Volume 4, Issue 12, December 2014 ISSN: 2277 128X

International Journal of Advanced Research in Computer Science and Software Engineering

Research Paper

Available online at: www.ijarcsse.com

Analysis of Indian languages Text Entry Performance for Mobile Devices

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Abstract— With the extensive growth of Information and Communication Technology (ICT), the handheld devices have become an imperative part of our daily lives. They have become smaller, economical and more prevailing, allowing their users to perform diverse tasks in standalone as well as moving condition. Recent technical advancements make demand of text messaging using mobile devices in users' mother tongue especially for English illiterate common Indian people. However, the text messaging or entry performance, like text entry rate and users' error rate during the message composition is not analyzed till now. This paper presents an exhaustive empirical study on the text entry performance like - text entry rate and users' error rate during the text message composition with mobile device. We explore the statistical impact of different font size of key of mobile keyboard on both text entry rate and error rate while user type message in stand-alone and walking condition. We also examine the impact of Indian languages like, Hindi Bengali on text messaging task. Statistical analyses of the empirical studies establish that the text entry rate and error rate are significantly varied with the key size in both for the user in staying ideal or sand-alone and moving by walk condition. Those are also different while the users compose message as well walking and stand-alone. However, only the considering language (Hindi, Bengali) without considering other factor, has not significance impact of text entry performance while the users in movement by walk or sitting ideal and type message only. The outcome of this research would be helpful to design Indian language compatible mobile user interface for more efficient text messaging in both for the user in walking mode or stand-alone mode.

Keywords— ICT, mobile phones, survey, nomadic, target acquisition task.

I. INTRODUCTION

At Present, people around the globe are communicating with each other using mobile hand-held devices. The market survey released that the total numbers of mobile phone subscribers in India have reached 875.48 million as on October 2013[1] . According to statistical survey held in March 2012, the cell phones were increased around 227.27 million[1]. The market research study reveals that 32% people prefer to communicate by text messages[2]. All these statistical studies made a strong background and motivation to design a mobile interface which would be more usable and user friendly to increase user satisfaction and overall throughput.

Nowadays, most of the people use their mobile phone while walking in order to call someone or to read or type the text message or browse the webpages etc. However, the mobile user interfaces are generally designed and developed by considering the user would operate the devices either sitting or standing at a stable position like a stand-alone user ideally busy with on his mobile only. These design strategies are not being supportive with the user accessing the mobile interface as well as walking altogether. At the time when the user is walking in a crowded place (such as a market), it becomes very problematic to perform these operations considered such as reading or typing text messages. While walking, the users' whole body is shaking, which makes it difficult to read or write the text or interact with the device via a keypad or touch screen for typing text message. This leads to the problem that users are distracted from walking as well as the task they are currently performing [1]. It may also be increase the cognitive load to perform their desire task which would be degraded the overall users' efficiency. So, a mobile user interface that adapts itself with the walking users could be one major feature of the upcoming future design approach.

Apart from all these previously discussed issues, there are several linguistic issues are came into the play for the mobile device which operates in Indian language [2]. According to our knowledge, there have not been conducted any empirical analysis on the user performance for simple task like- making call to somebody, compositing message, reading text etc. in the context of Indian languages compatible mobile devices. Moreover, common Indian mobile users are facing the problems in coping up with the relatively newer devices with complex features. All these issues are needed to be addressed for designing new mobile interfaces with more supportive to operate as Indian language based interactive device for English illiterate of an Indian common man.

[1] http://en.wikipedia.org/wiki/Telecommunications_statistics_in_India

[2] http://techland.time.com/2012/08/16/we-never-talk-anymore-the-problem-with-text-messaging

In the enlightenment of those discussed issues, the purpose of this paper is empirically analyzed how the text entry rate and error rate is differ from the user is walking or sitting ideally and compose text message either Hindi or Bengali with the mobile device. It is also noted that the text messaging task is not only one single task but also it is covered the several other sub-tasks like – target search by visually search keys in mobile keyboard, target selection task accomplished by tapping the key, reading typed text. This paper is also critically examine how the text entry rate and error rate varies with the variation of key's font size of the mobile keyboard in both for user either enter text while walking or by sitting ideal or standing in a fixed position. The statistical analysis also established that only changing the language (Hindi, Bengali) without changing any other parameter the text entry performance is insignificantly varied.

In Section II, we have presented the existing literature on the text entry performance for the user compositing text with mobile. Details of our experimental procedure with the result of the study are discussed in Section III. Finally, Section IV concludes the work with the future direction of work.

II. LITERATURE SURVEY

In this section, we have discussed some prominent works in the usability aspect of mobile devices operated in different conditions, namely stationary, mobile condition or operations by a novice user etc.

Mustonen et al. [3] conducted an empirical study on how visual performance affected on walking in the text reading task. According to their study, visual performance is suffered with the walking speed. However, they are limited with the reading task only without considering any other task, message composition, make a call etc.

Lin et al. [4] accompanied the empirical studies to examine stylus based tapping operations on a Personal Digital Assistant (PDA) under three mobility conditions, like – seated, walking on a treadmill, and walking through an obstacle course. The work concluded that the users' visual resources are divided between interacting with the mobile devices and maintaining awareness of the nearby environment. The empirical studies shown that target selection times did not differ between those considered mobility conditions; however, overall task completion times, error rate, and several measures of workload differed significantly. Results exposed that 90% accuracy can be achieved for 6.4 mm- diameter target for the users are walking through the obstacle course; but they reduced their walking speed by 36%. The studies analyzed the scenario for stylus based interaction, which is unable to represent the scenario for finger based text composition task for mobile environment.

Kane et al. [5] performed pragmatic studies to evaluate the feasibility of Walking User Interfaces (WUIs) that adapt the mobile device interface when user is moving by walk. Firstly, they conducted a pilot study with 6 users to evaluate the effect of different button sizes on performance when walking while using a portable music player. The outcome of the study showed significant impact of walking on the users' performance with soft button. Lastly, they also accompanied another empirical study with 29 users to evaluate the performance of a WUI. The result proved that dynamic user interface performs at the level of its component static interfaces without any additional penalty due to adaptation. The result proved that dynamic user interface performs at the level of its component static interfaces without any additional penalty due to adaptation. However, their considered task does not imply the effect of walking on the text messaging task. Moreover, English based WUI is not directly applicable to Indian language based interface due to linguistic issues.

Another important work on the study of user performance for text reading and target selection task using mobile device during walking was accomplished by Schildbach et al. [1]. In this work, they have considered that the devices were interacted with one-hand only with a touch screen whereby the thumb is used as the input pointer. The results conveyed that the users' performance significantly decreased when they are involved with reading or selecting target task as well as walking. Furthermore, the negative effect of walking condition on target selection task can be compensated by increasing the target size, but it is not hold for text reading task as the larger font size demand for scrolling. However, the work does not analyze the same for the text entry task, one of the most demanding tasks for messaging service.

A.S. Arif (2012) [6] conducted an empirical study on text entry using mobile device with the user on move by walking, commuting and driving. The users were categorised by age, language proficiency, gender etc. The experimental results shown that a considerable number of users compose text message with their mobile while walking, commuting, or driving. The work concluded that there is no significant effect of gender on the text entry task in moving condition. Moreover, younger users are more inputted text while in movement. However, this work does not give any clue regarding how the user performances varies with the change in operational options like- how changing the font size affects text entry rate or error rate etc. Therefore, this work unable to give any direction towards the advancement of mobile interface designs strategy to make it more effective.

Nicolau et al. [7] performed two experiential studies with 23 and 17 participants, respectively. The first experiment was conducted to understand the impact of walking on the text entry performance and the effectiveness of assistive technologies in mobile context. In the second experiment, adaptive keyboards incorporated with character prediction and pre-attentive attributes were developed and evaluated. Their experiment concludes that text entry rate is affected by users' mobility but assistive technologies are ineffective in this context. Moreover, pre-attentive attributes do not affected on text entry performance. However, the work is unable to deliver a significant improvement over the traditional approaches.

The above mention works are mostly focused on the users' performance on several task completions while they are movable. They are also mostly based on task complication with the mobile devices operate using English language. However, those works would not be provided any analysis for the mobile devises operate with Indian language. Moreover, text messaging task in Indian language with different font size and movable users is also need to analyze.

III. EXPERIMENTAL PROCEDURE

The objective of this work is to critically examine the impact of walking over the sitting ideal condition on the mobile text message composition in Hindi and Bengali. Here, we analyze how the text entry rate and error rate is varied with the variation in key size for the user composing text as well as moving by walk and staying ideal while compositing text. In order to accomplish the objective several empirical studies has been carried out, which are discussed in the successive section.

A. Apparatus Used

Two mobile devices namely Samsung Galaxy Mega 5.8 and Samsung Galaxy Mega 6.3 have used in our experiments. Both of those devices have enabled with touch sensitive display. Those devices have dual-core processor, 1.5GB RAM and each having 8, 16 GB internal memory respectively. In our experimental study, we have configured both of the devices for text entry in Hindi and Bengali. A custom virtual keyboard application also developed with those devices SDK to automatically analyze the user performance for text messaging. Both of the developed virtual keyboard layout are designed based on the standard Inscript[3] keyboard layout as shown in the Fig. 1.

(a) Hindi Keyboard interface (b) Bengali Keyboard interface

Fig.1 Experimental Design

B. Experimental Path

The participants are requested to walk on the above shown path (Fig. 2) and also simultaneously compose the text message in either Hindi or Bengali as per their choice. The effect of walking on the text composition task through this selected path will be further analyzed. The size of the path approximately 38×2.5 meters with 5 nearly blind curves, namely A, B, C, D, and E as shown in the Fig. 2. The minimum distance and maximum distance between any two blind curves is approximately 4 meter and 12 meter respectively. The user have to start the walking from the point A and come back to the same point through B, C, D, E points as illustrate in the Fig. 2.

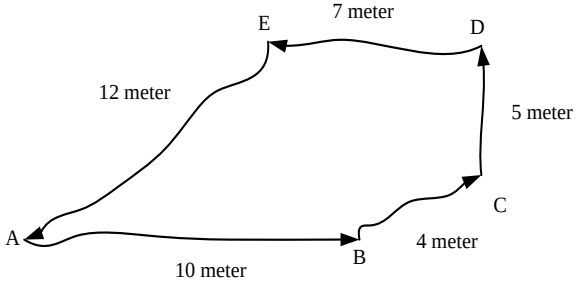


Fig.2 Experimental Path

C. Participants

Here, our target users are Hindi (or Bengali) literate people who are able to read and write in Hindi (or Bengali). However, they are unable to read and write in English properly. To carry out the experimental studies eighteen unpaid volunteers (10 male and 8 female) are deputed from our university and people from nearby villages. The age of the users are varies from 17 to 52 years (Avg. 34.1 years, SD. 9.72 years). They all are Hindi speaking by birth. We also consider another set of eighteen unpaid volunteers (11 male and 7 female) from our university and nearby area. All member of this

[3] http://en.wikipedia.org/wiki/InScript_keyboard

set are Bengali people by born and studied the basic education in Bengali medium school. They obviously communicate to each other in Bengali in their home environment. Moreover, they all are staying outside of Bengal not more than two years. The age of those Bengali users are varies from 18 to 47 years (Avg. 28.3 years, SD. 8.61 years). The both Hindi and Bengali users have different level of experience on the usage of handheld mobile devices due to diversified educational and social background. According to usage proficiency of mobile device, the participants are classified into three categories viz. expert, intermediate and novice user.

The users that have at least 3 years of experience on basic mobile operations like calling, messaging etc. in Hindi or Bengali are considered as expert user. They perform these basic operations on daily basis. People studied up to high school standard in either Hindi or Bengali medium school, like - shop keepers, office attendants, construction supervisors etc. are belong to this group. The user having primary school level educational background and around 1 year of experience on mobile usage are considered as intermediate user. Moreover, they use their devices to call daily basis but occasionally send text messages. Security guards, masons, craftsmen, restaurant waiter etc. are belonged to this group. Novice users have less than 1 year experience with mobile phones. Moreover, they usually make a phone call once or twice in a week and hardly send messages. Farmers, Rickshaw pullers, servants etc. are considered as the member of this group. More detail characteristics of the selected participants for the experiment are shown in the Table 1.

D. Experiments

Two different models of mobile devices namely, Samsung Galaxy Mega 5.8 and 6.3 have selected for conducting the experimental study. One hour training session for each user

TABLE I USER DESCRIPTION

User Group	Professional Background	Educational Background	Mobile Phone Usage	Number of Users	
				Hindi	Bengali
Expert	Hindi medium high school students, shop keepers, office attendants	High school level	At least 3 years' experience with a good proficiency on basic mobile operations. Able to use the phone in Hindi also.	5	5
Interm ediate	Security guards, auto rickshaw drivers	Primary school level	1 year experience with mobile phone. But, occasionally send the messages.	7	6
Novice	Farmers, Rickshaw puller, bus drivers	No standard education	Less than 1 year operates the mobile phone. Moreover, usually they make a phone call in a week and never send a message.	6	6

group is organized separately. In this session we have given an introduction session on how to use those devices for performing the basic operations like – making call, typing text message etc. Then, those devices are given to them individually for performing different operations by own. We also constrictively clarify their problems which are faced by them while performing the operations by own.

The actual testing session has started after the completion of the training session. The participants are requested to type text message with the considered keyboards, while they are either walking or standalone/sitting position as an ideal condition The users are restricted to walk through the previously mention path only. Any vehicles are not allowable to this experimental track for avoiding the unexpected incident of accident. In the case of siting ideal condition, users are requested to type the text message by sitting or standing in our laboratory. They are performing their own work without interruption by any other environmental factors. It is also to be mention that the users are restricted to type their own thoughts only. It is also mention that, transcribed text entry is not permitted due to the extra cognitive overhead of this process. Moreover, the modifier keys like, backspace, delete key etc. are disable to restrict the modification after typing, as the setup is going to quantify the error rate. Due to this, the users are not able to edit the text messages which are already typed. The user typed text is automatically store into the log file for further analyzing the text entry rate and error rate.

E. Results

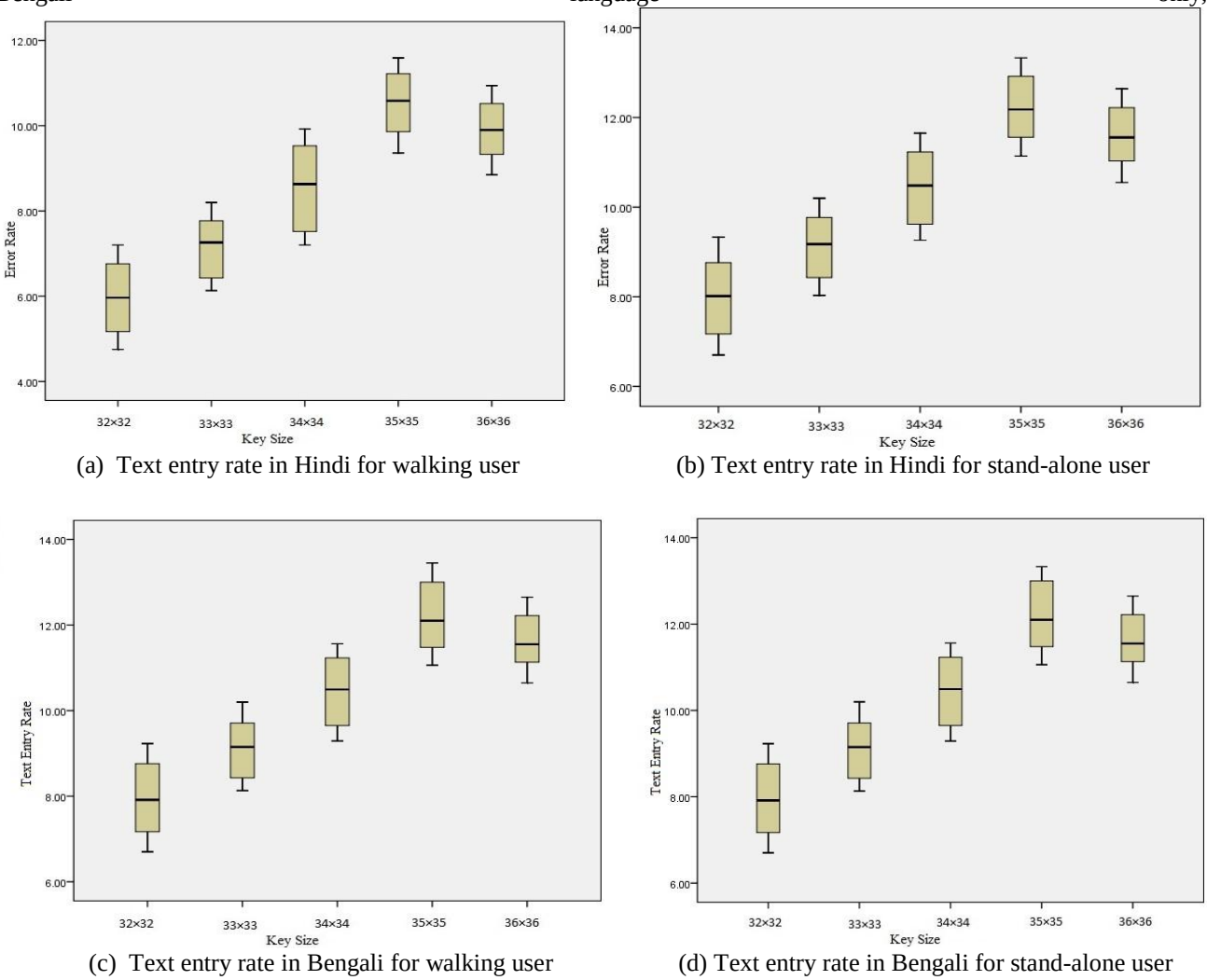
The impact of walking and the size of the keys on the both Hindi and Bengali text messaging task are critically examined in this empirical study. This study is also carried out the same set of experiment with sitting in ideal position to quantify the negative effect of walking on text messaging. The outcome of this experimental study both for text entry and error rate is thoroughly discussed in the successive sections respectively.

1) *Text entry rate*: We have considered only square shaped keys on the above discussed mobile interface in section III. The size of each key varies from 32×32 to 36×36 scale-independent pixel (sp)[4] with the increment of 1 sp in both height and width in each time all together in Hindi and Bengali keyboard interface. Users are requested to type text message on the basis of their own thoughts during walking through the previously mention path or sitting ideally in our lab. The analysis of log file for text entry rate both for Hindi and Bengali, while user stand alone and walking are

[4] http://blog.edwinevans.me/?p=131

illustrated graphically from the figure 3a to 3d respectively. Here, font size of character keys and corresponding user text entry rate (measured in WPM) is represented through x-and-y axis respectively for both walking and stand-alone condition. The experimental outcomes for most of the users are shown that the text entry rate for the stand-alone users are is quite low for a small key size (like 32×32 sp). The text entry rate is increased with increasing key size up to a moderate font size (35×35 sp). But when the font size is high enough (e.g. 32×32 sp), the curve corresponding to users' text entry rate is slightly decreased. Similar behaviour is also observed while the users compose the text message as well as walking through the previously mention path (Section III). However, the text entry rate is quite low in comparison with the stand-alone user in the exactly same experimental setup, like keyboard, messaging language, font size. So, form the empirical study, it can be concluded that user text entry rate for most of the user is maximum with moderate font size both for while moving and stand-alone as well as Bengali and Hindi.

Further, ANOVA test shown that, irrespective of language, the text entry rate is significantly varies with the variation of font size while the users types message and walking altogether ($F(4, 85) = 45.23$, where $p<0.05$, and ($F(4, 85) = 44.71$, where $p<0.05$), for Hindi and Bengali respectively. Same situation is also happened with the stand-alone user ($F(4, 85) = 38.25$, where $p<0.05$, and ($F(4, 85) = 37.68$, where $p<0.05$), for Hindi and Bengali respectively. Moreover, it also observed that, there is a significant impact of walking condition over the sand-alone condition on the text composition task ($F(1, 13) = 8.75$, where $p<0.05$). It is measured by comparing the text entry rate in between the stand-alone user and user in walking motion by considering other parameter remain fixed (like, key font size, text composition language). Furthermore, there is an insignificant impact of language on text entry rate in both for typing message task performed by walking and stand-alone users ($F(1, 13) = 1.37$, where $p<0.05$). However, this conclusion is taken for only Hindi and Bengali language only,



(a) Text entry rate in Hindi for walking user

(b) Text entry rate in Hindi for stand-alone user

(c) Text entry rate in Bengali for walking user

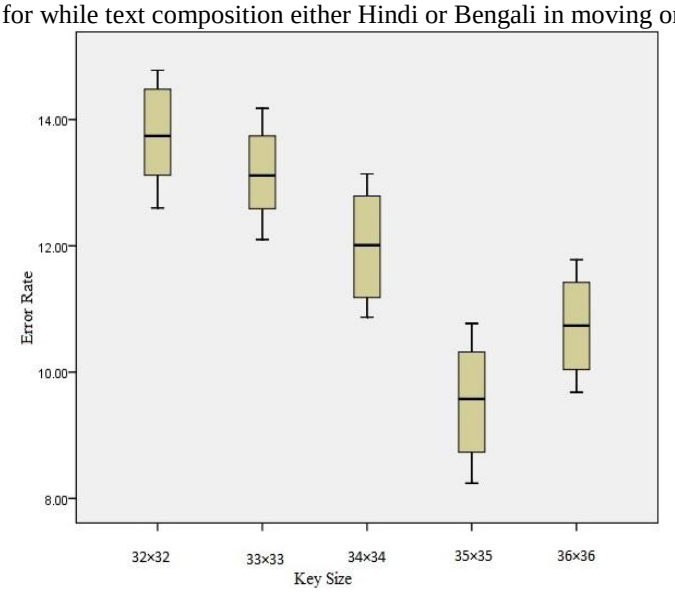
(d) Text entry rate in Bengali for stand-alone user

Fig.3 Text entry rate for different key size in both Hindi and Bengali keyboards with walking and stand-alone user

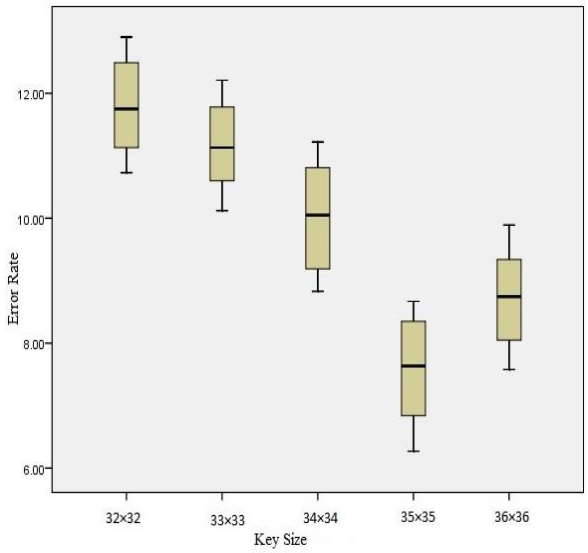
on which the empirical study was carried out.

2) Error rate: We also empirically analyze the users' text entry error rate in the text messaging task with the same experimental setup as discussed in the previous section (Section). Users' error rate for the text messaging task both for both Hindi and Bengali with the walking mode and stand-alone mode user are represented graphically from the figure 4a to 4d respectively. Here, font size and corresponding error rate are represented through x-and-y axis correspondingly.

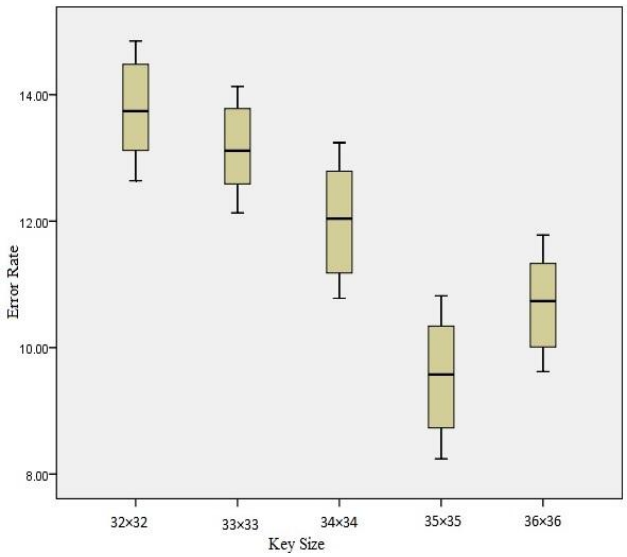
The experimental outcome proved that for most of the users' the error rate is more while the users compose Hindi or Bengali text in stand-alone condition with the keyboard interface having small sized key (32×32 sp). The users' error rate gradually decreases with the increment of key font size up to a rescannable font size of the key (35×35 sp). However, when the font size of the key is adequately high (e.g. 32×32 sp), the curve corresponding to user s' error rate is slightly increase. Similar user behaviour is also observed for users' error rate while they are composing text as well as walking through the previously mention path (section III). Nevertheless, the users' error rate for all users is relatively high while they are walking as well as type the text message in compare to stand-alone user. Hence, form the empirical study, it has been concluded that users' error rate for most of the user is minimum with moderate font size (32×32 sp) of the key both for while text composition either Hindi or Bengali in moving or stand-alone condition.



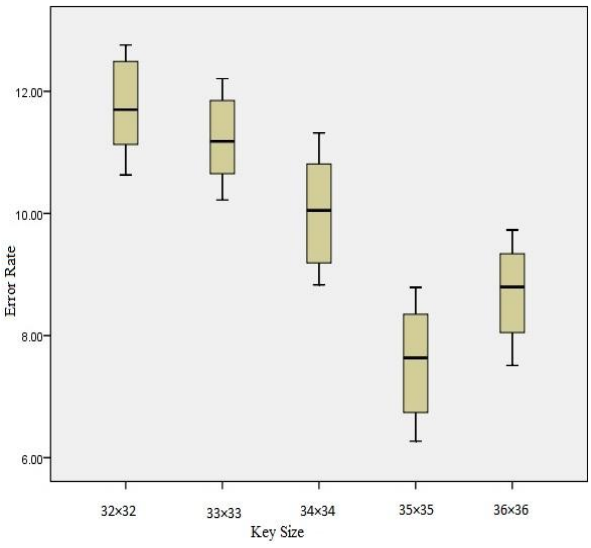
(a) Error rate for walking user while typing in Hindi



(b) Error rate for stand-alone user while typing in Hindi



(c) Error rate for walking user while typing in Hindi



(d) Error rate for stand-alone user while typing in Hindi

Fig.4 Error rate for different key size in both Hindi and Bengali keyboards with walking and stand-alone user

Moreover, ANOVA test reveals that, there is a significance difference between users' error rate and font size of keys both for while users compose the text message in the walking condition ($F(4, 85) = 41.92$, where $p<0.05$, and ($F(4, 85) = 41.71$, where $p<0.05$, for Hindi and Bengali respectively). Similar users' erroneous behavior has been observed for most of the stand-alone user ($F(4, 85) = 34.8$, where $p<0.05$, and $F(4, 85) = 34.29$, where $p<0.05$) for Hindi and Bengali respectively). However, the rate of error is not same exactly same for stand-alone and moving condition. Rather, it is significantly differ for walking to stand-alone condition with keeping the other parameter fixed ($F(1, 13) = 6.18$, where $p<0.05$). It is quantified by comparing the users' error rate in text messaging task between the stand-alone user and moving user by with the fixed value of other condition (like, key font size, text composition language). Besides that , there is an insignificant impact of language, particular Hindi and Bengali, on users' error rate in both for message composing while walking and stand-alone condition ($F(1,13) = 1.28$, where $p<0.05$). Hence, effect of one language over the other one is irrelevant on the occurrence of users' error.

IV. CONCLUSIONS

Mobile devices base text messaging in users' mother language has become an imperative part of our daily commination lives in all around the glove. However, usability aspects especially for Indian language (Hindi, Bengali) for the text messaging task have not been explored still now. Therefore, in this paper we have presented an exhaustive empirical study on users' text entry rate and error rate while they are compose text either stand-alone or walking condition. It must be beneficial to know the users' text entry performance for most of the user in walking as well in stand-alone condition. That should be helpful to designing more efficient text entry tools, especially keyboard in Indian language.

The outcomes of the empirical studies clearly convey that users' text entry rate and error rate are significantly different while user compose message in compare to walking and stand-alone condition. It is also concluded text entry rate and entry rate are varied with the font size of keys in both sand-alone and walking condition. Moreover, text entry rate and error rate for most of the user are maximum and minimum respectively for a particular font size in both stand-alone and walking condition. However, only the considering languages (Hindi, Bengali) without considering other factor, has not significance impact of text entry rate while the users in movement or stand-alone. The future work would more focus on other nomadic aspects by considering different walking speed, occurrences of collision or wrong turn, text reading task etc. It may also be included other Indian language except Hindi and Bengali for the user performance analysis.

ACKNOWLEDGMENT

We are very much thankful to all the participants who are involved in the experimental study. We extended our sincere thanks to our colleagues for their support during experimental study.

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