(39) Memory subsystem **216** further includes operating system (OS) **279***a*, firmware interface **279***b*, such as basic input/output system (BIOS) or Uniform Extensible Firmware Interface (UEFI), and firmware **279***c*, which may be considered as program code **273**.

(40) Data storage subsystem **214** of communication device **201** includes data storage device(s) **280**. Controller **210** is communicatively connected, via system interlink **219**, to data storage device(s)

280. Data storage subsystem **214** provides program code **273** and computer data **277** stored on nonvolatile storage that is accessible by controller **210**. For example, data storage subsystem **214** can provide a selection of program code **273** and computer data **277**. These applications can be loaded into memory subsystem **216** for execution/processing by controller **210**. In one or more embodiments, data storage device(s) **280** can include hard disk drives (HDDs), optical disk drives, and/or solid-state drives (SSDs), etc. Data storage subsystem **214** of communication device **201** can include removable storage device(s) (RSD(s)) **281**, which is received in RSD interface **282**. Controller **210** is communicatively connected to RSD **281**, via system interlink **219** and RSD interface **282**. In one or more embodiments, RSD **281** is a non-transitory computer program product or computer readable storage device. Controller **210** can access data storage device(s) **280** or RSD **281** to provision communication device **201** with program code **273**.

(41) FIG. **3** depicts a three-dimensional view of an example electronic system **300** for imitating a typewriter that includes communication device **301**, extendable display **303** in a retracted position, and keyboard **305** with user **307** positioned at keyboard **305**. Communication device **301** is an example of electronic device **101** (FIG. **1**) and communication device **201** (FIG. **2**). Communication device **301** may be placed in or on dock **309** for receiving power and access to communication channels. Communication device **301** is communicatively coupled to extendable display **303** and keyboard **305**, such as via respective wireless links **311** and **313**. FIG. **4** depicts a front view of extended display **303** of FIG. **3** in a retracted position presenting initial position **401** of virtual typing sheet **403** that is clear of characters. Typewriter image **405** of a mechanical typewriter is presented below virtual typing sheet **403** to enhance an illusion of typewriter operation. Virtual typing sheet **403** may appear to be spooled upwardly from typewriter image **405**. Vertical dimensions of virtual typing sheet **403** are limited to physical limitations of extendable display **303** to extend. Vertical dimensions of virtual typing sheet **403** may be further constrained by a software limit, such as to correspond to a traditional size of a sheet of typing paper.

(42) FIG. **5** depicts a three-dimensional view of electronic system **300** of FIG. **3** having extendable display **303** in an at least partially extended position. User **307** is entering keystrokes at keyboard **305**. FIG. **6** depicts a front view of extendable display **303** of FIG. **5** in the at least partially extended position presenting full position **601** of virtual typing sheet **403** having the characters **603**, which are based on keystrokes by user **307** (FIG. **5**). In an example, keys and print arms of typewriter image **405** may animate to correspond to keystrokes detected at keyboard **305** (FIG. **5**). Indication **605** is presented of storing completed typing sheets in response to completing virtual typing sheet **403**.

(43) FIG. **7**A depicts a front view of electronic system **700** for imitating a typewriter being implemented in electronic device **701** in a laptop design form with integral extendable display **703** and integral keyboard **705**. Extendable display **703** is in retracted position **706**. In response to keystrokes by user **707** on keyboard **705**, corresponding characters **709** are entered on top row **711** of virtual typing sheet **713**. In one or more embodiments, electronic device **701** is communicatively coupled to printer device **715** and the characters are transmitted to printer to produce a physical typing sheet **717**. Depending on capabilities of printer device **715**, characters **709** may be printed character-by-character, line-by-line, or page-by-page as virtual typing sheet **713** is completed. FIG. **7**B depicts a front view of electronic device **701** with extendable display **703** in at least partially extended position **712**. When entry of characters on virtual typing sheet **713** is complete, indication **719** is presented of storing virtual typing sheet **713**, and printing of physical typing sheet **717** is completed.

(44) FIG. **8**A depicts a side view of extendable display **803** that is a rollable display, implemented with blade assembly **805** in retracted position **807** and received on both front side **809** and back side **811** of device housing **813**. Blade assembly **805** includes flexible display **814** that rolls across bottom edge **815**. FIG. **8**B depicts a side view of extendable display **803** of FIG. **8**A with blade assembly **805** in extended position **817** rolled onto and extending beyond a top edge of front side

809 of device housing. Blade substrate **819** supports flexible display **814** and is rigid in portions that do not roll across bottom edge **815** such supporting distally extending portion **821**.

(45) FIG. **9** depicts an exploded view of blade assembly **805** of FIGS. **8**A-**8**B including flexible display **814** and blade substrate **819**. In one or more embodiments, flexible display **814** includes one or more layers that are coupled or laminated together to complete flexible display **814**. In an example, flexible display **814** includes flexible protective cover **901**, first adhesive layer **902**, flexible display layer **903**, second adhesive layer **904**, and flexible substrate **907**. Beginning from the top of the layer stack opposite to blade **914**, in one or more embodiments, flexible protective cover **901** includes an optically transparent substrate such as a thin film sheet of a thermoplastic material. In an example, flexible protective cover **901** is manufactured from a layer of optically transparent polyamide or polycarbonate having a thickness of about eighty microns. Flexible protective cover **901** may function as a fascia by defining a cover for flexible display layer **903**. In one or more embodiments, flexible protective cover **901** is optically transparent, in that light can pass through the flexible protective cover **901** so that objects behind flexible protective cover **901** can be distinctly seen. Flexible protective cover **901** may optionally include an ultraviolet barrier. Such a barrier can be useful in improving the visibility of flexible display layer **903**.

(46) Beneath flexible protective cover **901** is first adhesive layer **902**. In one or more embodiments, first adhesive layer **902** is an optically transparent adhesive. The optically transparent adhesive can be applied to two sides of a thin, optically transparent substrate such that the first adhesive layer **902** functions as an optically transparent layer having optically transparent adhesive on both sides. Where so configured as "double-sided tape", first adhesive layer **902** may have a thickness of about fifty microns that can then be spooled and applied between, to couple together, flexible protective cover **901** and flexible display layer **903**. In other embodiments, first adhesive layer **902** may be applied between flexible protective cover **901** and the display layer **903** as an optically transparent liquid or gel that is allowed to cure or optionally cured by heat, ultraviolet light, or other techniques. First adhesive layer **902** mechanically couples flexible display layer **903** to flexible protective cover **901**.

(47) In one or more embodiments, flexible display layer **903** includes image producing portion **909** having a same length and width, and aligned with, flexible protective cover **901** and flexible substrate **907**. In one or more embodiments, flexible display layer **903** includes T-shaped tongue **910** attached along major axis **908** of flexible display layer **903**. Blade **914** is sized to receive flexible display layer **903** attached to T-shaped tongue **910**. In one or more embodiments, electronic circuit components configured to operate image producing portion **909** of the flexible display layer **903**, connectors, and other components can be coupled to this T-shaped tongue **910** and further coupled to image producing portion **909** of flexible display **814**. For instance, as shown in FIG. **9**, flexible display layer **903** includes a T-shaped tongue **910** that extends beyond image producing portion **909** of flexible display layer **903** and other layers (**901**, **902**, **904**, and **907**) of flexible display **814**. While T-shaped tongue **910** is T-shaped in this illustrative embodiment, T-shaped tongue **910** can take other shapes.

(48) Flexible display layer **903** optionally may be touch-sensitive. In one or more embodiments, flexible display layer **903** is an organic light emitting diode (OLED) display layer. Flexible display layer **903** can bend in accordance with various bending radii. For example, some embodiments allow bending radii of between thirty and six hundred millimeters. Other substrates allow bending radii of around five millimeters to provide a display that is foldable through active bending. Other configurations of flexible display **814** may accommodate both bends and folds. In one or more embodiments, flexible display layer **903** may be formed from multiple layers of flexible material such as flexible sheets of polymer or other materials. Flexible display layer **903** may include a layer of optically pellucid electrical conductors, a polarizer layer, one or more optically transparent substrates, and layers of electronic control circuitry such as thin film transistors to actuate pixels and one or more capacitors for energy storage. In one or more embodiments, flexible display layer

903 has a thickness of about 130 microns.
(49) In one or more embodiments, to be touch sensitive, flexible display layer **903** includes a layer including one or more optically transparent electrodes. In one or more embodiments, flexible display layer **903** includes an organic light emitting diode layer configured to present images and other information to user **106** (FIG. **1**). The organic light emitting diode layer can include one or more pixel structures arranged in an array, with each pixel structure including a plurality of electroluminescent elements, such as organic light emitting diodes. These various layers can be coupled to one or more optically transparent substrates of flexible display layer **903**. In one or more embodiments, flexible substrate **907** includes a thin layer of steel having a thickness of about thirty microns. In one or more embodiments, flexible substrate **907** includes a thin layer of thermoplastic material.
(50) In other embodiments, a layer (**901**-**902**) above flexible display layer **903** may be configured with enough stiffness to make the flexible substrate **907** unnecessary. In an example, flexible protective cover **901** is configured with enough stiffness to provide sufficient protection for flexible display **814** during bending, enabling flexible substrate **907** to be omitted.
(51) Flexible display **814** is supported by flexible substrate **907** and by blade **914** having blade substrate **925**. In one or more embodiments, blade substrate **925** includes a layer of steel. In one or more embodiments, blade substrate **925** is thicker than flexible substrate **907**. In an example, flexible substrate **907** includes a steel layer with a thickness of about thirty microns and blade substrate **925** includes a layer of steel having a thickness of about one hundred microns. In one or more embodiments, blade substrate **925** is a rigid, substantially planar support layer. In an example, blade substrate **925** may be manufactured from stainless steel, from a thin, rigid thermoplastic sheet, or from nitinol material, which is a nickel-titanium alloy.
(52) In one or more embodiments, the flexible substrate **907** is slightly longer along a major axis of the flexible substrate **907** than is the image producing portion **909** of the flexible display **814**. Since the T-shaped tongue **910** is T-shaped, this allows one or more apertures **911** to be exposed on either side of the base of the T of the T-shaped tongue **910**. As will be described in more detail below, this extra length along the major axis provided by the flexible substrate **907** allows one or more fasteners to rigidly couple the first end of the flexible substrate **907** to a tensioner.
(53) Embodiments of the disclosure contemplate that some of the layers comprising the flexible display **814** are stiffer than others. Similarly, other layers of the flexible display **814** are softer than others. For example, where the flexible substrate **907** is manufactured from a metal, one example of which is stainless steel, this layer is stiffer than the first adhesive layer **902**. In one or more embodiments, the stainless steel is stiffer than the flexible display layer **903** as well. In one or more embodiments, the flexible substrate **907** is the stiffest layer in the flexible display **814**, while the first adhesive layer is the softest layers of the flexible display **814**. The flexible protective cover **901** and the flexible display layer **903** have a stiffness that falls between that of the flexible substrate **907** and the adhesive layers in one or more embodiments.
(54) In one or more embodiments, the various layers of the flexible display **814** are laminated together in a substantially planar configuration. Said differently, in one or more embodiments the flexible substrate **907** is configured as a substantially planar substrate. The first adhesive layer **902** can be attached to the flexible display layer **903**, with the flexible protective cover **901** attached to the first adhesive layer **902**. To ensure proper coupling, flexible display layer **903** can be cured, such as in an autoclave at a predefined temperature for a predefined duration. Where employed, such curing allows any air bubbles or other imperfections in the various layers to be corrected. In one or more embodiments, flexible substrate **907** is configured as a substantially planar substrate resulting in flexible display **814** being substantially planar.
(55) In one or more embodiments, blade substrate **925** of blade **914** includes both flexible portion **912** and rigid portion **913**. Flexible portion **912** is positioned to encounter bending in translation of blade assembly **805** from the retracted position to the extended position. Rigid portion **913** is

positioned to remain on front side **809** of device housing **813** (FIG. **8**B) during translation. In the extended position, rigid portion **913** extends beyond front side **809** of device housing **813** (FIG. **8**B). In an example, blade substrate **925** is manufactured from a metal such as steel having a thickness of one hundred microns that provides rigidity to rigid portion **913**.

(56) In one or more embodiments, blade **914** includes silicone border **927** positioned around a perimeter of blade substrate **925** to protect the edges of flexible display **814** when attached to blade substrate **925** of blade **914**. In one or more embodiments, silicone border **927** is co-molded around the perimeter of blade substrate **925**.

(57) In one or more embodiments, rigid portion **913** of blade substrate **925** can define one or more apertures. These apertures can be used for a variety of purposes. In an example, some of the apertures can be used to rigidly fasten blade **914** to a translation mechanism, such as a display roller mechanism. Additionally, some of the apertures can contain magnets. Hall-effect sensors positioned in device housing **813** (FIG. **8**B) to which blade assembly **805** is coupled can then detect the positions of these magnets such that controller **110** (FIG. **1**) can determine whether blade assembly **805** including flexible display **814** are in the extended position, the retracted position, the peek position, or an intermediate position.

(58) In one or more embodiments, flexible display **814** is coupled to blade substrate **925** of blade **914** within the confines of silicone border **927**. In an example, a first end of flexible display **814** is adhesively coupled to rigid portion **913** of blade substrate **925** of blade **914**. The other end of flexible display **814** may be rigidly coupled to a tensioner by passing fasteners through apertures **911** of flexible substrate **907**.

(59) FIG. **10**A depicts a side view of extendable display **1003** having telescoping device housing **1005** in retracted position **1007** and with an excess portion of flexible display **1009** not needed to cover front side **1011** rolled over top edge **1013** onto back side **1015** of device housing **1005**. FIG. **10**B depicts a side view of extendable display **1003** of FIG. **10**A in at least partially extended position **1017** that rolls some of flexible display **1009** from back side **1015** to front side **1011** of device housing **1005**.

(60) FIG. **11**A depicts a side view of extendable display **1103** having telescoping device housing **1105** in retracted position **1107** and with an excess portion of flexible display **1109** not needed to cover front side **1111** scrolled within device housing **1105** in spool **1113**. FIG. **11**B depicts a side view of extendable display **1103** of FIG. **11**A in at least partially extended position **1115**, which draws some of flexible display **1109** from spool **1113**.

(61) FIGS. **12**A-**12**B (collectively "FIG. **12**") are a flow diagram of a method of imitating operation of a typewriter by an electronic system that includes an extendable display and a text input device. The description of method **1200** (FIG. **12**) is provided with general reference to the specific components illustrated within the preceding FIGS. **1**-**6**, **7**A-**7**B, **8**A-**8**B, **9**, **10**A-**10**B, and **11**A-**11**B. Specific components referenced in method **1200** may be identical or similar to components of the same name used in describing preceding FIGS. FIGS. **1**-**6**, **7**A-**7**B, **8**A-**8**B, **9**, **10**A-**10**B, and **11**A-**11**B. In one or more embodiments, controller **110** (FIG. **1**) and controller **210** (FIG. **2**) respectively configure electronic device **101** (FIG. **1**) and communication device **201** (FIG. **2**) to provide the described functionality of method **1200** (FIG. **12**).

(62) With reference to FIG. **12**A, method **1200** includes detecting initiation (i.e., startup) of the typewriting imitating application (block **1202**). Method **1200** includes determining whether the extendable display is in an extended position (decision block **1204**). In response to determining that the extendable display is in an extended position, method **1200** includes retracting the extendable display (block **1206**). in response to determining that the extendable display is not in the extended position in decision block **1204** or after block **1206**, method **1200** includes clearing the display of any previous content and presenting, on an upper portion of the rollable display, a top horizontal row of a virtual typing sheet (block **1208**). In one or more embodiments, method **1200** can include presenting a cursor to identify a location of the virtual printer head (block **1210**). Method **1200**

includes monitoring keystrokes received by a keyboard (block **1212**). Method **1200** includes presenting characters corresponding to the keystrokes across the top horizontal row of virtual typing sheet (block **1214**). Method **1200** includes determining whether a next line transitioning condition has occurred (decision block **1216**). In an example, a next line transitioning condition has occurred when a last character reaches an end of a current row of the virtual typing sheet. In another example, a next line transitioning condition has occurred when a return keystroke received via the keyboard is detected. In response to determining that the next line transitioning condition has not occurred, method **1200** returns to block **1212**. In response to an occurrence of a next line transitioning condition in decision block **1216**, method **1200** includes determining whether the extendable display is fully extended (i.e., a hardware limit) (decision block **1218**). In response to determining that the extendable display is fully extended, method **1200** proceeds block **1226** (FIG. **12**B). In response to determining that the extendable display is not fully extended, method **1200** includes determining whether the virtual typing sheet has reached a vertical threshold (i.e., a software limit) (decision block **1220**). The vertical threshold may be based on avoiding presentation of an unrealistically narrow vertical aspect ratio of the virtual typing sheet that does not appear to match a letter or A**4** format of physical typing paper. In response to determining that the vertical threshold has been reached, method **1200** proceeds to block **1226** (FIG. **12**B). In response to determining that the vertical threshold has not been reached, method **1200** proceeds to block **1222** of FIG. **12**B.

(63) With reference to FIG. **12**B, method **1200** includes triggering the extendable display to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of the characters associated with the top horizontal row (block **1222**). Method **1200** includes upwardly adjusting presentation of the virtual typing sheet and the top horizontal row at the corresponding line spacing to insert a new lateral row for presenting keystrokes (block **1224**). Then method **1200** returns to block **1212** (FIG. **12**A). In response to determining that the extendable display is fully extended in decision block **1218** or has reached the vertical threshold in decision block **1220**, method **1200** includes at least partially retracting the extendable display (block **1226**). Method **1200** includes resetting the virtual typing sheet by presenting, on the upper portion of the extendable display, a top horizontal row that is empty of characters (block **1228**). In one or more embodiments, method **1200** includes storing the virtual typing sheet and presents an indication of storing the virtual typing sheet that was previously presented (block **1230**). Method **1200** includes communicating the virtual typing sheet to a printing device to print (block **1232**). Then method **1200** returns to block **1212** (FIG. **12**A).

(64) Aspects of the present innovation are described above with reference to flowchart illustrations and/or block diagrams of methods, apparatus (systems) and computer program products according to embodiments of the innovation. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer program instructions. These computer program instructions may be provided to a processor of a general-purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

(65) As will be appreciated by one skilled in the art, embodiments of the present innovation may be embodied as a system, device, and/or method. Accordingly, embodiments of the present innovation may take the form of an entirely hardware embodiment or an embodiment combining software and hardware embodiments that may all generally be referred to herein as a “circuit,” “module” or “system.”

(66) While the innovation has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made, and equivalents may be

substituted for elements thereof without departing from the scope of the innovation. In addition, many modifications may be made to adapt a particular system, device, or component thereof to the teachings of the innovation without departing from the essential scope thereof. Therefore, it is intended that the innovation not be limited to the particular embodiments disclosed for carrying out this innovation, but that the innovation will include all embodiments falling within the scope of the appended claims. Moreover, the use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another.
(67) The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the innovation. As used herein, the singular forms “a”. “an” and “the” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprise” and/or “comprising.” when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, elements, components, and/or groups thereof.
(68) The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the present innovation has been presented for purposes of illustration and description but is not intended to be exhaustive or limited to the innovation in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the innovation. The embodiments were chosen and described in order to best explain the principles of the innovation and the practical application, and to enable others of ordinary skill in the art to understand the innovation for various embodiments with various modifications as are suited to the particular use contemplated.

Claims

1. An electronic device comprising: a memory storing a typewriter imitation application; and a controller communicatively connected to a text input device, an extendable display, and the memory, and which: executes the typewriter imitation application, which presents, on an upper portion of the extendable display, a top horizontal row of a virtual typing sheet; monitors keystrokes received by the text input device; presents characters corresponding to the keystrokes across the top horizontal row of virtual typing sheet; and in response to an occurrence of a next line transitioning condition from among a last character reaching an end of a current row of the virtual typing sheet and detection of a return keystroke received via the text input device: triggers the extendable display to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of the characters associated with the top horizontal row; and upwardly adjusts presentation of the virtual typing sheet and the top horizontal row at the corresponding line spacing to insert a new lateral row for presenting keystrokes.
2. The electronic device of claim 1, wherein the text input device comprises a keyboard.
3. The electronic device of claim 2, further comprising the text input device that comprises an integrated keyboard, wherein the extendable display and the integrated keyboard are configured with a laptop design form.
4. The electronic device of claim 1, wherein the text input device comprises: a microphone; and a dictation system communicatively coupled to the microphone to convert words and symbols recognized in an audio input to the microphone into the keystrokes and corresponding text.
5. The electronic device of claim 1, wherein the extendable display comprises a rollable display comprising: a telescoping frame configured to vertically translate between a fully retracted position and a fully extended position; a flexible display extended across the telescoping frame; a rollable display mechanism that rolls an excess portion of the flexible display away from a front side of the

telescoping frame; and a translation mechanism that positions the telescoping frame at a plurality of extended positions from the fully retracted to the fully extended positions.
6. The electronic device of claim 5, wherein the rollable display mechanism rolls the excess portion of the flexible display onto a back side of the telescoping frame as the flexible display is being retracted.
7. The electronic device of claim 5, wherein the rollable display mechanism rolls the excess portion of the flexible display into a scrolled portion contained with the telescoping frame as the flexible display is being retracted.
8. The electronic device of claim 1, wherein, in response to the occurrence of the next line transitioning condition, the controller: determines whether the extendable display is fully extended; and in response to determining that the extendable display is fully extended: at least partially retracts the extendable display; and resets the virtual typing sheet by presenting, on the upper portion of the extendable display, a top horizontal row that is empty of characters.
9. The electronic device of claim 1, wherein, in response to the occurrence of the next line transitioning condition, the controller: in response to determining that the virtual typing sheet has reached a vertical threshold: at least partially retracts the extendable display; and presents, on the upper portion of the extendable display, a top horizontal row of a reset virtual typing sheet that is empty of characters.
10. The electronic device of claim 1, wherein, in response to determining at least one of that the extendable display is fully extended or the virtual typing sheet has reached a vertical threshold, the controller stores the virtual typing sheet and presents an indication of storing the virtual typing sheet that was previously presented.
11. The electronic device of claim 1, further comprising a communications subsystem communicatively connectable to a printing device, wherein the controller communicates the virtual typing sheet, via the communications subsystem, to the printing device to print in response to determining that the virtual typing sheet is complete based on at least one of: (i) identifying a new page input; (ii) determining that the extendable display is fully extended; and (iii) determining that the virtual typing sheet has reached a vertical threshold.
12. The electronic device of claim 1, further comprising a communications subsystem communicatively coupled to the controller, and wherein the controller: communicatively connects to an external input device comprising the text input device that comprises an external keyboard to monitor the keystrokes; and communicatively connects to an external display device comprising the extendable display to present the characters corresponding to the keystrokes and to trigger extension by the extendable display.
13. A method comprising: presenting, on an upper portion of an extendable display, a top horizontal row of a virtual typing sheet; monitoring keystrokes received by a text input device; presenting characters corresponding to the keystrokes across the top horizontal row of virtual typing sheet; and in response to an occurrence of a next line transitioning condition from among a last character reaching an end of a current row of the virtual typing sheet and detection of a return keystroke received via the text input device: triggering the extendable display to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of the characters associated with the top horizontal row; and upwardly adjusting presentation of the virtual typing sheet and the top horizontal row at the corresponding line spacing to insert a new lateral row for presenting keystrokes.
14. The method of claim 13, wherein monitoring keystrokes received by the text input device the text input device comprises: monitoring a microphone; and converting words and symbols, recognized by a dictation system, in an audio input to the microphone into the keystrokes and corresponding text.
15. The method of claim 13, wherein the extendable display comprises a rollable display comprising: a telescoping frame configured to vertically translate between a fully retracted position

and a fully extended position; a flexible display extended across the telescoping frame; a rollable display mechanism that rolls an excess portion of the flexible display away from a front side of the telescoping frame; and a translation mechanism that positions the telescoping frame at a plurality of extended positions from the fully retracted to the fully extended positions.

16. The method of claim 13, wherein, in response to the occurrence of the next line transitioning condition, the method further comprises: determining whether the extendable display is fully extended; and in response to determining that the extendable display is fully extended: at least partially retracting the extendable display; and resetting the virtual typing sheet by presenting, on the upper portion of the extendable display, a top horizontal row that is empty of characters.

17. The method of claim 13, wherein, in response to the occurrence of the next line transitioning condition, the method further comprises: in response to determining that the virtual typing sheet has reached a vertical threshold: at least partially retracting the extendable display; and presenting, on the upper portion of the extendable display, a top horizontal row of a reset virtual typing sheet that is empty of characters.

18. The method of claim 13, wherein, in response to determining at least one of that the extendable display is fully extended or the virtual typing sheet has reached a vertical threshold, the method further comprises storing the virtual typing sheet and presents an indication of storing the virtual typing sheet that was previously presented.

19. The method of claim 13, further comprising communicating the virtual typing sheet to a printing device to print in response to determining that the virtual typing sheet is complete based on at least one of: (i) identifying a new page input; (ii) determining that the extendable display is fully extended; and (iii) determining that the virtual typing sheet has reached a vertical threshold.

20. A computer program product comprising: a computer readable storage device; and program code on the computer readable storage device that when executed by a processor associated with an electronic device, the program code enables the electronic device to provide functionality of: presenting, on an upper portion of an extendable display, a top horizontal row of a virtual typing sheet; monitoring keystrokes received by a text input device; presenting characters corresponding to the keystrokes across the top horizontal row of virtual typing sheet; and in response to an occurrence of a next line transitioning condition from among a last character reaching an end of a current row of the virtual typing sheet and detection of a return keystroke received via the text input device: triggering the extendable display to upwardly extend by an increment corresponding to vertical dimensions of a line spacing and font size of the characters associated with the top horizontal row; and upwardly adjusting presentation of the virtual typing sheet and the top horizontal row at the corresponding line spacing to insert a new lateral row for presenting keystrokes.