LifeRec: A Mobile App for Lifelog Recording and Ubiquitous Recommendation

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In recent years, context information has played an increasingly significant role in recommendation systems. With the rapid growth of portable sensor devices, lifelog data, such as mood, location, and daily activity, has been recorded and used for ubiquitous recommendation tasks. However, since the multi-modal lifelog data contains objective context information and subjective user labeling, it is challenging to record the lifelog thoroughly and perform personalized recommendations in real-time. In this work, we design a mobile application (App), **LifeRec**, to record multi-modal lifelog data and perform personalized recommendations by communicating with the remote server. The App helps users collect various lifelog information (e.g., location, diet, activity, and mood) and receive real-time recommendation with privacy protection and little effort. It is useful for lifelog data collection, user status monitoring, and various ubiquitous recommendation tasks. We examine **LifeRec** in a one-week field study with seven subjects. The users' experience feedback and recording results show great usability and task completeness with our App.

CCS Concepts: • **Human-centered computing → Interactive systems and tools**; **Ubiquitous and mobile computing systems and tools**.

Additional Key Words and Phrases: Lifelog, Recommendation system, Mobile application, User study.

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1 INTRODUCTION

Context information has been widely used in recommendation systems[6]. In the traditional online recommendation, rich context information, including user demographics and item attributes, is leveraged to improve the performance of recommenders [1]. With the development of wearable sensors, real-life context information, including location, activity, and mood, has been applied for ubiquitous recommendation [8, 12]. As a result, collection and usage of daily lifelog with digital sensors have drawn much attention in the recommendation scenario [5].

However, collecting comprehensive lifelog and performing recommendation is challenging. Previous lifelog collections mainly focused on the objective context information [6], while subjective user labeling is ignored, which is essential in personalized recommendation. For studies that collected the subjective labels, participants used online questionnaires or spreadsheets to record their status [3, 14], which is inconvenient and impossible for real-time recommendation.

Therefore, a flexible, user-friendly, and polyfunctional application for lifelog collection and ubiquitous recommendation is in great need. It should record the objective context (e.g., location, weather, and phone usage) and the user's subjective understanding of life such as mood and events in a convenient way to perform ubiquitous and personalized recommendation in real-time.

In this work, we design a mobile application (App), **LifeRec**, to record lifelog data of context and user logging, and perform personalized recommendations by communicating with the remote server. The app can help users collect

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real-life information with little effort and receive ubiquitous recommendations. To be specific, location, weather, and smartphone usage are collected automatically, and users can (1) mark mood, (2) record diet, (3) track activities, and (4) receive recommendations with personalized configurations. Meanwhile, to protect the users' privacy, all data are stored locally, and records will not be uploaded until consent from the user is obtained.

To examine our design, we use **LifeRec** to implement a ubiquitous music recommendation system. We examine the app in a 1-week field study with seven subjects. All participants are instructed to record their daily-life information, experience the music recommendation, and give feedback at the end of the study. The user experience and recording results show great usability and task completeness with the **LifeRec**.

To the best of our knowledge, **LifeRec** is the first public mobile application that collects multi-modal context information and performs ubiquitous recommendation. The source code is available at Github[1]. **LifeRec** suits many tasks such as daily-life tracking, diet recording, and ubiquitous recommendation in various scenarios.

2 RELATED WORK

Recommendation is ubiquitous in our daily life, happening in various activities and statuses. Therefore, context information is essential for user preference modeling [6]. With the help of context information about routes [8], mood [12], and location-time-activity features [2] , the scenario of recommendation is enriched, and the performance is promoted. Recently, portable devices provide a possible way for collecting rich context information as lifelog, and performing real-life recommendation [7]. In the lifelog researches, information about bio-metrics, activities, and environment can be collected and recorded in participants' daily life [4, 14, 15], which is possible to apply in the ubiquitous recommendation.

In previous works, various methods have been proposed to collect and store the lifelog data. Participants were asked to record mood or activities with a questionnaire or spreadsheet in some researches [3, 14], which is complex and inconvenient. With the spread of smartphone usage, Apps have been designed for lifelog collection. HealthyOffice [15] is used for collecting moods of employees and making working status analyses. HealthTalks [9] helps patients record and understand health tasks and appointments with audio input and medical assistance. MORIBUS [10] is designed for depression patients to arrange positively emotional activities as a supplementary for psychological therapy. However, these applications only record one or two kinds of subjective labeling without objective context. Meanwhile, they focus on self- or group-monitoring without extension to recommendation tasks.

In **LifeRec**, rich context and label data is collected, and connection with the server makes it possible for the ubiquitous recommendation.

3 APP DESIGN

3.1 Objectives and Considerations

LifeRec aims to combine the collection of multi-modal lifelog data with the ubiquitous real-time recommendation. As such, the overall objectives of the App are: (1) record mood from users; (2) track users' daily activities with annotations; (3) gather rich context information (e.g., indoor/outdoor, GPS, diet); (4) perform recommendation in real-time.

Mood is an important and complex factor in lifelog collections. To ensure optimal objectivity, rationality, and reliability of mood data, we referred to the suggestions on affective computing field studies [11]. For mood collection, the App needs to notify users to record mood at fixed intervals and encourage users to mark their mood actively,

[1]https://github.com/JiayuLi-997/LifeRec. We will continue updating the App.

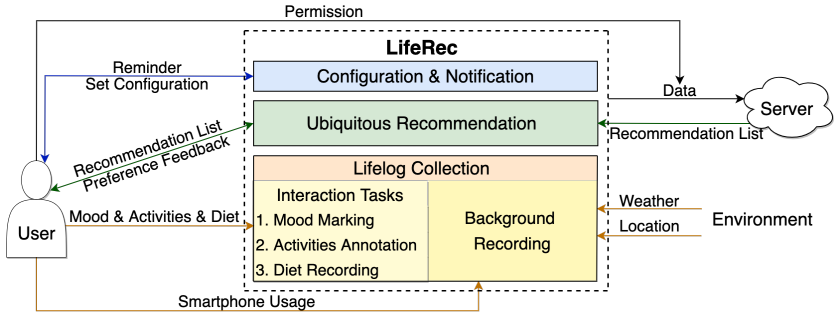


Fig. 1. Application workflow. **LifeRec** is in the middle and consists of three parts: configuration and notification, lifelog collection, and ubiquitous recommendation.

especially when unusual events happen, to capture changes in mood status. Since mood is complex, a simple and intuitive method to record it is also essential.

For activity tracking, it is impractical to request users to record each activity after finishing it, and frequent interruption is annoying. Therefore, the App should reduce interaction times with users by collecting ongoing activities when users mark their mood or helping users recall the whole routine at the end of day.

Inspired by LSC'21[4], rich context information is considered in our task. The App should obtain smartphone usage, location, and weather information. Furthermore, records of user status (e.g., indoor or outdoor, alone or not) and diet data are also in need, which constitutes to multi-model lifelog data.

In practice, the App should be used for various ubiquitous recommendation tasks, such as music, activity, or restaurant. Therefore, an extensible recommender interface and easy connection with the remote server should be included in the App.

Besides the functional objectives, user privacy is also a significant concern. As the lifelog data is highly private, all data should be collected with privacy protection. For instance, the App should collect data with explicit notification and local storage. And users should consent to the data transmission when data is uploaded to the server.

3.2 Architecture

The workflow of the application is presented in Figure 1. **LifeRec** mainly consists of three parts: Configuration&Notification, Lifelog Collection, and Ubiquitous Recommendation.

In the Configuration&Notification module, the user sets the expected notification time for annotation reminder, and the App will remind the user as scheduled during usage.

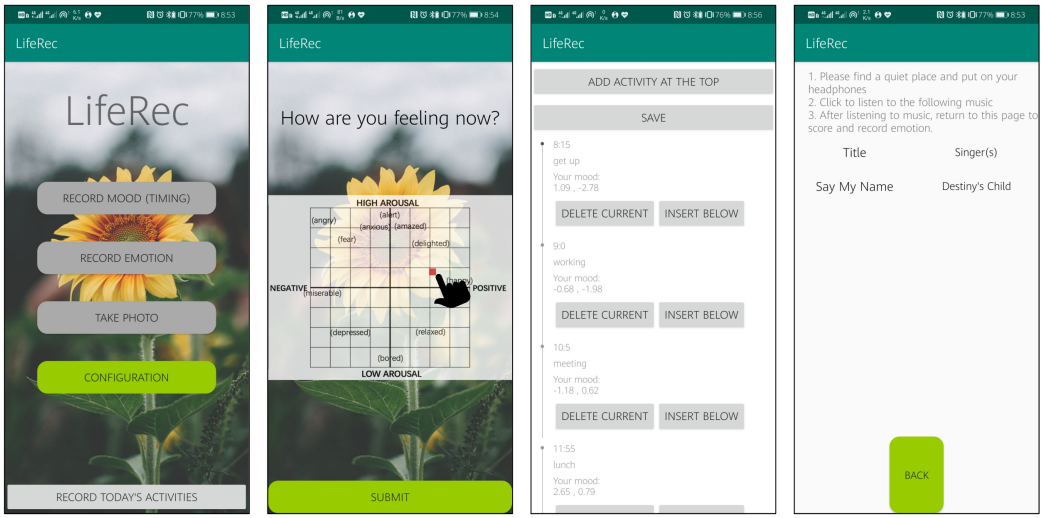
Lifelog data is collected by interaction tasks and background recording. Interaction tasks include (1) mood marking, (2) ongoing event and daily activities annotation, (3) diet recording. The users are notified to report their moods at the time they have chosen in the configuration. Meanwhile, recording mood for accidental events actively is also possible. A 2-dimensional Thayer model is used to record the mood [13], where users only need to click a point to represent mood (as shown in Figure 2(b)). Ongoing activities, important events, and environmental context are also recorded along with mood recording. At the end of the day, the user can recall the whole schedule and annotate daily activities in time order. Moreover, the system camera is incorporated for diet recording. Apart from the participants'

input data, background recording is always in progress, constantly collecting information, including weather, location, and smartphone usage.

The ubiquitous recommendation module is another prominent part. Generally, **LifeRec** sends the user's current status to the remote server and receives recommendation lists from the server. Then the user can give preference feedback. In particular, the server can fine-tune the recommendation method based on the user's preference and real-life information. All these build up to a ubiquitous and personalized recommendation system.

For privacy concerns, user permission is required for uploading data to the remote server at each time. The user can check records of the data in detail. Only with the user's consent, the data could be uploaded to the remote server and used by researchers.

4 APP IMPLEMENTATION



(a) Dashboard (b) Mood submission (c) Daily activities recording (d) Music recommendation

Fig. 2. Some main interfaces of LifeRec. The interfaces include lifelog collection of mood and activity, as well as ubiquitous recommendation (Take music recommendation for example).

LifeRec is developed on the Android system, and the implementation details are as follows.

4.1 Interface Design

Some main interface designs are shown in Figure 2. The interfaces are completed with light green and grey as the main theme.

Starting from the dashboard (Figure 2(a)), user is allowed to perform the following 5 actions (from the top to bottom): (i) **record mood** at fixed interval, (ii) **record emotion** aroused by accidental events, (iii) **take photo** for diets, (v) **configuration** for user information and customized personal preference, and (iv) **record daily activities** with annotation.

For a typical task of **mood record** or **emotion record**, the users will record mood, ongoing activity, and context information (e.g., location and surroundings) on sequential pages. Easy recording of mood is achieved by introducing

the 2-dimensional Thayer mood model [13], which is intuitive for the user to understand and select current status from the graph (Figure 2(b)).

Also, we design a clever interaction interface for users to **record daily activities** (Figure 2(c)). On this page, users can create a personalized list of daily activities with starting time and mood in a timeline. It is also user-friendly for the user to adjust the activities by insertion and deletion operations.

Each time user submits a mood record, the App will ask the user whether he/she is willing to receive a recommendation. If the user consents, the **recommendation page** will be triggered (Figure 2(d)). The App will display music received from the server. After the user chooses and views an item, the App will collect the user's rating and mood as feedback.

Due to the limitation of space, we omit the display of some other interfaces. For example, the **configuration** page allows users to set a convenient time list for receiving reminders on mood records. And the **take photo** page will call the system camera to take photos for a diet.

4.2 System Implementation

LifeRec is developed primarily with Java. We follow the basic guidelines of Android SDK and Java SDK to achieve a straightforward implementation. With consideration of user privacy, **LifeRec** saves most of the user record data locally with *.txt* format. The App will automatically collect environment information such as GPS and weather every 15 minutes, once the user's permission is received. When making the ubiquitous recommendation, the app needs to communicate with the server. Here the Android Okhttp framework is used, which assures stability and scalability. Moreover, we carefully test our application to make sure it runs smoothly on various Android devices.

5 APP APPLICATION

LifeRec is extensible for various user study tasks. For instance, it can be used for integrated multi-modal lifelog collection with less user effort. The App is also useful for health monitoring, including diet control, biorhythm adjustment, and psychological awareness with analysis of recorded information. In ubiquitous recommendation, **LifeRec** can easily be applied for music, activity, or restaurant recommender with different items on the remote server.

5.1 Application Research

As an example, we applied **LifeRec** as part of our effort to conduct a ubiquitous music recommendation user study on smartphones. In a one-week field study, subjects are requested to install **LifeRec** on the smartphone and complete tasks to record mood, track activity, and collect diet. Each mood record will trigger a time of music recommendation from the remote server, and the App collects mood and rating after listening to the music. At the end of the study, subjects will check and consent for data uploading.

The research protocol was reviewed and approved by the Department of Psychology Ethics Committee, Tsinghua University (THU202118). Seven subjects were recruited from a public university (3 females, 4 males, 18-26 years old with average age of M = 21.14, SD = 2.91). All subjects used smartphones with Android systems in daily life. All subjects completed the one-week experiment and gave feedback about **LifeRec** with a questionnaire in the end.

5.2 Evaluation: User Feedback

We design a questionnaire with an online platform[2] to ask users their experience of using **LifeRec** (The original questionnaire is in Supplementary Material). The main findings are as follows.

Firstly, all subjects think that the *installation and configuration of the App are simple* and the *graphical interface is intuitive*. As for the *interface switching smoothness*, 85.71% of users agree the GUI is smooth, while one user complains that interface switch is somewhat stiff. It may be because that we design some popups to guide the recording process, which is not preferred for some users. For the recommendation task, 85.71% of subjects believe **LifeRec** is capable for *making instant music recommendations*, and one of them strongly agrees with it. In addition, almost all users (85.71%) conclude that our App maintains *highly convenient when operating for psychological recording and photographing*. As for the privacy issue, all subjects accept *musical recommendation apps' extensive collection of their daily lives information*. And most users (71.43%) think that **LifeRec** *performs sufficiently and comprehensively in protecting personal privacy*.

Therefore, we conclude that in general, **LifeRec** is convenient for recording lifelog, and the interface is easy-to-use. However, we recognize that the interface switching is not always fluent, and the privacy protocol needs improvement. Moreover, the connection between **LifeRec** and wearable devices (e.g., smartwatches or bracelets) is unavailable, which makes data transmission inconvenient.

5.3 Evaluation: Task Completeness

During the field study, we required subjects to record 5 valid activities and listen to 6 pieces of music by **LifeRec** per day at least. *Valid activities* are judged by whether both mood and activity contents are filled in. *Valid Music* is determined if listening time is between 1/3 and 3 times of the duration of the given music.

We consider the record types of daily activity tracking (2(c)), music listening (2(d)), diet recording, and GPS collecting (location). And the number of average records through seven days for each user (user1-7) is in Table 1. It shows that, on average, all subjects report satisfactory number of valid activities (8.33±1.92), and most subjects (71.43%) record desirable number of valid music listening. It illustrates that users can follow the main tasks with **LifeRec**. However, subjects' compliance on *Diet* and *Location* is not good enough. Only two subjects record more than 2 meals per day while the number should be at least 3. This is because some subjects have no habit of breakfast. In addition, our requirement for *Location* recorded in background management is 60 times per day (once per 15 minutes), but the real value is 54.57(±26.54) which appears great fluctuation. The GPS signal is not stable indoors, so other location resources should also be considered in the future.

In conclusion, great task completeness is shown with **LifeRec** on some of the tasks, and users show good compliance for two main tasks, mood recording and music recommendation. However, the completeness for diet recording is low, which may be because that sometimes notification module fails to remind users on time. We will optimize the notification module in the future.

6 CONCLUSIONS AND FUTURE WORK

In this work, we introduce **LifeRec**, a mobile App to collect multi-modal lifelog data and perform ubiquitous real-time recommendations. We discuss the objectives for the tool and show how **LifeRec** is designed to achieve the goals. The interface and system implementation is also displayed. In general, **LifeRec** helps users record mood, activity, and diet. Environment context and smartphone usage are also collected in the background. All the data recording and

[2]https://www.wjx.cn/

Records	user1	user2	user3	user4	user5	user6	user7
Activity	6.14	6.57	9.00	9.71	6.86	9.29	11.29
Valid Activity	6.00	6.57	8.86	9.71	6.86	9.00	11.29
Music	4.29	6.29	3.29	6.29	6.43	6.43	6.57
Valid Music	3.57	6.14	3.14	6.29	6.14	6.29	6.14
Diet	1.29	1.57	2.00	2.00	2.29	1.14	3.00
Location	82.57	43.43	32.14	33.00	41.43	48.57	100.86

Table 1. Number of average task records per day for 7 users.

transmission are performed with privacy concerns. Meanwhile, ubiquitous recommendation is performed by sending current context information and receiving items from the remote server. Furthermore, we conducted a field study of music recommendation, and the user feedback and recording results show great usability and task completeness with **LifeRec**.

To the best of our knowledge, **LifeRec** is the first public App for lifelog and ubiquitous recommendation research. It offers a convenient tool for activity collection, health monitoring, and context-aware recommendation in user studies. In the future, we will incorporate more kinds of context information into our App. We also plan to simplify the recording process and make the App run more smoothly. Furthermore, the critical directions for developing tools for lifelog researches should include the plug-and-play port to connect with multi-modal portable sensors for data collection. Local personalized optimization for data processing and recommendation is also a possible direction to improve recommendation performance, as well as protect user privacy.

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