ABSTRACT

In affective computing, the primary focus is on developing emotionally intelligent computational systems, which can perceive human emotion and respond accordingly. As a result, the prerequisite of developing such systems is to determine emotion accurately. But, the traditional affect determination technologies are often restricted in sheltered labs and in controlled environments. Although the ubiquity of smart devices (e.g. smartphone, wearable) has influenced the affective computing technology, still there exists a number of challenges to make this technology widely applicable. We, in this thesis, address few of these challenges.

The affect determination process is typically data driven i.e. it (a) collects sensor and usage details from different modalities present on the smartphone, (b) acquires emotion ground truth labels, mostly in the form of emotion self-report, and (c) combines both of these to develop a machine learning based emotion detection model. However, as smartphone usage is personalized, it often requires to collect individual data and develop personalized affect determination model. Moreover, monitoring activities and usage logs from smartphones can be intrusive, leak personal information and consume significant resources. We find that keyboard interaction pattern (not actual content) on smartphone is non-intrusive, resource-efficient and provides clues about human emotion. We leverage on this and develop a smartphone based emotion detection application *TouchSense*, which determines four emotions (*happy, sad, stressed, relaxed*) based on keyboard interaction pattern.

The construction of emotion detection model is highly dependant on the emotion ground truth labels, which are mostly collected as manual survey response by deploying an Experience Sampling Method (ESM). But manual self-report collection is time-consuming, labour-intensive and fatigue-inducing. This often forces

the user to skip responding, respond randomly or withdraw from the studies in between. All of these influence the quality and quantity (number) of self-reports, which in turn impact the emotion detection performance. We investigate ways to improve the self-report collection method. We propose intelligent ESM driven self-report collection strategy so that probing rate is reduced and self-reports are collected timely to improve the emotion classification performance. We also propose a user similarity based self-report aggregation strategy, which reduces the self-report collection effort of individual user in a long-running user study.

Finally, we investigate how keyboard interaction based emotion determination applications can be used in real-world scenarios. Towards this objective, we identify two scenarios - (a) improving keyboard interaction interface based on human emotion and (b) monitoring mental health based on keyboard interaction. In the first case, we investigate the possibility of improving smartphone keyboard interaction interface based on emotion. For this, we analyze the correlation between human emotion and auto-suggest usage (while typing). Auto-suggestion facilitates typing in small devices like smartphone by allowing them to select suggested word so that users need to type less. However, using auto-suggestions requires user to parse the set of suggestions and select the appropriate one; hence exerts cognitive load and disrupts the flow of typing. As a result, this facility may not be used often; users may be likely to use them when they are tired or in low arousal (active) state. So, it becomes imperative to inspect if auto-suggest usage is guided by emotions. If found so, this facility may be enabled only when the users are likely to use; thereby providing the opportunity to optimize the keyboard layout further. In the second scenario, we develop an emotion-aware keyboard *EmoKey*, which determines multiple emotions based on typing interactions and provides user the feedback about the temporal variation in emotion. We execute a Deep Neural Network (DNN) model

on the device for emotion inference and find its implication in terms of resource usage. Our findings reveal the promise of unobtrusively monitoring mental state in long-term from smartphone interactions.

Summarizing, in this thesis, we investigate the suitability of keyboard interaction on smartphone for multiple emotion detection. We also devise novel emotion self-report collection methods to reduce survey fatigue and improve response quality. Furthermore, we explore the possibility of using smartphone keyboard interaction based emotion detection for mental health monitoring and emotion-aware auto-suggest usage.

Keywords: emotion classification, affect determination, smartphone, keyboard interaction, self-report, Experience Sampling Method, ESM, mental health, auto-suggestion.