SMS Text Based Affective Haptic Application

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SMS Text Based Affective Haptic Application

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Abstract— **In this article, we propose a new mobile application which automatically detects secondary level emotions from SMS text by applying lexical rules based analysis and maps emotions to unique vibrotactile haptic actions. In our prototype application, a SMS receiver can feel affective haptic effect through her mobile phone or wearable haptic jacket before reading any SMS. We envision such application as a preview of SMS content's emotion which will guide the receiver to select a message for reading or discarding at various contexts. In this article, we have presented our emotion analysis method, application architecture, some performance analysis and users perception towards such application.**

Keywords- Emotion; Haptic; Lexical Analysis; SMS, Vibrotactile effect

I. INTRODUCTION

Most of the carriers, mobile equipment makers, and other service providers are looking for applications which can drive the growth of wireless data exchange. Their main interest is to add new subscribers, increase network utilization and generate additional revenues. A study shows that the number of mobile subscribers by the end of 2009 is 4.6 billion all over the world [32]. According to the business firms, subscribers are also looking to get more out of their mobile phones or wireless PDAs [13]. Short Message Service (SMS) is one of the most usable applications in mobile telephony until now. Another study shows that mobile operators reached revenue close to $800 billion by the end of 2008. The same report declares that SMS contributed 20% of this revenue gain. Around 1.2 billion SMS messages are transferred every month in the U.K. It is considered as the killer application in Europe and in Middle East [14].

According to International Data Corporation (IDC) [1], mobile network operators are now looking for the next level of mobile messaging and considering new media types: haptics / vibrotactile effects. Above study also reports that tactile feedback of mobile sets has come to an advanced point where it can produce unique and versatile types of vibrations to mobile users. Vincent [2] shows that human beings are emotionally attached to their mobile phones. His study recognizes that people are most of the time carrying their mobiles in their pockets, holding or fondling them. Though some research works were conducted which denote the emotional attachment of human beings to mobile, there is hardly any work which describes how a mobile can convey emotional messages to human beings.

According to Averil [21], when a person expresses any emotional state through writing, facial or verbal communication methods he is provoked to do so. In fact, all emotional states are targeted to something or someone with specific aims. It is said that, emotion is a composition of five features: elicitors, receptors, states, expressions, and experiences [3]. Averil further describes that friends, colleagues and beloved ones are most often the target of a particular emotion. Though emotion is a topic of broad interest for many decades but automatic detection of emotion from text is a relatively new field of study in computer automated cognitive science. Hence, emotional haptics is an emerging field of research interest.

Current tactile and kinesthetic devices are targeting human body surface for representing touch (haptic) information. Multimodal human-computer interaction has opened this new era of research. As a result, tactile device based sense of touch research interests have gained pace to certain extent [16] [17]. In 2008, Samsung launched two mobile sets (SCH-W420 and SPH-W4200) in South Korea which are capable of providing haptic feedback when using certain functions of the device. These phone models support 22 kinds of unique vibrations [1] [17].

Though there are many mobile applications related to SMS but haptics with SMS is yet to explore. There is a SMS related haptic system where two end-to-end haptic devices communicate using SMS. In another SMS haptic system which is by far closest to our theme, translates emoticons of SMS text to haptic signal in the receiving end. In both of these systems full capabilities of SMS content is ignored. In this paper, we focus on total analysis of SMS text, detection of secondary level emotions from text and mapping of emotions to various unique vibrotactile patterns. This application introduces a novel idea of SMS based affective haptic alert which can be considered as a preview of SMS content before reading it. Such application will help to get content idea at various situational contexts.

In our prototype haptic application we map individual emotion to distinct haptic vibration using modern haptic mobile phones or haptic jacket [10]. It is worth to be mentioned, Samsung's first haptic mobile had 22 unique vibrations [19] and Samsung sold half a million of their YUNA haptic phone [4] in 80 days. The remainder of the paper is organized as follows. Section II presents some related works, Section III describes the proposed system, and Section IV discusses some experimental results and presents performance evaluations. Finally Section V concludes the article.

II. RELATED WORKS

Researchers differ in the method of emotion classification but most of the theorists normally address "*love*", "*joy*", "*surprise*", "*anger*", "*sadness*", and "*fear*" as basic emotions [22]-[25]. From Parrot's [26] research article, we find that emotion can be presented in a tree structure where emotions are listed as primary, secondary and tertiary emotions. According to Parrot *joy* can be of type *cheerfulness*, *pride*, *relief* etc. and *love* can be of type *affection*, *lust*, *longing*. If we analyze the emotional labels of the following three sentences, "*Take my love"*, "*Love you :-X honey!(:-X denotes a big wet kiss)"*, "*Loveeeee to see u soooon!"* using the methods provided in [24] and [31] we will label them all with *love*, however if we use Parrot model [26], we can conclude that the above sentences intend *affection*, *lust* and *longing* respectively. Hence, this model is a good candidate for fine grained detail emotional tagging which can be used for a wide range of application domains e.g. handheld small device, serious games, haptic interaction, detail 3D emotion modeling, complex robotics etc.

A very important work for emotion analysis is affective labeling of WordNet [29] *synsets* which is called WordNet-Affect [27]. In WordNet-Affect noun, adjective, verb and adverb of WordNet are labeled to emotion, cognitive state, trait, behavior, attitude, feeling etc. WordNet-Affect follows the emotion model of Ortony and Turner [25]. Though Chuang [28] proposed a semantic network based text to emotion extraction method but it lacks necessary corpus for better results. Mulder et al. [30] made an attempt to formalize the affection in word and grammatical level of a fraction of Dutch and English. They tested their system in a pilot experiment but they do not provide their detail formalization or implementation methods.

A new type of SMS was proposed named SenseMS [6]. SenseMS is a specially tailored SMS just only for teens. It has options of adding avatars, text color, font size, facial expression, location awareness through background pictures. From that perspective it looks more like an implementation of MMS.

There is an U.S patent about wearable haptic garments that uses SMS to transfer hug or touch information between end-to-end haptic devices [7]. Though this haptic system uses SMS but SMS text is just used for remote communication to initiate command in receiver end not as a source of rich text. Another U.S patent maps a limited set of SMS elements to sound or vibration [8]. Limitation of this system is that it is workable only for predefined set of symbols like smiley etc. As a result, we cannot interface this system with our day-to-day SMS system.

A very popular work about affective haptic is iFeel_IM! [11] where 9 basic emotions are detected from SecondLife [20] chatting text and the emotion is conveyed to the end users using a set of devices. This research work is limited to the domain of SecondLife and their emotion detection does not support detail emotion tracking. HugMe system [10] facilitates users' hugging using a specific haptic jacket while they are using instant messenger. This work does not have automatic emotion awareness. We have used this haptic jacket in our prototype application.

Rehman and Liu conducted research [9] to support visually impaired people by wearing video camera that points to the face of the person of interest. Then the captured video is analyzed and facial emotional parameters are extracted and this information is conveyed to a mobile phone to vibrate based on that information.

To the best of our knowledge, this paper for the first time attempts to combine the idea of wide scope SMS text analysis to find detail emotions and emotion based haptic vibration to utilize vast opportunities of haptic mobile phones and other haptic devices for conveying a new dimension of SMS alert named emotional alert.

III. EMOTION AWARE HAPTIC APPLICATION

In this section we present different salient components of our system architecture. Following system design is an application of our affect analysis model in the domain of SMS text. Fig. 1 shows the high level design of the proposed system. Total system is divided in *Emotion Server* and *Mobile Client*. In our prototype system we have developed them as *J2SE Based Emotion Server* and *J2ME Based Mobile Client* respectively.

A. Emotion Server:

The main purpose of the server part is to detect emotion from text. A Simple Object Access Protocol (SOAP) based web service is published for external use which is maintained by the Remote Emotion Manager (REM). Web service clients call the published web method and pass the SMS text to REM along with authentication profile for emotion extraction. After receiving the text, REM checks authentication profile and if emotion request is made from an unauthentic client REM sends a failure message to the requesting client. Otherwise, authentic client requests are transferred by REM to affect analysis model. At this moment, REM waits for emotion vector output and after receiving it finally transfers it to the mobile client. Following is a brief description about the emotion analysis model.

Figure 1. *High level design of the propsed System*

1) Emotion Analysis Model

In our emotion detection model we have extended an existing model presented in [31] to support some detailed secondary level emotions [26] in Table I. As depicted in Fig. 2, the overall components of our proposed affective analysis system are *Text Content Module*, *Emoticon Processor*, *Abbreviation Processor*, *Non-grammar highly intensive word processor*, EmoHeart [31] based Syntax, Word, Phrase, Sentence Analysis, *Interjection Processor* and emotion tagged output. All these modules are centrally controlled by the *Step Forwarding Controller*. This controller module decides which step to execute at which instant of time. Now we describe briefely each of the modules.

TABLE I. TYPED EMOTION LISTS FOR USER'S PERSONAL SELECTION

Basic Emotion	Secondary Emotion
Love	Affection, Lust, Longing
Joy	Cheerfulness, Zest, Contentment, Pride, Optimism, Enthrallment, Relief
Surprise	Surprise
Anger	Irritation, Exasperation, Rage, Disgust, Envy, Torment
Sadness	Suffering, Sadness, Disappointment, Shame, Neglect, Sympathy
Fear	Horror, Nervousness

a) Text Content Module: At this phase, the text content is analyzed and tagged with our predefined tags: *<emo>..</emo>, <abb>..</abb>, <ng>..</ng>, <g>..</g>, <exc></exc>, <punc>..</punc>, <int>..</int>*. *Here emo, abb, ng, g, exc, punc, int* stands for emoticon, abbreviation, non-grammar, grammar, exclamation, punctuation and interjection respectively. Example of non-grammars would be *loveeee, uuuu, cooool*. The processed tagged input is transferred to *Step Forwarding Controller*.

b) Step Forwarding Controller: This module acts as the central controller as well as the transit to every intermediate input and output of the analysis model. Based on the tagged content of input (text), this module calls other low level modules to process the corresponding tagged part. At this stage, parallel execution is performed on different tagged part of the text to improve the performance of the system. For example, emoticon processor, abbreviation processor, non-grammar processor and interjection processor can work simultaneously to translate the input text and symbols to proper transcriptions. The Punctuation processor is applied at the end of the sentence level processing. Finally a detailed emotion description of the inputed text is obtained.

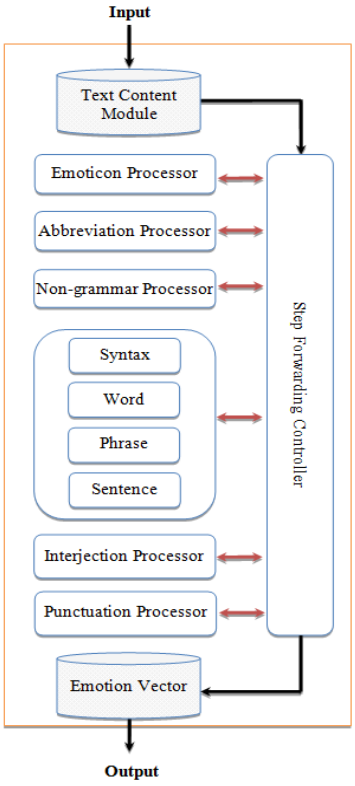

Figure 2. *System flow of secondary level emotion detection system*

c) Emoticon Processor: In this phase, the emoticon tagged contents are translated to the corresponding emotion based on a list of secondary emotions [38]. We show a partial list of our emoticon database in Table II.

d) Abbreviation Processor: Abbreviation processing module uses a rich abbreviation database we developed to translate the symbol to its corresponding transcription. We have prepared this database after detail study of SMS, online conversation, blog and video commenting etc. We used the database provided by [33]-[37] to devise

900 mostly used abbreviated symbols. In Table III we show a partial list of our abbreviation symbol table.

e) Non-grammar Processor: This module is especially designed to calculate a possible word from a non-grammar word. We have selected some mostly used words analyzing SMS archive [42] and public chat room texts (Yahoo Messenger, Google talk) like *bye, love, u, so, cool, ah, wow* etc. for this phase of calculation. When we get *hiii, byeee, loveeee, uuuu, sooo, cooooool, ahhh, woowwwww* etc. words in a sentence after some string editing we calculate their Levenshtein string distance [39] and select the basic word. Based on the string distance we decide the approximate emotional intensity of the basic word. For example *loveeeee! uuuuu* has strong emotional intesity than *lovee uu*.

f) Syntax, Word, Phrase and Sentence Analysis: We follow the steps presented in EmoHeart [31] for syntax, word, phrase and sentence analysis but we increased the number of elements in the vector of emotional state intensities from 9 to 25. Our intention is to find more detailed emotion labels from the input text. In our model, the vector of emotional state intensity is e = [Affection, Lust, Longing, Cheerfulness, Zest, Contentment, Pride, Optimism, Enthrallment, Relief, Surprise, Irritation, Exasperation, Rage, Disgust, Envy, Torment, Suffering, Sadness, Disappointment, Shame, Neglect, Sympathy, Horror, Nervousness]. As emotion intensity value range is {0-1}, the calculated intensity of compunction or e("compunction") is [0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0.1, 0.1, 0, 0, 0.1, 0.1, 0.1, 0.4, 0, 0, 0, 0.1]. We manually converted 539 nouns, 517 adjectives, 238 verbs and 15 adverbs of WordNet-Affect [27] to emotion intensified vector data.

g) Interjection Processor: This module is used at the end of the sentence level analysis because interjection changes the emotion intensity of a sentence. For example, "I really like this dish" is a straight forward calculation but when it says "Wow! I really like this dish." the emotional intensity should be different from the previous one. We have selected a list of interjection words with emotional values after analyzing [43]-[47]. Table IV presents a partial list of those interjection words. Each interjection word is annotated with emotion intensity vector neutrally i.e. irrespect of its use in a sentence e.g. e(wow) = [0, 0, 0, 0.3, 0.2, 0, 0.1, 0, 0.1, 0.1, 0.2, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]. We add the interjection vector intensity with rest of the sentence vector intensity to find the intermediate vector intesity e.g. e(wow)+e(I won the lottery). As a result we get strong detailed emotion vector.

B. Mobile Client

First of all, sender writes SMS and send it to the receiver client using our application software. After receiving SMS, receiver client handovers affection processing control to Mobile Affection Manager (MAM). MAM then makes a web service call to the REM and transfers the SMS text along with authentication information. For the prototype we have made the mobile version using J2ME which uses JSR172 for making web service call. After the web service call is initiated, the mobile client waits for the response from the emotion server. The emotion server sends an emotion vector in return to the call or failure message. Now, it is the part of the mobile client to select the dominant or the detailed emotions based on the personalized selection of the user. A user can select the type of emotion he/she wants to receive. We have implemented two types of emotion sets: the basic and the detail emotions. Now, based on the user's settings, the mobile client generates vibrotactile effect.

TABLE II. PARTIAL LIST OF EMOTICONS AND CORRESPONDING SECONDARY EMOTIONS

Emoticon	Meaning	Emotion Label
;-)	So happy, I'm crying	Zest
:-o	Wow!	Cheerfulness
:(	Sad	Sadness
:-ll	Angry	Rage
8-O	Omigod!!	Surprise
:-X	A big wet kiss!	Lust

TABLE III. PARTIAL LIST OF ABBREVIATION SYMBOL TABLE.

Abbreviation	Description
AMBW	All my best wishes
BS	Big Smile
CUL	See You Later
DYLM	do you like me
GLLA	Great lovers love alike
HAK	Hugs and kisses

TABLE IV. PARTIAL LIST OF INTERJECTION TABLE.

Interjection	Interjection
Alas	Gee
Bingo	Hurray
Bravo	Oops
Cheers	Ssh
Dang	Wow
Eureka	Yuck

IV. RESULT AND DISCUSSIONS

In this section, we have described various performance measurements of our proposed system. At first we have described the performance of our affect analysis model and next we have provided measurements related to our haptic SMS application.

A. Performance Evaluation of Affect Model

We have extracted mood based blog posts from LiveJournal.com [41]. It is believed that LiveJournal.com blogs are more likely close to the ongoing life of people and mostly user mood annotated. We assumed that content analysis of these texts will give a true picture of the mood of the blog authors. We also annotated our test text sets by human annotator. As a result, we had two

types of emotions, one is blog author's annotation and another one is based on human annotator's annotation. In case of annotation conflicts we have requested annotation from third person and selected annotations based on annotator agreement. After testing our affect analysis model on 500 average size blogs, 84.5% of the cases the output emotion vector was recognized correct.

We also used SemEval-2007 Affect Sensing corpus [40] which has news headline related emotional sentences for evaluating our system. In 82% of the cases our result was found correct. To check the efficiency in different domain we have used 300 SMS from a rich SMS archive [42] and found that 81.7% emotion vectors are recognized as true emotions. We have also extracted comments of 80 highly commented YouTube videos, and found that our text to emotion analysis model determines detailed emotion vector with 83% success which were cross-checked. For all of the above results, the test concludes that most of the data, 60% were neutral and 40% is emotive data. It is important to note that the above results are part of ongoing research.

B. *Performance Analysis of SMS Based Haptic Application*

To analyze our SMS haptic application performance, we have considered time and user experience as main factors. For emotional haptic time measurement, we have considered web service call time, emotion calculation time, web service response time, and personalized selection based emotion vector to haptic mapping. For user experience analysis we have conducted a survey where we provide some questionnaires which looks for user interest in such kind of application. We also conducted usability test and devised a haptic feedback pattern which users can easily follow. Easily understandable haptic feedback pattern is important because we are providing users with 25 unique vibrations.

TABLE V. SMS RECEIVE TO HAPTIC ALERT GENERATION TIME

SMS Length (character)	**Average Time (millisecond)**			
	Web Service Call	***Emotion Calculation***	***Web Service Response***	***Personalization Based Vibration***
< 50	4.20	400	5.1	15
51-90	4.50	440	5.1	16
91-130	4.60	475	5.6	18
131-160	4.60	530	5.8	22
160 >	4.75	580	6.0	25

In our prototype system, our Emotion server is hosted in our lab and we use an existing mobile network provider for creating SMS. When an emotive SMS is received at the receiver end then we started calculating the total delay before the haptic alert is generated. For this reason, we have created 300 real unambiguous emotive SMSs. Based on server and client systems' log files we have presented time delay in Table V. Following time delay calculation depicts that emotional haptic rendering phase takes less time.

For user interest survey, we placed our prepared questionnaires to 20 users and 85% of them were very interested about this new application. 10% users reported that there is a possibility that new type of SMS spamming i.e. affection spamming may be introduced which we argue that can be controlled significantly by considering privacy control. 50% survey users expected the system to be smarter to consider various contexts and act upon that. 80% users said that they feel that after some training haptic recognition rate through various devices like mobile phone, haptic jacket, arm band etc. will improve. 20% said they will prefer only 12-15 emotion mapping because they have no idea will it be possible to distinguish them? Only 5% were not interested about the application and 10% users were not sure about its benefit. Overall we conclude that, people demonstrated significant interest about such haptic SMS system.

In our system, we have used haptic vibration to transfer emotion to mobile phone users. For that, we implemented different encodings of the emotion. We tested the system on 20 persons and found that it was difficult for our test persons to distinguish between 25 different randomly selected vibration patterns. Next, we introduced a "*parent-child-vibration-pattern*" where primary emotions are numbered 1 to 6 as parent and their corresponding secondary emotions are numbered from 1 to onward as child. To distinguish between parent and child pattern we encoded one number in short (200ms) and one in long (500ms) vibrations, each followed by a break of 1 second. We decided not to change the intensity of the vibrations, since it is not possible to control the perceived reception of the user. Thus, *Love* gets the number set {1}, *Fear*-{6}, *Affection*-{1, 1}, *Lust*-{1, 2}, *Relief*-{2, 7}, *Nervousness*-{6, 2} etc. When we introduced this vibration pattern and asked the very users to detect the vibration pattern using count, after 4 to 5 training sessions every user was able to detect 25 distinct vibration patterns where their maximum count was for *Sadness*-{5, 6} equal to 11. It should be noted that after successful detection of the patterns, user's pattern recognition graph was incremental. Thus, counting based *parent-child-vibration-pattern* helped us to reduce the 25 random vibrations to counting based vibrations where maximum count is 11. From the usability study we find that our method of haptic vibration pattern is detectable by users and they can easily distinguish 25 detail emotions.

V. CONCLUSION AND FUTURE WORK

This paper introduces a novel SMS based affection related haptic application. In this regard, we have presented an emotion analysis model which can detect 25 unique emotions from text. Our proposed application maps text based emotions to unique haptic vibrations. We also provided performance evaluation results of our proposed emotion analysis model and haptic SMS application. Mobile network operators can unveil the opportunity of this novel haptic alert application as next generation SMS based application. Our future goal is to

add context awareness and privacy controlling features to the application so that it can act smarter.

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