AmbientLetter: Letter Presentation Method for Discreet Notification of Unknown Spelling when Handwriting

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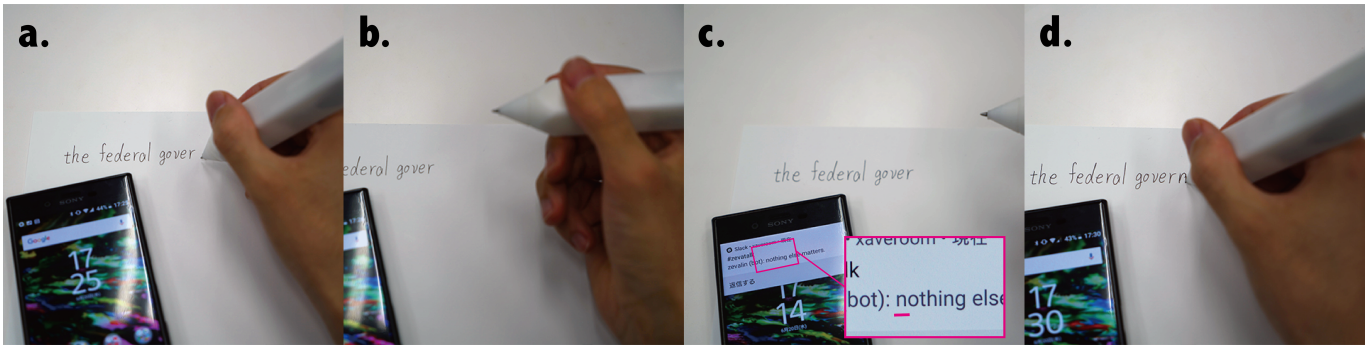

Figure 1. Process flow of AmbientLetter. (a): While writing a sentence, a word comes up that the user does not know how to spell. (b): The user performs a casual gesture like tilting a pen. (c): The system sends a message starting from the next letter to the user's smartphone. (d): The user continues writing after glancing at the notification.

ABSTRACT

We propose a technique to support writing activity in a confidential manner with a pen-based device. Autocorrect and predictive conversion do not work when writing by hand, and looking up unknown spelling is sometimes embarrassing. Therefore, we propose AmbientLetter which seamlessly and discreetly presents the forgotten spelling to the user in scenarios where handwriting is necessary. In this work, we describe the system structure and the technique used to conceal the user's getting the information.

Author Keywords

Subtle interaction; Ubiquitous computing;

INTRODUCTION

Functions such as autocorrect and predictive conversion work well on computers, but they are not much use with traditional handwriting implements such as pencils, markers, and chalks, which are often used in meetings and lectures. You might have to look up the correct spelling on a smartphone or PC, and in certain cases, this could be quite embarrassing. It would also disrupt the flow of the discussion and/or negatively affect the ambience. This is undesirable because people are likely to miss key information or become distracted.

There have been a number of studies in which surrounding people do not perceive a user making use of a computer. An interface using the abdominal circumference as an input [7], using glasses-type display and belt-type devices [3], and using a globe-type device [4] have been proposed. Anderson et al. [1] argued that current approaches to subtle interactions tend to feature inconspicuous devices and discreet behavior. He proposed a guidelines to blend inputs and outputs into ordinary action, demonstrated a prototype, and showed through evaluation that his guidelines are effective. These guidelines cover user customization, modularity, simulation and dissimulation, separating cause and effect, and user training. However, his proposed devices are somewhat impractical because they do not actually perform the basic functions it seems they would. For example, a display built into a cup would break if liquid were poured into it. It is necessary to design a device more conscious of actual use.

In light of the above, we propose AmbientLetter, a pen-based system that supports writing activity with traditional handwriting implements in a confidential manner.

AMBIENTLETTER

AmbientLetter is a system that uses a smart device and a pen with a nine-axis IMU. It recognizes the written letter and predicts the next letter from the preceding contents. Then, the prediction result is presented to the user through a smartphone, smartwatch, or similar device by an optimum method when

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the user makes a gesture to request the presentation of the next letter in the course of writing a word. The process flow of this system is shown in Figure 1. Here, the user wants to write a text like "the federal government is ...". However, when she gets to "...gover", she notices that she has forgotten whether or not a letter is needed before "ment". She tilts the pen and the system sends a notification of "n" in encrypted form. How to encrypt is described in the "Camouflage Notification" section.

Design Consideration

In this research, we consider the following issues with regard to an actual use case. The system has to constantly recognize the written content and keep predicting the next letter in order to respond to the user's letter presentation request, so the device always has to be in operation. However, it is preferable that the pen be designed to appear as though it is not a computing device but rather an actual pen. It is also necessary to design an interaction such that surrounding people do not notice the acquisition of letter information. For this reason, the gesture used to request the letter presentation should be a behavior found in typical writing activities such as a null gesture [6], which is a method of using normal, meaningless actions for gestures, such as rubbing the chin or crossing the legs. Furthermore, the letter presentation needs to be done in an encrypted manner so that only the user can recognize it.

System Overview

The procedure of AmbientLetter consists of three steps. First, the system recognizes handwriting contents by using CNN to the value of a nine-axis IMU and this methods has been extensively explored by other researchers [8]. The IMU-equipped SoC we used is Blueninja from Cerevo. The PC and Blueninja communicate via Bluetooth Low Energy(BLE). Implementing this system is very easy, because all you need to do is attach an IMU to the pen. Second, the system estimates which letter is the most probable on the basis of the previously written contents by using LSTM [9]. Figure 2 shows how to predict the next letter with the example of the word "written". Finally, "Camouflage Notification" is executed by null gesture triggering. This time, we set the act of tilting the pen as a null gesture for requesting the next letter.

Camouflage Notification

Camouflage Notification is a method to place a predicted next letter into a normal notification message in the n-th position. We determine this rule such that only the user knows n-th in advance so that only the user can grasp the real meaning of the notification. For example, when we set the first letter of the notification message as the presentation letter, the system randomly selects a word starting with the predicted next letter and uses the sentence generation model by using LSTM to create the following sentences. This notification message is sent to a smartphone via the Slack Bot API in our implementation. Figure 1(c) shows how the notification to the smartphone is executed as a presentation. We opted for smartphone notification because it is normally sent from the outside, not controlled by the user, and is sent on average about 63.5 times per day [5]. Moreover, there is a prejudice that a notification has only one meaning, and it is unlikely for others to suspect that it is an unnatural act because it is common for people to glance at pop-ups even while they are doing something else.

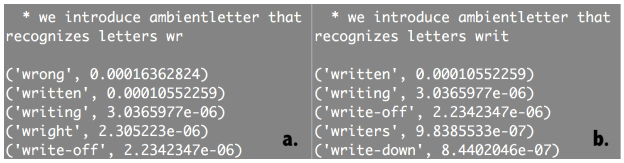

Figure 2. Letter prediction process. In the situation that only "wr" of 'written' is detected(a), the system predicts that the most probable word is 'wrong', but when "writ" is detected(b), the system correctly predicts that the word is 'written'.

LIMITATION

As shown in Figure 2, the accuracy of the predicted letter will change depending on the position of a letter that the user do not know, although we used LSTM to predict the next letter. The Oxford Online Dictionary reports that many misspellings occur from input situations of more than two billion words [2]. According to this site, there is a certain law of misspelling, as described below.

1. X "dissapoint" -> O "disappoint"
   Omission/addition overlapping letters.
2. X "acheive" -> O "achieve"
   Order of a part of string is reversed.
3. X "existance" -> O "existence"
   Similar in pronunciation as the way to finish.
4. X "truely" -> O "truly"
   Transformation of end part of string.
5. X "collegue" -> O "colleague"
   Spelling is difficult to infer from pronunciation.

There are of course other words that are likely be misspelled, but they can be roughly divided like this. From this classification, a certain performance can be expected in 3 and 4 concerning suffix. However, for the other 1,2, and 5, if the user's unknown part is in the relatively front part, this system will probably not work as expected.

CONCLUSION AND FUTURE WORK

In this paper, we discussed design considerations for the use of discreet predictive conversion with traditional handwriting implements. Then, we proposed a technique whereby the user secretly and seamlessly obtains the forgotten or uncertain spelling in the middle of the writing process using a pen-based device as a first prototype. As the method for getting information to the user discreetly, we focused on smartphone notification and proposed "Camouflage Notification". In the future, we plan to conduct a user study to obtain feedback.

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