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Inline Text Entry On Portable Electronic Devices

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Inline Text Entry On Portable Electronic Devices

Abstract:

This publication describes systems and techniques to provide inline text entry on portable electronic devices. Portable electronic devices, such as smartphones, generally include an on-screen keyboard to allow users to input alphanumeric characters. These keyboards generally provide several suggestions of the word that the user is currently typing or the next word to be input. Because the keyboard has a limited area on the graphical user interface (GUI) to display candidate words, the keyboard can only present a few suggestions (*e.g.*, two or three candidates), which are generally single-word candidates.

This publication describes a keyboard for portable electronic devices that displays inline candidate words, which can include multiple words, entire phrases, and complete sentences. The inline suggestions can be shown directly in the editor box of an application or a pop-up window. The inline suggestions allow users to type faster and reduce spelling and grammatical errors in applications on portable electronic devices.

Keywords:

Keyboard, input device, graphical user interface, GUI, language model, n-gram model, coupled-input-and-forget-gate model, CIFG model, beam-search algorithm, transformer algorithm, inline compose, smart compose, word suggestion, predictive text, auto-completion, auto-suggest, smart completion.

Background:

Portable electronic devices, such as smartphones, tablets, and electronic readers, include an on-screen keyboard (*e.g.*, keyboard application) that enables users to input alphanumeric text in various applications. The keyboard can generally provide several suggestions of the current word or the next word in a header area above the keyboard. Due to space limitations on the GUI of portable electronic devices, the keyboard usually only provides two or three candidates subject to a character-length limit (*e.g.*, 12 characters per candidate). The candidates are generally single-word suggestions or short multiple-word suggestions, as illustrated in Figure 1.

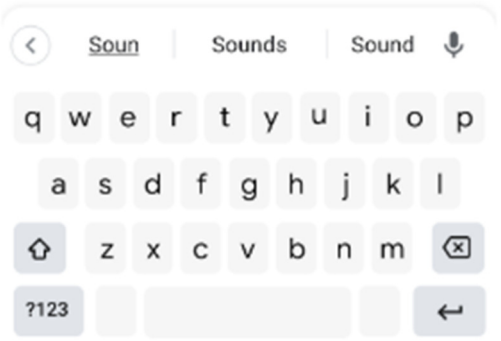

Figure 1

Figure 1 shows an example keyboard on a smartphone. The keyboard is displayed in the bottom portion of the GUI. Using the keyboard, a user can input alphanumeric text into an application (*e.g.*, an email application, internet browser, text messaging application, social networking application). As the user enters alphanumeric characters, the keyboard displays several predictive or suggestive candidates in a header area above the keyboard. In the depicted example, the user has input the characters “S-o-u-n” and the keyboard displays the current input and the candidates “Sounds” and “Sound” in the top header. The candidates are updated as the user enters additional characters via the keyboard.

It is desirable to provide a keyboard that generates inline suggestions of word candidates, including entire phrases and sentences, to improve the accuracy and speed of typing on portable electronic devices.

Description:

This publication describes systems and techniques for inline text entry and suggestions on a portable electronic device. The described keyboard on the portable electronic device can generate and display suggested words, phrases, and sentences. The candidates can be shown, for example, as part of the background of the editor box in an application. Users can accept candidate words and phrases by, for example, tapping or swiping on the candidate, swiping the spacebar, or using hand gestures. Figure 2 illustrates an example of the described inline text entry and predictive suggestions.

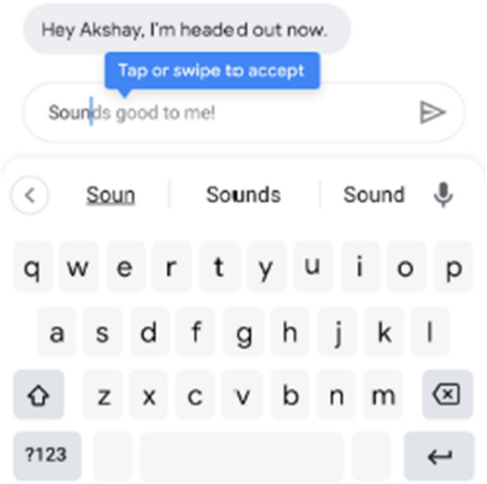

Figure 2

As illustrated in Figure 2, the smartphone user receives the following text: "Hey Akshay, I'm headed out now." In response, the user begins typing a response consisting of the letters "S-o-u-n." As described for Figure 1, the keyboard provides two single-word suggestions to complete

the first word of the user's response: "Sounds" and "Sound." The described techniques and systems offer an inline suggestion of "Sounds good to me!" The untyped portion of the suggestion is displayed in gray letters as part of the background in the messaging application's editor box. If the user wishes to use the suggested phrase, they may tap or swipe over the suggestion in the input field or select the space bar on the keyboard.

In other examples, the keyboard can show candidate words and phrases on the GUI, including, for example, using a floating chip. Several examples of a floating chip to display the inline suggestion are illustrated in Figure 3. As depicted, the keyboard can display the floating chip above or below the application's editor box. The floating chip can reveal either the entire suggestion with the typed characters grayed-out or only the characters and words of the inline suggestion that follow the typed characters.

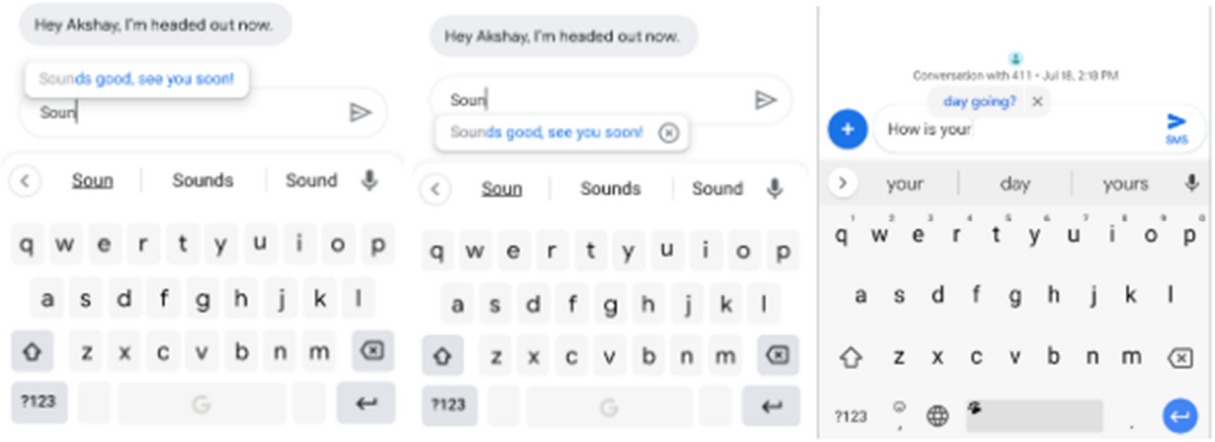

Figure 3

The keyboard can provide a tooltip guide to teach users how to accept inline suggestions. As depicted in Figure 2, the tooltip guide can, for example, state: "Tap or swipe to accept." As the user learns how to use the inline compose feature of the keyboard, the tooltip guide can be omitted or turned off in the settings.

The keyboard can calculate the boundary of the editor box to display longer phrases and sentences. Figure 4 illustrates an example means for the keyboard to determine the dimensions of the editor box. In this example, the keyboard determines the boundaries of the editor box based on the screen width and the side margins of the editor box. Alternatively, the operating system of the portable electronic device can add a new application programming interface (API) to allow the keyboard to obtain the boundaries of the editor box from the application. Using the keyboard boundaries, the keyboard can format the inline suggestions to fit within the editor box.

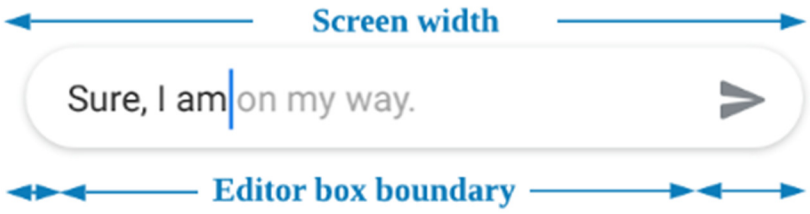

Figure 4

The keyboard can update the inline suggestions twice for each character typed by the user to avoid flickering. Generation of a new inline suggestion takes time and is, therefore, generated asynchronously in the background after each character is entered. The in-sync update is illustrated in Figure 5. The user has previously typed the letters "T-h-a." The keyboard displays the inline suggestion of "n-k y-o-u." As the user inputs a character, the cursor and the displayed characters are displayed in sync with the input. The user then inputs the letter "n." The keyboard notifies the editor box that the cursor needs to move forward and that the typed input is "T-h-a-n." A new suggestion (*e.g.*, "k-s") is then determined and displayed in the editor box by the keyboard.

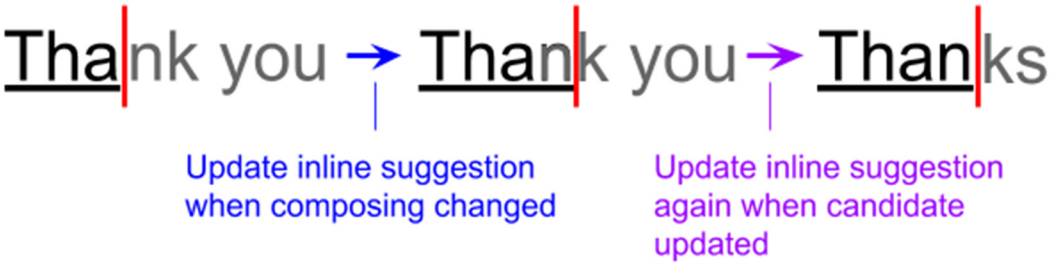

Figure 5

The inline suggestions can include both single-word and multi-word candidates. The candidates can be generated using various language models. For example, the keyboard can utilize a n-gram or a Coupled-Input-and-Forget-Gate (CIFG) language model for single-word candidates. An n-gram model provides a probability distribution for the next word in a contiguous sequence of words based on the previous words in the sequence. A CIFG model is a form of a long short-term memory (LSTM) model that makes word predictions based on time series data.

The keyboard can determine multi-word candidates using, for example, a beam-search solution, a transformer-based solution, or the user's typing history. A beam-search solution is illustrated in Figure 5. In this example, the user has typed the words: "how are." Given the current context, three top predictions are generated for the next step or word. Each of these top three candidates is combined with the context (*e.g.*, "how are") to generate candidates for the second step or word. Three top candidates are reserved for each additional step based on their higher language-model scores, which is illustrated in green (*e.g.*, "how are you doing," "how are you feeling," and "how are things going").

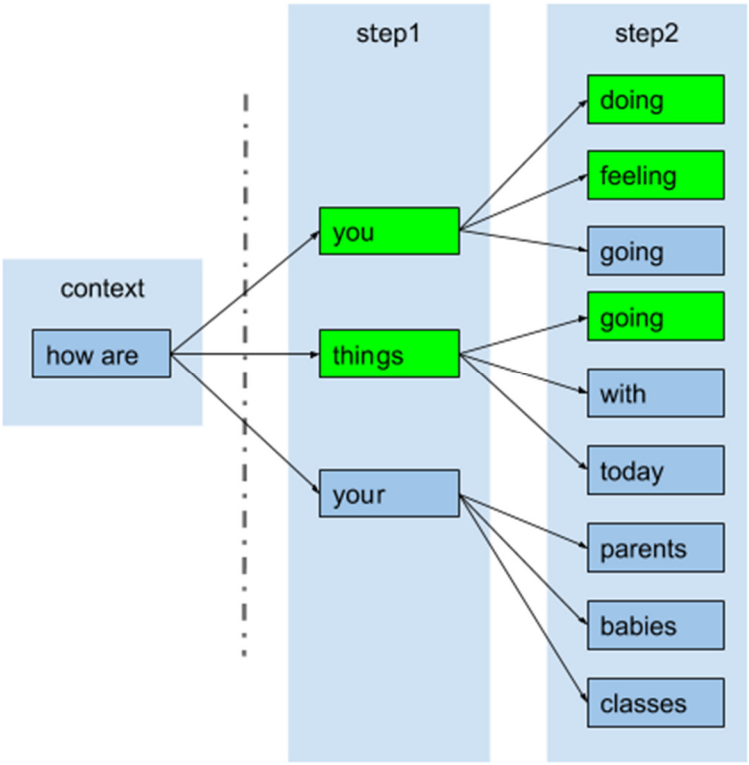

Figure 6

In the transformer-based model, candidate words and phrases are obtained from common phrases such as “how are you,” “going to be,” and “let me know.” Each new context is fed into the transformer-based model to update the candidate words. Similarities between candidates determined from context and those determined from common phrases are computed via a dot product. The most similar candidates will be chosen as the multi-word inline suggestion.

The described systems and techniques enable the keyboard on a portable electronic device to show candidate words, including entire phrases and sentences, as inline suggestions. The inline suggestions can increase the speed and accuracy of typing on a portable electronic device.

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