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Design and field trial of EmotionFrame: exploring self-journaling experiences in homes for archiving personal feelings about daily events

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ABSTRACT

Capturing people's spontaneous thoughts or daily emotions in their everyday living space can be difficult and can pose a psychological burden from a clinical standpoint. To address this issue, we have developed EmotionFrame, which allows users to archive their daily experiences by recording videos of their current thoughts and emotions at home. EmotionFrame serves as a journaling device, and the parameters for journaling have been determined based on a depression assessment model. This study explores the benefits of users' recording feelings about their daily events, which can also help with assessing depressive mood with the journaling data. Our three-week in-field study with eight participants showed that EmotionFrame could be integrated into participants' daily routines based on their previous diary-writing habits. In addition, its harmonious frame shape fits in with the everyday environment. Being able to engage in spontaneous journaling in private spaces – and in a way that allowed them to see themselves – prompted the study participants to effectively record their sincere thoughts and emotions during the archiving process.

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1. Introduction

Digital self-journaling allows users to collect vast amounts of information about themselves by self-recording their daily experiences, activities, health, and emotions. Accumulating self-relevant information helps the users to gain knowledge about themselves (Rapp & Cena, 2016). In addition, self-understanding from personal informatics could be used for clinical purposes (Chung et al., 2016; Elliott et al., 1996; Kelley et al., 2017; Yamashita et al., 2017), as it could inform the users of clinically relevant information and trigger behavioral change. Moreover, manual self-recording, as opposed to automatic recording, can allow one to organize information from a personal point of view and to think about one's internal state (Ayobi et al., 2020; Y.-H. Kim et al., 2017). In other words, it is suggested that the user can recognize the records collected through the manual record as their own, so they can easily identify with the records and attach meaning (Sengers & Gaver, 2006) to them.

Self-journaling can affect how users look back on themselves depending on how they recorded their events. In the HCI research stream, self-journaling research using handwriting and voice

recording has actively been conducted. Lindström's research team designed the Affective Diary (Elsden et al., 2016; Lindström et al., 2006), which automatically collects the user's bodily memorabilia and media on mobile devices, then provides the collected information when the user writes a diary with a digitized pen. The researchers found that users could interpret, understand, and record their motions and media through the Affective Diary. Mols's research team (Mols et al., 2020) utilized tangible interfaces for reflection through user-created media (e.g., text, audio) through the pyramid-shaped Cogito to annotate text (via handwriting) and the scale-shaped Balance to capture voice notes. Moreover, Sawhney et al. (2018) mentioned that audio journaling is an unobstructed and suitable method for capturing spontaneous and introspective experiences with a focus on emotional resonance.

Presenting a life narrative can be beneficial for one's mental health by externalizing issues related to life events through writing or speaking, as reported by (Wallis et al., 2011). De Vecchi et al. (2016) conducted review research which confirmed that there is potential for mental health benefits that arise from understanding and emphasizing daily experiences. One such benefit of presenting a life narrative is *mindfulness*, which involves accepting emotions derived from personal experiences. This could potentially improve emotional well-being (Kabat-Zinn, 2003) by reducing concern toward uncontrollable stimuli, such as emotions and experiences (Wiech et al., 2006).

In addition, research on video journaling has been conducted. Regarding health-related behavioral change, one study (Melton et al., 2013) compared video journaling to other journaling methods (i.e., pen and pencil). They found that the video-journaling group was more satisfied with the action of journaling as well as journaling maintenance. In addition, Parikh et al. (2012) conducted a study in which they collected students' internship experiences through video journaling and found that this method led to an increase in the students' confidence and genuine reflection. Clarke (2009) also found that the video journaling allows for fast and honest expression of complex emotions encountered during fieldwork.

Furthermore, video journaling in the form of vlogging using video or social network platforms (e.g., YouTube, Instagram) has also been used recently. Griffith and Papacharissi (2010) remarked that daily records through vlogging can be used as a means of self-expression. Similarly, Brott and Willis (2021) confirmed that vlogging is a way of providing meaning to one's experiences and allowing self-reflection.

The above-mentioned studies suggest that various means can be used for self-journaling, and a user may feel different emotions and experiences depending on his or her recording method. In addition, attempts to evaluate the user's state (e.g., mental state, depressive state) through the experience sampling method (ESM), especially based on the user's diary (one of the self-journaling methods), have been recently made. Berkel et al. (2017) confirmed that this approach is a reliable method for accurately recalling and recording the relatively close past by allowing users to archive their daily lives. In addition, it is reliable enough to be used for medical purposes (Csikszentmihalyi & Larson, 2014). In addition, Christoff et al. (2016) and Andrews-Hanna et al. (2013) suggested that user-generated spontaneous thought and the user's evaluation of those thoughts (e.g., valence, self-relevance, etc.) could be used to assess the user's depressive mood. Furthermore, accumulated recordings of self-journaling can provide information on spontaneous thought dynamics, which can also be used to assess one's mood state (Christoff et al., 2016).

To sum up, recording a diary about everyday experiences enables self-reflection and self-understanding. At the same time, data about self-generated spontaneous thoughts and their dynamics could be used to assess depressive mood. This suggests a possibility of evaluating depression through storing and retrieving users' recordings in their daily lives. However, it is not easy to maintain such records. Thus, new design interventions are needed to help the user to conduct self-journaling without lapsing, or stopping the process of recording about himself or herself. Epstein et al. (2015) discovered four factors (i.e., forgetting, upkeep, skipping, and suspending) that caused users to stop self-tracking. In addition, many researchers (Intille et al., 2016; Paruthi et al., 2018; van Berkel et al., 2022) mentioned that the length of time required to access a tracking app

after one decides to record could act as a barrier to recording. They utilized a tangible device to reduce the time required for daily recording.

To reduce these barriers and naturally prompt self-reflection among users by encouraging them to record daily events and feelings as part of their everyday routine, previous studies have suggested using appropriate ambient reminders (including physical presence (Mols et al., 2020; Paruthi et al., 2018) or ambient notification (Baharin et al., 2015; Gustafsson & Gyllenswärd, 2005; Müller et al., 2013; Papachristos et al., 2020) for triggering their journaling. In this regard, researchers (K. Lee & Hong, 2017; Sarzotti, 2018) have actively studied self-recording via the tangible form of a data – collection device. Especially, Mols et al. (2020) confirmed that the device’s physical presence could remain eye-catching and help the user better record their data or access the data contained in the interfaces. Similarly, Paruthi et al. (2018) revealed that a tangible self-report device could help users to keep recording through the physical presence itself. In addition, a proper intervention degree that can be applied in users’ environments is essential for deep integration into their daily lives. Regarding this, previous works have provided sounds (Baharin et al., 2015; Butz & Jung, 2005) and light (Gustafsson & Gyllenswärd, 2005; Müller et al.; Papachristos et al., 2020) for ambient awareness of TUI. In addition, aesthetic features should also be considered to integrate an interactive device into a daily routine (Park et al., 2019); and further studies (Mols et al., 2020)

This strand of previous research has opened a new design space for (1) designing a self-journaling device collecting users’ daily events and self-evaluations, which could also be used for assessing depressive mood, and (2) an appropriate system of intervention for prompting recording in an everyday living space.

However, before users’ depressive moods could be assessed through the daily self-journaling data collected from devices in everyday living spaces, the following issues need to be addressed: (1) appropriate device design and journaling parameters for promoting recording in everyday life; (2) examining in-situ experiences of collecting thoughts on life events through the self-journaling device, which can aid in the assessment of depressive mood in daily life; and (3) investigating whether the spontaneous thoughts and content variables contained in the collected records were suitable for applying Andrews-Hanna et al. (2013) method for the assessment of depression.

Accordingly, the scope of this study is to investigate the design and implementation of a self-journaling device based on a depression assessment model adopted from a previous study (Andrews-Hanna et al., 2013; B. Kim et al., 2022) and to examine how users accept and adopt their daily recordings through this device before we actually use the device to assess depression. In particular, we focused on the in-situ experience of using the EmotionFrame and its acceptability, rather than on reflection or interpretation of past records as a clinical diagnostic tool.

To this end, we pursued the following research questions:

RQ-1) How might a self-journaling device based on a depression assessment model be designed?

- (1) To answer this question, we employed research through a design approach (Zimmerman et al., 2007) and developed an interactive frame-shaped device, called EmotionFrame (Figure 1). It is a self-journaling device that allows users to archive their daily experiences at home through video recording and a simple questionnaire to assess emotional states adopted from Andrews-Hanna et al. (2013)

RQ 2) How can users accept and adopt their experience of capturing their everyday thoughts and emotions through the EmotionFrame device in their homes?



Figure 1. EmotionFrame installed in homes. The device is in idle mode and shows an animated background picture (airplane flying) (left). The cover of Emotion Frame can be physically moved to show mic-camera for self-journaling, and users record their emotional state (right)

More specifically, we aim to examine (a) how users feel about the content recorded by EmotionFrame (i.e., their daily events and self-evaluations), which they can use to assess depressive moods; and (b) how the video-journaling method through EmotionFrame influences users' daily recording behaviors.

- (2) To answer these questions, we conducted a three-week in-field study with eight participants who had a history of, or felt the need to receive, medical examination and consultation for depression.

This paper makes two contributions. First, it introduces EmotionFrame and its design process, which provides implications for integrating self-journaling through a frame-shaped device for archiving personal feelings about events within people's daily lives. Second, it describes the results of an in-field study on EmotionFrame, providing insights into how the device can be accepted among users and can offer the potential for everyday self-journaling at home.

2. EmotionFrame design, rationale, and implementation

2.1. EmotionFrame design

We began our research by designing and implementing EmotionFrame, a frame-shaped self-journaling device that allows users to record their everyday moods at home through video recording and answering simple questions. EmotionFrame is shaped like a frame and displays an animated picture, and its cover can be moved to reveal interfaces (e.g., camera, microphones, and speaker) for recording within a set time period.

The main features of EmotionFrame are as follows:

2.1.1. Frame-shaped self-journaling device for home context

First, EmotionFrame's design aims to devise an artifact that is physically visible (e.g., hanging on the wall) to users and can be seamlessly integrated into their living space. In addition, rather than a multi-functional device such as a mobile smart TV, we want to design a device only for self-journaling because we want the user to focus on their self-journaling without being distracted by other functions.

We considered that an easily noticeable physical device for users' self-journaling could prompt natural self-reporting by means of the intuitive use of the interface, including someone unfamiliar with digital devices (Fuentes et al., 2017). At this point, in the recent HCI field, various types of digitally augmented everyday objects (e.g., chronoscope (A. Y. S. Chen et al., 2019), desktop calendar

(Jang et al., 2019), bookshelf with books (K.-R. Lee et al., 2021) have been proposed to provide easy access to the desired information only (e.g., personal photos, schedules, audiobooks).

Among several other options, we considered properties (e.g., method of interaction, purpose) of everyday objects used in the home (e.g., mirror, frame), and we decided to apply a wall-hanging frame form to the EmotionFrame.

Moreover, Luria et al. (2017) revealed that the task conducted by a wall-hanging touch display was suitable for collecting data without cognitive load.

More specifically, it also has two roles (i.e., leading a person to the front of a frame, and focusing on the content in the frame). We found that these roles have common points with the EmotionFrame concept in terms of inducing users to focus on self-journaling (i.e., content in the frame) and providing feedback to prompt their continuous self-journaling. In addition, the shape of the frame might also have an advantage because it does not look like a device that collects data for assessing depressive mood. Specifically, these data still have a social stigma, and a device for assessing depressive mood could be seen as an aid for emotional disease, which could yield negative emotions.

2.1.2. *Hiding and appearing camera and mic for self-journaling in home environment*

When implementing a video-recording device within residential spaces, it is crucial to take into account the privacy concerns of users (Hernandez et al., 2012; Heshmat et al., 2017). Thus, we intended to hide and reveal the interface, showing the camera only when necessary. (Figure 2). Once a user attempts to start recording, the cover physically and automatically moves to the left about 6 cm, then it reveals hidden camera, microphone and speaker. Through this, we expected that our hiding and appearing approach could also reduce privacy concerns, which come from an unauthorized recording of people's lives through embedded camera and mic. Besides, Hallnäs and Redström (2001) mentioned, hiding electronic parts could allow the device to be naturally and deeply integrated into users' living environment. Accordingly, we wanted to make EmotionFrame in idle mode (frame cover is closed) to look like a normal digital photo frame.

2.1.3. *Drawing attention to EmotionFrame through reminders*

Papachristos et al. (2020) examined the modality of physical objects' notification, alerting users so as to reduce user disruption and stress in the home environment. It has been shown that the proper degree of system intervention is important to consider (e.g., notification) within the home environment for prompting self-journaling in less stressful and disturbing ways. Thus, we considered using gentler methods of notification to draw users' attention by providing self-journaling reminders in less disruptive ways. We explored the various reminding methods, and Figure 3 (left) includes some of our previous concepts in the early design stage. It included the shelf-frame form, which provides reminders through the candle's scent on the shelf, interacting with virtual pets to remind by means of emotional attachment, and subtle changes through an animated element in pictures (Figure 4).



Figure 2. Hiding and revealing of embedded camera and mic in EmotionFrame

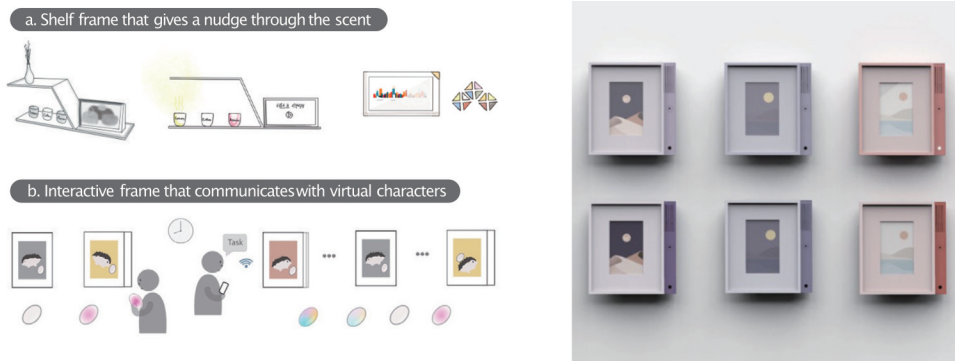


Figure 3. (left) Initial ideations, and (right) color renderings of EmotionFrame

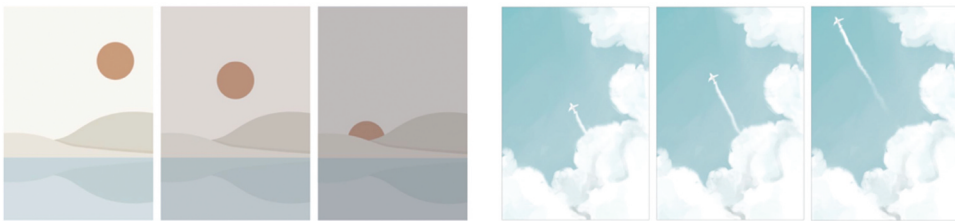


Figure 4. Subtle changes through an animated element in pictures: (left) The sun sets, and (right) airplane flying

From these alternatives, we selected animated picture changes and created scenes for their seamless movements. We also investigated what other options might be suitable to provide reminders through a frame-form and decided to utilize the physical shape change (used for showing mic-camera) which has the potential to give a low-stress index (Papachristos et al., 2020) and naturally trigger users to interact with the device (Mols et al., 2020). Lastly, we added ambient light on the back of the device and sound playing the movement of an element in the picture going through several variations considering harmony with the device and whether these can be reminders for the home environment. In sum, we programmed those reminders to be provided based on users' settings (e.g., number of daily record goals, and start and end times to receive reminders).

2.2. Self-journaling parameter, sequence, and reminders

2.2.1. Determining self-journaling parameter for daily integrated archiving

The point that we focused on the most during the design process was the exploration of data parameters for self-journaling through a device to archive data in a home environment. Specifically, we focused on which types of parameters would be appropriate for collecting users' thoughts and feelings about their daily lives, along with data that can be used for assessing depressive mood. The data to be collected from EmotionFrame were as follows:

2.2.1.1. Video diary. (Figure 5d): The video diary includes multidimensional data constituting the daily events of the user. It is used for self-reporting on events, thoughts, daily emotions, facial expressions, and tones of voice. These types of data reflect daily episodic memories, which can assist with self-reflection and self-understanding when recording or reviewing records. In addition, spontaneous user-generated thoughts in a video diary could be used for assessing the user's depressive mood through the experience sampling technique (Christoff et al., 2016). In particular,

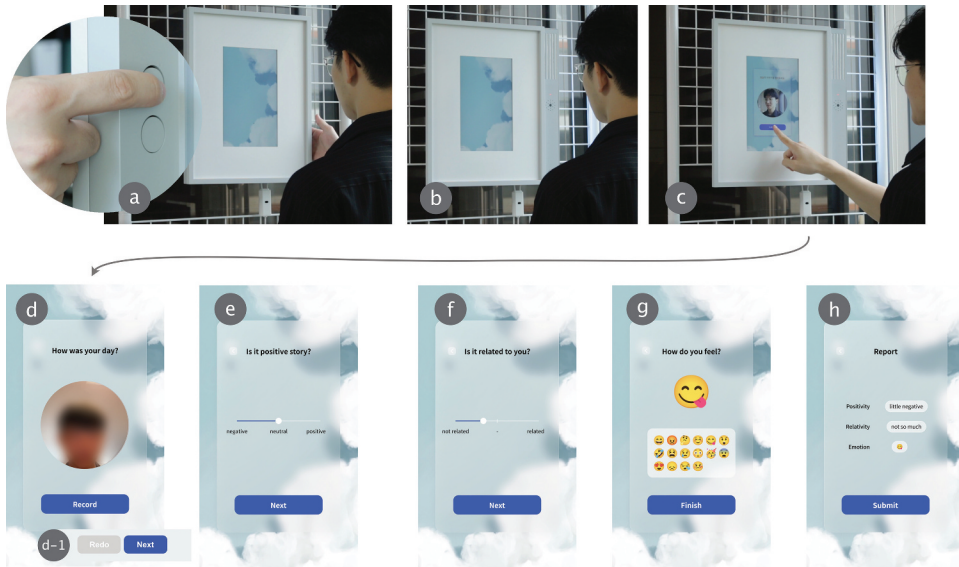


Figure 5. The interaction process with EmotionFrame for journaling, and journaling content

these symptoms could be assessed through the inflexible, self-focused, and negative contents of the diary that the user has recorded.

2.2.1.2. Self-evaluation of daily event. In addition to the video diary, we provided an additional journaling parameter that allows users to think about their experiences once more. With this approach, a user selects the degree of positivity of an experience in a video diary on a five-point scale [Valence, (Figure 5e)]. However, the diary may contain records that are relatively minor or that are not directly related to the user (e.g., social issues heard on the news). We thus added a tracking parameter to record the self-relevance degree of the user's thought and event on a five-point scale [self-relevance (Figure 5f)]. Finally, by selecting an emoji (Figure 5g), the user can think again about his or her feelings regarding the event. By providing the above additional tracking parameter to the video diary, we allowed users to reevaluate their feelings about daily events. Such tracking parameters (valence and self-relevance) are the most important content variables for assessing depressive mood through spontaneous thought among 14 content variables as Andrews-Hanna et al. (2013) proposed. Torre and Lieberman (2018) found in their research that reappraisal and affect labeling help people think about and regulate their emotions by directing their attention away from stimuli. In this context, we expect that our self-journaling parameters will assist users in reviewing and reappraising their daily events through affect labeling (through emoji) and reappraisal (through valence and self-relevance). Specifically, the data could serve as multi-dimensional information representing users' days that includes episodic memories, facial expressions, voice tones, emojis, and the degrees of positiveness or negativeness and self-relevance of their feelings.

2.2.2. Self-journaling sequence and reminder of EmotionFrame

Once the user presses the button (Figure 5a) on the back of the EmotionFrame, the frame's cover moves to the left, the sensor (e.g., camera, microphone, speaker) appears (Figure 5b), and a journaling UI on display pops up (Figure 5c).

First, users record the event they experienced through the video recording (Figure 5d), and if they want, they can redo the recording after completing it (Figures 5d-1). In the following pages, users

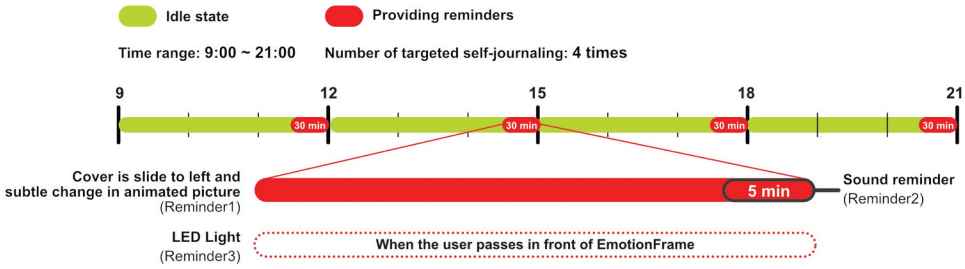


Figure 6. Showing EmotionFrame's reminders based on users' settings on its display before use

select the degree of positiveness and self-relevance through the five-scale slider (Figure 5e and, 5f). Then, they select the proper emoji that best implies the emotions of what they just said (Figure 5g). Finally, they can review through the summary page and submit (Figure 5h).

Before starting self-journaling through EmotionFrame, users initially set the time range to 1 day and determine how many times they want to record their emotional states through the device. For instance, if the user's set time is 9:00 to 21:00 in a day, with a goal of four self-journaling reminders (Figure 6).

After the user's setting, EmotionFrame provides the reminders as follows:

2.2.2.1. Idle state. (Figure 7a). EmotionFrame shows a cloud image without the airplane's movement in the picture.

- **Reminder 1:** 30 minutes before the first period of self-journaling ends, the cover of EmotionFrame physically slides to the left. Then, the clouds and planes on the display begin to move (Figure 7b).
- **Reminder 2:** After 25 minutes, reminder 1 starts, and a plane sound (semantically similar to the animated flying plane) begins to play with gradually increasing volume (Figure 7c).
- **Reminder 3:** If the user passes in front of the EmotionFrame, the LED lights up on the right side of the device. (Figure 7d).

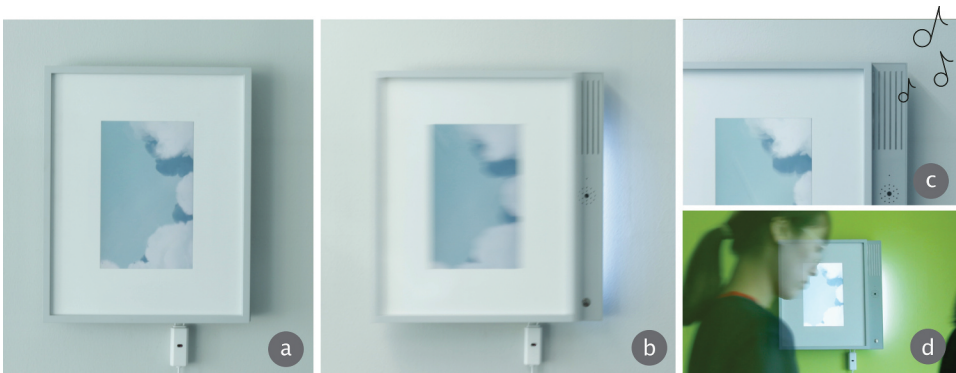


Figure 7. Reminder methods of EmotionFrame. a) Idle state; b) Reminder 1: cover moves to left and paused video starts playing; c) Reminder 2: plays a sound of flying plane; d) Reminder 3: once EmotionFrame detects users' movement the LED lights up

Reminders 1 and 2 are maintained until the user records/skips his journaling. Also, EmotionFrame automatically switches to an idle state if there is no user manipulation for 30 minutes because there might be a situation when the user cannot record (e.g., in another room, in a meeting).

2.2.3. Implementation

2.2.3.1. Software. EmotionFrame is implemented as an Electron-based desktop web app. When the Raspberry Pi boots up, the video containing the animation of clouds and an airplane appears to pause (does not move), and the self-journaling page is loaded invisibly. Once users push the start button, the self-journaling page becomes visible by covering the animated image. As users perform the self-journaling, the input data are temporarily saved in JSON forms, except for the video recording, which is saved as a file (Blob type). Once users complete their journaling, EmotionFrame uploads a video-recording file to Google Firestore first and acquires the storage URL. Then, it adds this URL to the JSON file and uploads the JSON file to Google Firebase.

2.2.3.2. Hardware. EmotionFrame is mainly divided into two separate parts. It consists of a sliding front panel with a display (Figure 8a), as well as a back part (Figure 8b) with embedded mechanical components, sensors, buttons, LEDs, an actuator, and two main boards (Raspberry Pi, Arduino). For developing the sliding structure, two slidable parts were mounted on the top and bottom of the front plate, and two corresponding grooves were placed on the back part. As the slidable parts of the front panel were fixed to the groove of the back part, the front plate can move horizontally over the rear part. In addition, to minimize up – down shaking during sliding, we installed rack-and-pinion gears on the top and bottom of the rear part. We used a linear step actuator for the slide operation to reduce the noise required for the operation as much as possible. We used a 13-inch touch display with a resolution of $1920 \times 1080p$ so that the user would not encounter any inconvenience from the size and resolution of the display while performing the task. The camera (Figure 8c) was attached at a three-degree angle from the front of the frame toward the user so he can see his front view on the display when performing a task. To determine whether the user moved in front of the frame, we placed a ToF sensor directly below the frame. We designed a separate case for the ToF sensor to make it look like a power adapter (Figure 8d). The LED was implemented with a diffuser plate on the side of the frame (Figure 8e). To stably operate all electronic components, we supplied enough power: 12 V-5A (Figure 8f). Lastly, for our field trial, we built four EmotionFrame devices (Figure 8g).

3. User study

We conducted a three-week in-field study to explore the experience self-journaling through EmotionFrame in a living space. More specifically, we wanted to figure out the following points: 1) whether users accept EmotionFrame and how they experience the provided self-journaling method for collecting of data for assessing depressive mood (i.e., spontaneous thought, facial expression,

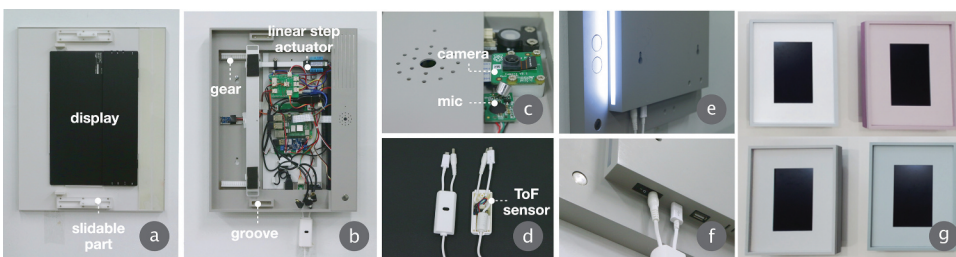


Figure 8. (a ~ f) Hardware structure and components of EmotionFrame, and (g) four devices built for the field trial

relativeness, positiveness, and emoticon about thought); and 2) whether EmotionFrame's physical presence and designed reminders are suitable for supporting continuous self-journaling in the home.

3.1. Participants

After our study's approval by IRB (Institutional Review Board), we recruited participants through an online survey, which included questions about their existing depression diagnostic/counseling experiences. Among the 36 candidates, we selected final participants using the following criteria:

- A person who has a history of or feels the necessity to receive depression – related diagnosis/counseling
- A person who wants to receive a diagnosis/consultation but gave up or was unable to finish for some reason
- A person who has been keeping a journal or is not burdened by writing about him/herself

We recruited participants using these criteria because we wanted those who have the internal motivation to record data for assessing depressive mood through journaling. We also wanted to document their unique experiences of EmotionFrame compared to their previous experiences (e.g.,

Table 1. Brief information about participants.

Code	Occupation	Gender	Age	Therapy experience	Journaling experience
P1	Self-employed person	F	33	Counseling and medication after diagnosis of depression	Write about what happened today and her state of mind.
P2	College student	F	20	-	Upload her daily life on private social media
P3	Delivery service staff	M	27	-	-
P4	Housewife	F	49	-	Write about her emotions through various means (e.g., picture diary, diary, health diary)
P5	Mechanic	M	39	Counseling at the city's family culture center	-
P6	Company researcher	M	46	-	-
P7	Ambulance crew	M	35	Counseling experience with PTSD for work	-
P8	College student	F	22	Counseling at the school center for a feeling of helplessness	Write thoughts about feelings and their causes

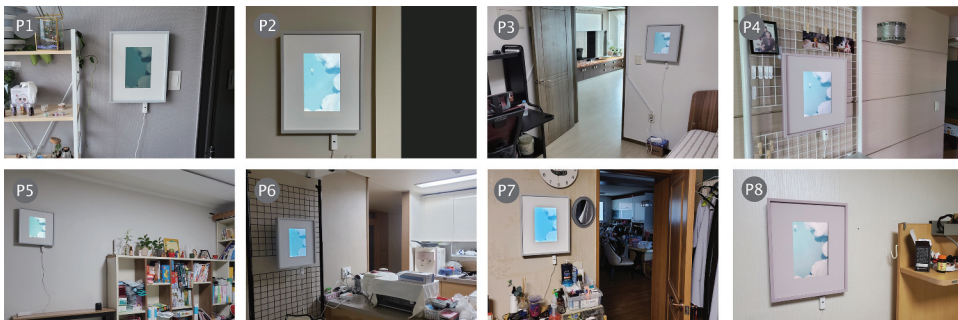


Figure 9. EmotionFrame installed in participants' homes

hospital visits, consultations, questionnaire responses). We selected the final eight participants (Table 1, aged 21–50; 4 males; 4 females; 4 with diagnosis/consultation experience [P1, P5, P7, P8])

3.2. Deployment, interview, data collection, and analysis

One day before starting the field study, we visited participants' residences and installed EmotionFrame on the wall where participants wanted to use the device in their homes (Figure 9).

By doing so, we want to explore how participants' perceptions of the installed place changed during the three weeks study. Figure 9 presents the place where participants install EmotionFrame. Five participants installed EmotionFrame in a private space (e.g., personal room, home), and three participants installed it in a shared, non-private space. The reasons for installing it in a non-private space were as follows: P4 (living room): She wanted to install the EmotionFrame in a space 1) where she spends most of her time, 2) where she usually stays alone even though it is shared space since, her husband spends most of his time upstairs. P5 (Living room): He usually sits on a worktable in the living room, so he installed an EmotionFrame in the living room, where he spends most of his time. P6 (Kitchen): He wanted his family to know about his situation by opening up to them about his thoughts and emotions, so he installed EmotionFrame in the kitchen.

For wall-mounted installation, drills, screws, and crew anchors (for concrete walls) were used to create a supporting structure for EmotionFrame. In a residence where screws were unavailable, we installed a partition close to the wall to create a structure where EmotionFrame can be hung (i.e., P4 and P6 of Figure 9). After installing EmotionFrame, we provided a tutorial to familiarize the user with video- and touch-based self-journaling and the notification method. The pre-interview was conducted about 20 minutes after installing EmotionFrame. During the pre-interview, we asked about their previous methods of emotional state recording, barriers experienced during the monitoring, and previous diary-writing habits.

During the study, a total of three semi-structured weekly interviews were conducted for each participant. Each interview took about 40 minutes. We commonly asked which content they record through EmotionFrame, when did they record and overall use experiences. We also compared their

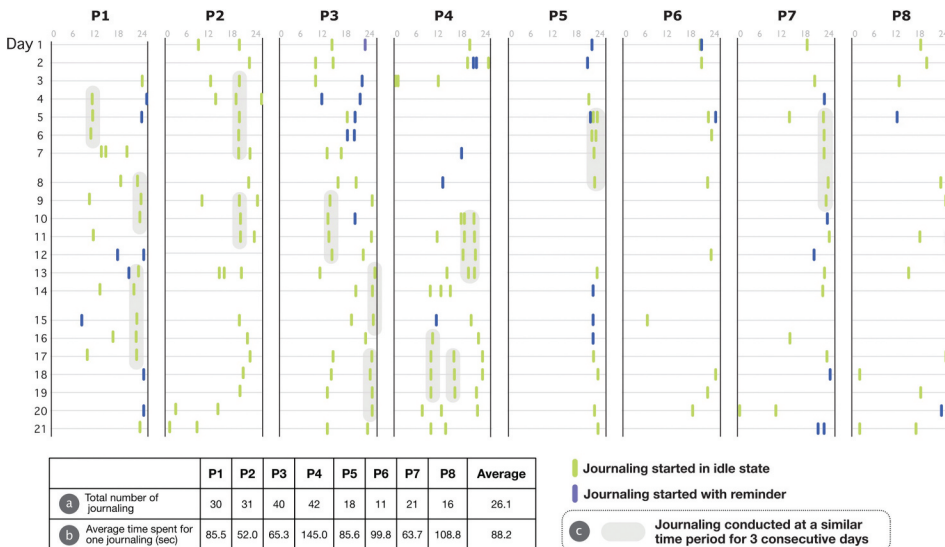


Figure 10. Usage log data of eight participants over three weeks. a) Shows the total number of journaling events per participant, b) the average time spent on one journaling was 88 seconds, and c) shows self-journaling was conducted at a similar time period for more than 3 consecutive days from 6 participants (P1, P2, P3, P4, P5, P7)

experiences of self-journaling through EmotionFrame with previous diary methods, and we added some questions specific to each participant based on their previous week's interview contents and usage log data (Figure 10). This log data included the timestamp regarding when the user starts a task, the EmotionFrame state when the user starts the task, and the elapsed time for finishing the task; which were saved to EmotionFrame and Google Firebase.

The interview recordings were transcribed, and we generated open codes right after each interview. Using these codes, four authors conducted the iterative affinity diagramming process using the codes. We grouped the participants' common statements and supplemented them with related statements from colleagues, which were related to 1) recording experiences through the frame device, 2) a mental health data – collection method for a home environment, and 3) use experiences on the reminder feedback. After initial grouping, we recruited two additional researchers who were not involved in the field study and interview process. Thus, all six researchers carefully looked at whether any coinciding or conflicting statements existed among the participants and colleagues. Also, we selected the codes that were commonly agreed between the researchers. Through several iterative groupings by our research team, we derived four themes: 1) how EmotionFrame's appearance affected participants' self-journaling; 2) how or whether they build their routines to self-report their emotional state; 3) effects of the space and environment in conducting self-journaling; and 4) detailed experiences with regard to recording and reminder methods. Based on the themes, we checked the usage log data as to whether there are any patterns (e.g., participants' journaling routines through EmotionFrame) related to the analysis.

4. Findings

During the first week of the field trial period, some participants remarked that they found it somewhat awkward to verbally record their daily lives on a device shaped like a frame. In the first-week interview, P2 mentioned, *"In my space, I mostly sit and do not get up very well, but it is a bit unnatural that I have to get up to record."* On the other hand, mostly from the second-week interviews, we learned that they tended to adapt to the self-journaling method of EmotionFrame. Regarding this, P7 mentioned, *"I think I'm more used to it than the first time, so I can speak well and feel more natural. At first, I was embarrassed to do it while looking at my face in the video, but as I got used to it, I felt more comfortable, and I think the tendency to finish it quickly was decreased."* P6 mentioned, *"At first, I thought it was related to mental health, but when I actually record it, I think I'm going to reconsider myself. It also brings back memories."*

In addition, all the participants commonly answered that the shape of the frame did not look like a medical device, and they easily accept it in their personal space. The actual purpose of the device (emotional health data recording) and the felt purpose (a diary to record a day) of the user were perceived differently by participants. P3 remarked, *"Devices that look like medical devices are psychologically repulsive. But I think this device is positive because when I hang a picture in my house, I often hang it because I am pursuing aesthetics. For example, I put the sunflower painting because it has a psychological meaning that the feeling of being a sunflower brings good luck, and I think it (EmotionFrame) can do the same thing as a frame."*

In addition, during the field study period, all participants' perceptions of the location where the EmotionFrame was installed did not significantly change, except for P5. Furthermore, through the opinions of P4, P5, and P6, who installed EmotionFrame in non-private spaces shared with family, we could confirm their perceptions of self-journaling in those spaces.

P4, who installed the device in the living room, mentioned that it was convenient because her husband is usually not at home, but she mentioned that she does not record when her husband is in the living room. Regarding this, she noted that *"If family members were always in the living room, I think I would change the location of the EmotionFrame. Even if they were my family, I don't think I could sincerely record my story. Maybe I would install it in my room."* In the case of P5, who also

installed it in the living room mentioned that he wanted to move the location of the EmotionFrame. In the interview during the second week, he said, *“There are things I can’t tell even to my family, and recording my story in front of them is inconvenient because they might feel sad hearing my story. If it were a private space, it would be comfortable, and if I could change the place later, I think I would move it to my room or study.”* However, P6 had a different perspective from P4 and P5. He mentioned that he has no qualms about keeping records even though he has a family.

Furthermore, they all remarked that their eyes were drawn to the frame in their routine through the existence of EmotionFrame and its reminder feedback. P1 commented, *“The reminders of the frame is a motivated me to record my daily event and it makes me feel better ... (omit). It makes me think that I should do it with an open mind.”* Also, P7 mentioned, *“I think the notifications themselves lead well. When the frame opens, and the plane seems to move, I feel like I should do it when I recognize it. I think it’s because I didn’t stay in that space for a long time, but when I pass by, I think I’ll definitely have to do something that lights up and makes a sound later.”*

4.1. Building self-journaling routines based on previous diary-writing habits and internal motivations

We can confirm that the physical presence of the EmotionFrame and its reminders through audiovisual notifications helped the participants to conduct self-journaling within their set time. At the same time, some participants wanted to record their emotional state when they usually do self-journaling (e.g., writing their diary).

4.1.1. Recording at their own regular time

Specifically, five participants (P2, P4, P5, P6, and P8) had their pre-existing habits of self-recording. These participants had a sense of their own personal needs with regard to recording. Regarding this, P8 stated, *“I thought I had to follow my routine, which I record before going to bed.”* P5 stated, *“I mainly record at my regular time, so even if feedback sounds, it doesn’t stop me from continuing to do what I’m doing.”* Also, this pattern was revealed in his log data (P5 of [Figure 10](#)). In addition, as the usage log data shows, P2 conducted her self-journaling during the regular time for her diary writing. For her, reminders did not affect recording as she only did her recording when EmotionFrame was in an idle state. In the same vein, we can confirm that six participants (P1, P2, P3, P4, P5, P7) made a journaling routine and recorded it at a similar time for more than three consecutive days ([Figure 10c](#)). At this time, we could see that all journaling activities were triggered through participants’ own will rather than by reminders.

4.1.2. Talking about what they usually wrote in their journal

We could also see that participants’ self-journaling contents through EmotionFrame were influenced by what they usually recorded (e.g., dreams, health, diary, work-related records). Some participants had an internal motivation that came from the pleasure of knowing themselves well, such as asking questions about themselves before going to bed (P8), recording ideas to use at their jobs (P7), and checking their health status (P4). They showed a tendency to maintain their existing recording habits despite reminder feedback and questions (e.g., “How was your day?”) from EmotionFrame. P8 had previously recorded dreams when receiving emotion-related counseling in the hospital. Based on this experience, he recorded his dream and today’s to-do list in the morning and a diary in the evening. Regarding this, he stated, *“I spoke (in EmotionFrame) about a dream I had. Also, I recorded something like what to do next.”* P4, who was recording health-related records, mentioned that it would be good if other information (e.g., blood pressure) was also recorded and expressed.

Collectively, we determined that even if the participants received the reminder from EmotionFrame, their acceptance could differ depending on their existing recording habits, recording

contents, and intrinsic motivation to do the self-journaling in their daily routines. This finding suggests that, as mentioned in a previous study, it is necessary to customize the notification method and recording contents according to the participants' preferences. Specifically, giving a reminder to those who already have a routine for recording can act as an unnecessary system intervention in the habit of following their original plan. On the other hand, the reminder method of EmotionFrame can act as a way to avoid the lapse that cannot be habituated because of being busy or forgetful (Epstein et al., 2015); for example, for those who feel the need to record but do not have a time to record.

4.2. Effects of space designation for self-journaling

As EmotionFrame was installed in the space that the participants frequently occupied, we found that it helps them naturally reflect and think about themselves in daily life by prompting them to perceive that the space is to record and think about themselves. Regarding this, P1 stated, "I use a smartphone and its apps a lot, but I don't record through them, even to this day. Now, I'm recording because I have that frame. It motivates me." Similarly, P4 mentioned, "Records and thinks, and it was fun. So, yes, standing over there (in front of EmotionFrame) and talking made me think about what happened. It seems to work like a thinking chair." The space where EmotionFrame was installed helps the user secure the space for recording. In this space the participants looked back on their day and talked about themselves, reflecting on themselves, expressing their daily event and daily emotion, and thinking about their future.

In our field trial, the four participants installed it in a space other than their personal space, and three of them were part of a couple who did not have a personal space; thus, they installed it in a space shared with the family, such as the living room and kitchen, and this caused them to speak in a quiet voice (to EmotionFrame). Regarding this, P7, who installed EmotionFrame in their personal room noted, "*I think it might be easier to do it at home because there is a sense of stability that home gives.*" More specifically, P4, who installed EmotionFrame in the living room, mentioned that it is hard to record when her husband was there. Regarding this she remarked that "*In the evening, when my husband comes home from work, it is difficult to say (record through EmotionFrame) if my husband is there. I have the most restrictions on the weekend (since he stays at home all day).*" Moreover, it made her finish journaling quickly, "*There were also moments when he teased me. So, when my husband was there, I just hung up (stop recording in EmotionFrame).*"

We found that even though the EmotionFrame can be installed at home, the fact that the participants' families can see or hear their recordings may act as an obstacle for sincere recording. This is in line with research by Hoppe et al. (2000), who conducted daily verbal recordings through telephone interviews (i.e., verbal recordings with the listeners). They found that socially undesirable (e.g., drinking, smoking) contents may not be recorded if there was a listener. These series of findings suggest that it is important to help users to secure spaces that others will not disturb, even if journaling devices are installed at home, as this is necessary to achieve sincere recordings.

4.3. Effects of seeing one's own face during self-journaling

Based on whether facial expressions were visible during the recording process, we were also able to confirm issues related to the sincerity and self-understanding of a recording. Seeing one's face during self-journaling helped users to know how they were feeling (e.g., happy, depressed) and whether they were speaking honestly. Participants were able to recognize facial expression changes when they were recording through EmotionFrame, and they mentioned that it helped them understand their current state and record sincere thoughts. Regarding this, P1 mentioned, "*It's okay now that my face comes out when I use it. I can read what I'm saying and my facial expressions better. It may be different from what people are saying and what I'm really saying, but somehow my facial expressions don't lie. Even if*

I said I feel fine, I don't think it's the same by looking at the expression on my face. I think I'll be able to recognize my sincere thought like this." Also, P8 stated, *"At first, it was a little awkward to see my expression, but I don't think I became very conscious after that. Rather, it seems to make me think (about my mood) while checking my expression when I am depressed or happy. It's reflected in the way I talk, my tone of voice, and my facial expression."* At the same time, it was found that, in certain cases, seeing their own faces while recording could act as a burdensome factor that prevented them from journaling. For example, P2 and P4 noted that seeing their faces was embarrassing, and they tended to end their speaking quickly. P2 mentioned, *"There seems to be a tendency to want to finish speaking faster. I finish quickly, although I can speak slowly. There was a time when I was alone with the camera covered and I felt more comfortable."* On the other hand, he also found that monitoring facial expressions could help him to understand the situation when he later looked back at the records. Regarding this P5 mentioned that *"Even when I watch my recording later, I think I'll be able to understand the situation better at that time with the recorded content since it is short and contains facial expressions and voice tones based on my emotions."*

However, he noted that looking at his negative face did not help when P5 recorded a very negative event. He said *"(When recording a negative event) I hate seeing my face because I can see that my expression is not good. At times like this, I want to see something other than (my face). If I record while watching positive things, I think I will be able to talk more comfortably."*

P5's comments share something in common with previous studies (Qu et al., 2019; Wittenborn et al., 2016), which confirmed that negative thoughts could cause a negative bias. In addition, his comment implies that recognizing negative facial expressions also causes negative bias. Therefore, to reduce the negativity bias experienced by P5, future discussions should focus on dynamically providing journaling content according to the situation (the user's current mood, experienced events, etc.).

Collectively, based on these diverse opinions, we found that the experience of self-journaling by looking at one's own face reflected on a display in a personal space can be perceived differently by each person. As mentioned in a previous study (I. Li et al., 2011), seeing one's own face lowers access to emotions and is associated with emotional reflection and coordination. The participants were burdened by the need to see their own faces, which can be embarrassing, but at the same time, they offered positive opinions about their self-understanding increases that arose from being able to see facial expressions. This provides an opportunity to design a better self-reporting method through video-journaling by recognizing and visualizing only facial expressions in real time through alternative mediums (e.g., animal characters imitating the user's facial expressions).

4.4. Capturing daily raw thoughts through verbal recording in the home context

Based on the interview analysis, we can see that recording through EmotionFrame was a retrospective self-think-aloud process that involved recalling events that the users had experienced. Through the field study, we grasped the characteristics of verbal recordings recorded through EmotionFrame in the following personal space.

4.4.1. Fast recording for casual self-journaling in everyday life

During the field study, for an average of about one minute [88.2 seconds (Figure 10b)], participants conducted one cycle of self-journaling (Figure 5(a-h)) through EmotionFrame. As Palen and Salzman (2002) noted, we confirmed that the verbal recording method allowed users to quickly record their feelings about their daily events and moods. In this regard, all of the participants noted that it was suitable for recording for a while because it did not interfere with their daily lives and did not become burdensome. Regarding this, P4 mentioned that *"the time I felt was a little short, and it was nice to be able to finish my recording quickly and concisely. If it is too long, it will be boring."* Similarly, P6 noted that *"(recording) was not burdensome. It took about a minute, so I did not think it would take that long. One minute is usually acceptable for recording in the home."* The reason they

mentioned that the EmotionFrame's method was suitable for recording in daily life was because of the short recording time. This was possible because EmotionFrame used the verbal method versus other methods (e.g., writing with a pen or typing as a means of recording) In addition, P8 mentioned that *"the diary tends to be longer and makes me think more. On the other hand, with EmotionFrame, I can directly record my thoughts quickly and straightforwardly."* This finding implies that a quick recording time can lower the entry barrier, thus allowing people to easily record easily in their daily living spaces. In addition, as a series of previous studies mentioned (Clark et al., 2018; Hoppe et al., 2000; Sawhney et al., 2018), we found that recording through voice is time efficient and makes it possible to record momentary thoughts.

4.4.2. Allowing for the recording of unrefined spontaneous thoughts

Due to EmotionFrame's characteristics of recording quickly by allowing the user to talk to himself or herself, we can confirm that this feature made users think less about the content when recording their daily experiences. They did not think too much about the composition of sentences and instead recorded the thoughts that came to their minds. Regarding this, P6 mentioned, *"In terms of organization, writing or typing seems to be more systematic and organized; speaking in words is not organized, so it can be a daunting story if I am not proficient, but it is more convenient. Typing or writing would be cumbersome, so speaking in words would be much more convenient."* In addition, we confirmed that most participants tended not to conduct re-recordings. P2 stressed that *"even though EmotionFrame has a re-recording function, I would have not used it. Even if I said something wrong and wanted to correct it, I could correct it with words directly with the following sentence without re-recording it."* EmotionFrame's self-journaling method supported participants in archiving the unstructured and unorganized spontaneous thoughts that their daily events triggered. In connection with this, Hoppe et al. (2000) clarified any ambiguity in the participants' verbal contents by asking the users about the ambiguous points in their recordings. In this respect, EmotionFrame may contain audio recordings that are not clear; however, it is suitable for capturing unrefined thoughts, as the user directly expresses the thoughts generated in his or her head without organizing them.

Regarding this, P3 noted that *"I find it easier to record through a verbal recording. With it, I can freely express what I want to express in a raw state. When I write, I have to go through the process of rearranging and refining what I think, but in a verbal recording, I could record without any process of refining it."* P6 also expressed a common point, mentioning, *"In terms of structure, I think writing and typing will be organized more systematically. And with verbal recording, the unstructured, raw story will be recorded in a short time."* These quotes are in line with Palen and Salzman (2002), who stressed that the method of verbal recording could be used to document activities or experiences as a stream of consciousness. The findings from the EmotionFrame study imply that recording daily events through the think-aloud method in a living space enables users to produce quick records. In addition, it is suitable to capture the flow of raw thoughts by immediately speaking what comes to mind at the moment, which may generate affective information from users for experience sampling.

5. Discussion and implications

Based on the findings, we propose the following discussion points and design implications for designing an in-home self-journaling device in three aspects: 1) how to utilize collected data, 2) how to reduce the psychological burden and barrier of recording, and 3) how to sustain the recording process. In addition, we discuss issues related to designing interfaces for collecting users' feelings about daily events, as well as its possible uses for assessing users' depressive mood.

5.1. From self-journaling experience to everyday assessment and re-encountering personal mental health status

5.1.1. Assessing depressive mood through video journaling

The records from EmotionFrame contained not only the users' daily thoughts but also the audio and visual information contained in the video. The collected data could be used to assess users' mood states, such as depression, in various assessing models. Moreover, M. Li et al. (2020) noted that utilizing various aspects of data could improve the classification performance of depression. This implies that using different aspects of data (e.g., audio, and visual signals from video recordings) along with different data (e.g., valence, self-relevance, and spontaneous thoughts) for Andrews-Hanna et al. (2013)'s experience sampling method could improve depression classification performance. Especially, the vocalization (Cowen et al., 2019) and acoustic features (Mundt et al., 2007) of the user's voice, the user's facial expressions (Bartlett et al., 2008), and the user's eye movement (e.g., the distance between the eyelids, the duration of a blink (Alghowinem et al., 2012)) in the recorded video could be used as additional valid features for assessing depressive mood. In this study, our focus was solely on the epistemological aspect of EmotionFrame. Furthermore, presenting the tool for either clinical purposes or self-reflective aids or journaling supporting tools might cause tension. To complete the service blueprint of EmotionFrame, further considerations are necessary. Some important questions that need to be addressed include, "Where does the collected data go?" "Who might be a potential audience of this record,?" and "How does the user access EmotionFrame? Is it through a psychiatrist's recommendation or voluntarily purchased?" For instance, if EmotionFrame is recommended by a psychiatrist to patients, the records will be handed over to the AI model for deeper analysis. Moreover, some records may be accessible to the psychiatrist if they need the data for better understanding of the patients. Additionally, if the user uses EmotionFrame for self-journaling, an emotional state assessment feature can be added to the device. In this case, with the user's consent, the AI model evaluates the emotional state score through the accumulated records so far, and the results are delivered only to the user. At the same time, EmotionFrame can also be used as a service tool that suggests matching the user with a specific psychiatrist if necessary.

5.1.2. Re-encountering a past record and its metaphorical expressions

In terms of users, re-encountering their video records from EmotionFrame causes them listen to or watch records that are not organized. This could make it hard for users to understand what has been recorded, but it can also be embarrassing for them to see their faces and voices. In addition, in the case of negative memories, they may have negative effects when recalled (Wittenborn et al., 2016). According to Zhang and Norman (1994), even when the same data are present, users feelings about these data could differ depending on how they encountered them. They suggested that it is possible to reduce negative effects by considering ways of expressing and providing re-encounters with collected records for users. In other words, it is important to explore how to visualize and enable interaction with records to help users to accept their past situations and states, rather than simply delivering records.

For example, EmotionFrame's airplane animation in the sky, which is used for expressing the idle state, could help with visualizing information about a user's record using the features of the graphical animation's metaphorical expressions. In particular, a star in the sky can be mapped to a single record, and the number of stars can be increased as the daily user records are archived. At this time, the self-relevance and valence contained in the record can be expressed metaphorically with the size of the star and the sharpness of the star, respectively. Through this, users can seamlessly recognize how much they have recorded (through the visual variations of stars). Moreover, before seeing a specific record, the user could think about the record through the sizes and sharpness of the stars, which could consciously prepare them for looking back on their pasts.

5.1.3. Reappraisal of a past record through record extension

It is also possible to provide additional content that can be utilized in different ways based on a user's record, rather than simply looking back at the record. For example, the design intervention (e.g., EmotionFrame) could provide an additional feature that helps current users to reappraise their past selves (thoughts about the events they experienced; their recorded voices, facial expressions, and eye gazes; etc.) and their thoughts at that time (Troy et al., 2018). Specifically, by reappraising why they thought in certain ways, why they felt specific emotions, and why they made certain faces in the past, users might be able to regulate their emotions (Salomons et al., 2007; Torre & Lieberman, 2018) they communicated in their recordings, even if they feel ashamed to see them again. Considering this, rather than simply replaying past records, asking questions such as "Leave a video message to the past me who made this record; why do you think you felt negative emotions at this time?" would be expedient. Then, the user would be able to understand the emotions and thoughts of the past, which is helpful for emotional regulation and self-reflection.

5.2. Reducing the psychological burden of daily recording

The data that the user recorded through EmotionFrame can be used for assessing the user's depressive mood through the experience sampling method. At this time, the physiological burden and pressure of recording may change depending on how the user perceives the data that he or she records, which may affect the content of the user's records.

If users perceive their records as serving the clinical purpose of assessing depressive mood, this may evoke a psychological burden during the everyday use of the device. Regarding this, as K. Chen (2020) revealed, using medical devices can stimulate users' negative emotions and prompt people to feel pressure from other people's observations. Moreover, taking medicine or using a diagnostic device for treatment could remind patients of their mental illness, thus causing negative feedback (Wittenborn et al., 2016). In line with previous studies (Henderson et al., 2014; P. Y. Kim et al., 2011), we commonly heard from participants that they were reluctant to be diagnosed with mental health issues because this could negatively affect their careers and cause them to appear to be emotionally unstable.

On the other hand, if users perceive their recordings as daily journals, this could reduce the psychological burden of daily recordings. Then, they could express both negative and positive emotions, open their minds (achieve mindfulness), and think about their daily events in a reflective way. Collectively, although user records can be used for clinical purposes (e.g., assessing depressive mood), the psychological burden of recording can be reduced by allowing users to feel their own value in the recording process or accepting its purpose for daily journaling. More specifically, it is possible to consider the user-side purpose of the recording process to reduce the user's psychological pressure or burden and help the user to accept the purpose of the recording. EmotionFrame uses a daily diary, which is commonly used to document everyday life, for the ostensible purpose of reducing the psychological burden of recording data for clinical applications. Through this, EmotionFrame allows the user to view the device's tracking data as diary content reflecting on his or her day rather "recorded data for assessing depressive mood." This suggests the possible benefits of making the recording device look like a daily object (e.g., picture frame) rather than a medical device to reduce the user's psychological burden.

Moreover, we found that even with reducing the user's burden of recording with EmotionFrame, the user was reluctant to record when other people (even family members) were in the space. Thus, if a private space is not secured, the presence of other people may make the recording process feel burdensome, and as a result, honest records about personal or socially undesirable contents may not be possible. In this regard, designing a private self-journaling device in the user's home environment needs to be considered to secure a journaling space. In Odom et al.'s (2019) research, the researchers discovered that the users themselves found suitable locations for using the devices on their own in the home. These points imply the possibility of reducing the psychological burden and pressure of

self-journaling by 1) providing additional meaning (e.g., my personal diary) or an ostensible purpose (e.g., today's record) and 2) considering how a device helps with securing a private space for recording and accumulating spontaneous thoughts for self-reflection and assessing one's state.

5.3. Considering proper questions and internal motivations for journaling sustainability

As Li's research team revealed, recording one's data features some barriers, such as forgetfulness or lack of availability/time (I. Li et al., 2010, 2011). For these issues, we considered the following two points in designing journaling devices for sustaining and drawing frequent records.

5.3.1. Proper reminder method based on internal motivation

A reminder for recording one's own mental illness data is required to prevent the user from *lapsing*, the period during which people stop writing about themselves. It is also part of the informatics model that Epstein et al. (2015) proposed. The utilization of the ecological momentary intervention approach for experience sampling in mental illness has been emphasized by Myin-Germeys et al. (2018). This approach involves the use of mobile push alerts triggered by various events such as time-based prompts or behavior (Heron & Smyth, 2010), which enables recording at critical moments in daily life, thus providing potential benefits for patients with mental illness. Timely support and the accumulation of quantitative data on the experiences and behaviors of patients with mental illness are crucial for motivating them and informing clinical care. In this vein, our field study revealed that users' internal motivation also needs to be considered when one is designing journaling reminders. A previous study remarked that a person who has sufficient internal motivation can record information about him or herself without additional feedback simply due to the physical presence of a device (Mols et al., 2020). This is because these users feel the need to record and have already been in the habit of recording. In addition, we confirm that people with various motivations for recording – that is, participants who record frequently and those who do not record at all – accept the notification method differently. In other words, those who have high degrees of motivation for recording – those who usually record about themselves – are aware of the need to record and want to maintain a recording routine in their daily lives. In this case, even relatively weak reminders could lead to self-journaling. On the other hand, it may be difficult for people with relatively little internal motivation to record – that is, those who do not record about themselves – to generate recordings just by hanging a frame. For these users, an additional feedback method may be as effective as a self-journaling reminder.

Moreover, it is also important to consider the appropriate timing to provide reminders. EmotionFrame determines the timing of reminders based on daily goals. This means that the user decides when to record, and the EmotionFrame also provides a reminder when the user does not record. Although the device's reminder is necessary for the user's steady recording, it might cause annoyance when the user has no recordable content or when he or she cannot record, such as when they are not at home or when they have an appointment elsewhere. To compensate for this, the following information can be used when the device determines the time of the reminder. First, it is possible to consider the time when an appointment occurred by utilizing calendar APIs. In addition, information about the user's location or the state of the user's mobile connection or disconnection with the home network could be used to determine whether the user is at home.

5.3.2. Journaling questions

Moreover, it is important to consider emotionally proper journaling questions and the right times to ask questions to sustain users' self-journaling behavior in their daily lives. EmotionFrame's question was a single and emotionally neutral question (e.g., "How was your day"). Such static questions are likely to be biased toward specific emotions, which may cause the user to quit recording for the

Table 2. Example question for helping users in their daily journaling.

Question Type		Potential Question
a) Different Question based on time	Morning Daytime Evening	"How was your dream today?;" "What do you want to do today?" "How was your lunch?;" "What are you going to do now?" "Tell me what happened today in the evening."
b) Triggering memory by	Listened Music Taken Photo	Please tell the circumstances in which this photo was taken. "What comes to mind when you hear this music?"
c) avoiding emotional bias from question		Divide "Tell me what happened today" into 1) "Recalling about something pleasant that happened today on your head for 1 minutes and please tell me about visualized image on your head" 2) "Tell me about something unpleasant that happened today."

following reasons: (1) It is difficult to respond at a certain time (e.g., in the morning when no event has taken place yet), (2) the user might find it hard to decide what to record, and (3) the device contains a single neutral question.

Accordingly, it is important to provide a journaling question that changes over time, provides a trigger for recalling an event, and provides for both positive and negative recordings to avoid emotional bias.

5.3.3. Different questions based on time

Rajcic and McCormack (2020) confirmed that users' reflections could be different based on the times at which they thought about their internal emotional states. They also revealed that people mainly think about their daily goals or attitudes regarding how they will spend their days in the morning, then reflect on the events they experienced during the day in the evening. This implies that the need exists to encourage users' spontaneous thoughts by posing various questions based on the time of the journaling (Table 2, a)

5.3.4. Triggering memory

In addition, users might keep recording if something is provided to trigger their memories of their past events. At this time, it is possible to provide content that can trigger the user's memory, such as music (Odom et al., 2019) or the photos (A. Y. S. Chen et al., 2019) taken that day (Table 2, b).

5.4. Video self-journaling: challenges and possibilities

When people record themselves, there is a tendency to record a desired aspect of themselves rather than their real experience (Ganesan, 2020; Higgins, 1987) as they observe themselves through their own biases (Elsden et al., 2016). It is difficult to record one's own appearance without biases, and thus it is important to see oneself from the perspective of others (i.e., meta-cognition or observing self (Vazire & Carlson, 2011)). In this regard, our field study found that the video journaling method allows users to notice their emotional expression – for example, facial expression and voice tone – and provides a bird's-eye view to observe themselves more objectively, which helps them to make more honest recordings compared to the written journaling method. However, we have also found some challenges and considerations in designing a self-journaling device that collects users' daily events and provides a self-evaluation.

First, it may be embarrassing for users to record their daily events while looking at their faces, and it may take some time to get used to it. Parikh et al.'s (2012) research found that people can quickly adapt to a video-journaling method and gain confidence, but some individuals may find it challenging to talk to themselves face-to-face, which could impact the sustainability of the recording. To

address this issue, we can use avatars. However, in that case, it would be difficult to make an objective observation of their emotional expression compared to seeing their faces directly (Clark et al., 2018). Therefore, it will be necessary to develop methods to use avatars, while allowing users to perceive their own expressions. For example, it may be possible to create avatars that closely resemble the user's current style (e.g., hairstyle, appearance, and clothing) rather than using animals or virtual characters.

The second challenge in using the video-journaling method is that it may reinforce negativity bias, which can be associated with a chain of negative thoughts, as well as leading to a vicious cycle of recalling negative thoughts and events (Wittenborn et al., 2016). We have observed it through P5's comments that seeing a sad facial expression can bring more negative thoughts and memories of negative events. To prevent this, it is possible to provide dynamic journaling content. First, rather than keeping questions neutral, it is possible to ask both positive and negative questions separately (Table 2, c) based on the user's mood. More specifically, encouraging positive memory retrieval may be helpful in creating a balanced view and disengaging from rumination (Qu et al., 2019). In addition, Lyubomirsky et al. (2006) suggested that just replaying positive events helps to maintain positive feelings rather than recording or analyzing the events through writing or talking. Thus, when users record positive events through video-journaling, the device could provide users with time to recall past events, and then ask, "Please record what comes into your mind" (Korb, 2015).

6. Limitations and future work

In this research, we proposed EmotionFrame and conducted a field trial to explore how users record their feelings about daily events through video journaling, then conduct self-evaluations (e.g., using valence, self-relevance, and emoticons) of those events. We examined users' self-journaling experiences and the self-initiated benefits of EmotionFrame, but we did not design and train an analytic model for depression assessment using the collected data. It is possible that the user's perception and recording experience might become different if an actual depression assessment component were added to the EmotionFrame device. This may cause the device to be perceived as a clinical tool and thus may increase the psychological burden of self-journaling. Thus, the need exists for careful design considerations when one is delivering the assessment results to reduce the psychological burden of recording before, during, and after users have performed self-journaling through devices. Finally, if the collected data is intended for clinical use, the recorded information may have potential audiences, including mental health professionals and caregivers. Furthermore, the collected recordings could be utilized to evaluate an individual's mental state through the use of artificial intelligence models. It is necessary to consider data privacy issues, such as determining the level of access to data that will be available according to the types of people who might access the EmotionFrame device. Regarding this, we are planning to explore how to manage the collected data, including the scope of who can access archived data (e.g., others cannot access the data, as only the user can see them; the data could be used for an analysis model for user state assessments; or some selected video records may be sent to professionals for medical purposes). We also plan to explore how to deliver information on the user's progress and provide access to results in a more personally engaging and meaningful way.

7. Conclusion

We introduced EmotionFrame, which collects users' feelings and thoughts about their daily events through video recording and answering simple questions derived from a depression assessment model in the home environment. To support users' everyday self-journaling experiences, EmotionFrame provided visual – auditory feedback as a reminder based on users' set times and

their goals for how many recordings they produce. To explore the daily self-journaling experience through EmotionFrame in the home environment, we conducted a field study with eight participants for three weeks. Our findings showed that the frame shape and process of recording allowed EmotionFrame to permeate users' living environments. In addition, we confirmed that careful consideration is needed for designing a system intervention based on users' previous recording habits and internal motivations. Finally, self-journaling in a private space and noticing one's own facial expressions through video-based recording allowed users to report unrefined and frank flows of thought. Based on our EmotionFrame design and the results of the field trial, our research provides potential insight into designing a daily journaling interface for self-understanding and self-reflection. Moreover, it provides further consideration points for sustaining daily journaling by providing proper questions and hints for triggering everyday memory and re-encounters with users' recorded data. This will help to reduce the negative emotions evoked from journaling about past negative events. Finally, our study offers potential insights into using the ostensible purpose of journaling to reduce the psychology burden of journaling for assessing depressive mood.

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Disclosure statement

No potential conflict of interest was reported by the author(s).

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