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Speculative Design for Emotional Support in Future Family Structures: AI-Assisted Memory Management

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This study examines the challenges of maintaining emotional support for families in the changing social structure anticipated in 2040. New challenges are posed to traditional family roles in providing emotional connections. Changes in family structure, including an increase in single-person households and diverse family types, may increase the distance between members and complicate the maintenance of family bonds. Research has shown that a lack of family emotional support can harm an individual's emotional regulation, social relationships, and overall mental health, especially for children, adolescents, and older adults.

In this regard, this study addresses the question: "How to maintain the emotional support function of the family in the future social structural changes?". Through literature analysis, questionnaires, and Kano modeling, this study identifies pain points and proposes solutions.

Utilizing a speculative design, this study proposes a "Future Family Memory Management System" that integrates artificial intelligence technologies to address the challenges of emotional connection and memory sharing. The system focuses on memory storage and family image cohesion, emotional accompaniment and interactive response, memory transmission and ritual visualization, digital roles, and privacy protection. The literature and questionnaires also show the relationship between strengthening family cohesion and family emotional support functions.

This study presents a new perspective on the application of artificial intelligence in the social domain, and it has been demonstrated that some of the functions of this solution can be accepted by the target group and provide meaningful emotional support for families under the changing social structure.

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1. Introduction

1.1 Research Motivation and Purpose

This study explores the implications of projected societal changes in 2040 on the emotional support functions of families. Emotional support from family has been identified as a critical factor for psychological well-being and life satisfaction. However, demographic forecasts suggest substantial structural changes in family composition by 2040. Global kinship networks are expected to contract, and the number of kin relations is expected to decline by more than 35% compared to historical levels. For example, the average number of children for 65-year-old women, which was 41 in 1950, is projected to fall to 25 by 2095 [5]. Such shifts are expected to weaken traditional emotional support systems, particularly as familial networks age and shrink, making emotional communication and caregiving increasingly challenging. Likewise, Amato concluded that children raised in intact families generally perform better in the cognitive, social, and emotional domains compared to those of single parents or step-family households[6]. These findings collectively suggest that the anticipated changes in family structures can have long-term effects on emotional exchange and psychosocial well-being. In the context of Taiwan, data from Executive Yuan's Gender Statistics Database reveal a 15% decrease in the proportion of nuclear family households over 24 years, while single-person, couple-only and non-traditional households have increased by 18%. The proportion of married individuals aged 15 and older has declined, and cross-cultural marriages involving foreign spouses have grown, illustrating a trend toward smaller and more diverse family configurations.

Against this backdrop, the motivation for this research is to investigate innovative approaches that can sustain emotional support functions amid evolving family dynamics, thus mitigating potential risks to mental health and well-being in future societies.

In light of these demographic and sociocultural changes, this research seeks to address the central question. How can emotional support within families be maintained in the context of future social changes? The increasing prevalence of single-person and nontraditional households suggests that conventional forms of family support may become insufficient. Call for novel strategies to ensure the continuity of emotional care.

1.2 Research Framework

This research is structured into three phases:1

1.2.1 Phase A: Background Research

This phase involves an extensive review of the literature, which examines previous work on emotional support, changes in family structures, and the integration of AI in affective technologies. The objective is to establish a theoretical foundation and clarify the research objectives.

1.2.2 Phase B: System Design and Development

Using a speculative design approach combined with the Kano model and the development of future scenarios, this phase focuses on the conceptual development of the Memory Tree system.

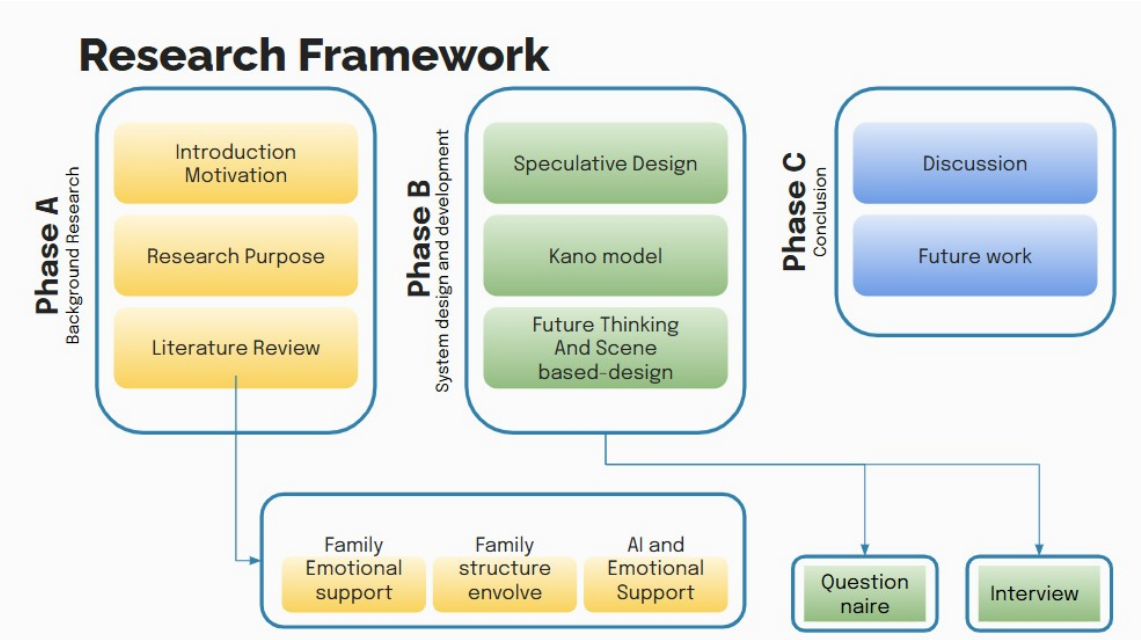

Figure 1: Research Framework

1.2.3 Phase C: Evaluation and Conclusion

In the final phase, user feedback is collected through surveys and interviews to evaluate the emotional resonance, usability, and cultural suitability of the system. The findings are analyzed to inform future research directions and potential applications.

2. Literature Review

2.1 Theoretical Foundations of Family Emotional Support

The theoretical framework of emotional support in the family highlights the critical role of family interactions in the promotion of mental well-being. A 2024 study has robust empirical evidence to support these theoretical assertions. The research revealed a significant positive correlation between perceived family support and emotional, social, and psychological well-being ($p < 0.001$), highlighting the pivotal role of familial support in enhancing overall well-being.[3]

In addition, many respondents identified family rituals as essential contributors to a sense of belonging and as crucial channels for emotional expression and support within families. These rituals are integral to creating and strengthening shared memories, serving both as a means of recalling the past and as symbolic actions that shape family identity [4].

In summary, the theoretical foundations of family emotional support emphasize the profound impact of family dynamics on mental health. These insights provide valuable guidance for future research and practical interventions aimed at promoting well-being through strengthened family connections and supportive rituals.

2.2 Changing Family Structures and Social Projections

Family structures are going through significant transformations, projections indicating that these changes will profoundly affect emotional interactions by 2040. Studies suggest a trend toward smaller household sizes, an increase in single-person households, and aging family networks, all of which may disrupt traditional modes of emotional support. A study by Alvarez-Gutierrez et al. , reported on Phys.org and based on the World Population Prospects of the United Nations in 2022, forecasts a global decline of more than 35 % in kinship bonds (as discussed in PNAS).[5] Specifically, the number of cousins, nieces / nephews, and grandchildren is expected to decrease sharply, while the number of grandparents and great grandparents will increase significantly. For example, the average number of kin for a 65-year-old woman was 41 in 1950, but this is projected to drop to 25 by 2095. This shift suggests a contraction in family networks, placing additional pressure on emotional support and caregiving systems, especially amid a rise in diverse single-person households.

Amato examined the effects of family structural changes on child development. The study found that children from intact families generally perform better in cognitive, social, and emotional domains, while those from single parents or remarried families may face greater challenges.[6] These findings indicate that evolving family structures could have long-term implications for emotional interactions, particularly as nontraditional households become more common. In summary, projections for 2040 point toward smaller and older family networks, underscoring the necessity for new forms of social support to maintain emotional connection.

2.3 The Application of Artificial Intelligence in Emotional Support and Social Interaction

Artificial Intelligence has become increasingly integrated in the domains of emotional support and social interaction, particularly in areas such as emotion recognition, human-computer interaction, and assistive emotional care. These technologies offer new possibilities for improving mental health services and social support systems. A study examined the role of AI chatbots in providing emotional support[7]. The findings highlight the potential of chatbots to support mental well-being and emphasize the need for continued technological and policy efforts to improve the efficacy of such systems in diverse cultural contexts.

Furthermore, a comprehensive review examined emotion recognition using physical and physiological signals such as voice, facial expressions, EEG, and ECG. The study emphasizes the ability of AI to analyze these signals, enabling a more accurate understanding and response to human emotions, particularly in healthcare and human-machine interaction contexts.[8] In conclusion, while the potential applications of AI in emotional support are promising, addressing ethical and technical challenges remains essential to ensure the effectiveness and safety of such interventions.

3. Research methods and analysis

3.1 Specification Elaboration and System Concept Development

The development comprises three primary stages:

3.1.1 Problem Context → Literature Review

Initially, we clarify critical issues such as changes in family structures and functional needs, synthesizing relevant literature and social trends to identify potential emotional support challenges. The focus is on evolving childbearing attitudes and family interaction patterns, establishing foundational research objectives.

3.1.2 Future Scenarios → System Concept Development

Drawing from reviews of the literature and foresight studies, we propose solutions including the *Family Memory Management System*, which addresses emotional needs, emerging media, AI integration and privacy concerns. Core concepts like emotional companionship and ritualized memory form the basis for the subsequent design.

3.1.3 Requirement and Functional Validation → Questionnaires and Interviews

Concept validation is conducted using questionnaires combined with Kano analysis and interviews across three stages:

- First questionnaire: Basic needs validation.
- Second questionnaire: System functionality assessment, particularly AI and privacy concerns.
- Third questionnaire: Final validation of refined concepts.

Feedback from each stage iteratively refines system functionalities, ensuring user concerns are addressed effectively.

3.1.4 Scope of the Research

The current study focuses on conceptual functional features and their prioritization, excluding prototype development and empirical testing. Future work may extend this framework through prototype creation and usability tests to evaluate practical effectiveness in real-world family contexts.

3.2 Design and Implementation of Three-Stage Questionnaire Survey

3.2.1 Kano-Based Questionnaire Design

The questionnaire utilized a five-point Likert scale (1=strongly disagree, 5=strongly agree) to measure respondents' agreement with various functionalities and needs.[9] For Kano analysis, a two-question format—"with this feature" and "without this feature"—was adopted to capture respondents' reactions, categorizing features into six Kano categories based on their positive and negative impacts: Attractive (A), One-dimensional (O), Must-be (M), Indifferent (I), Reverse (R), and Questionable (Q).

Survey 1: Initial Exploration aimed to preliminarily explore foundational needs, validate key issues, and assess respondents' satisfaction with family connections, openness to technological emotional support, and initial feedback on system scenarios. Demographic data on family backgrounds and emotional support expectations were collected.

Survey 2: Concept and Feature Validation focused on validating core system functionalities using the Kano model (Must-be, Performance, Attractive attributes). Key areas included memory storage, visualization, emotional interaction, and privacy concerns, clarifying user priorities and acceptance.

Survey 3: Revised Functional Validation targeted younger users (aged 20–29) to validate refined features and scenarios. Detailed Kano model feedback was obtained to finalize system functionalities concerning emotional interaction, privacy preferences, and usability.

Upon survey completion, responses to the two-question format were mapped to Kano evaluation categories, filtering out Reverse (R) and Questionable (Q) responses to minimize noise.

3.2.2 Evaluation Process

Weighted scoring through Better/Worse analysis quantified the positive or negative impact of each feature on user satisfaction:

$$\text{Better} = \frac{A+O}{A+O+M+I}, \quad \text{Worse} = -\frac{O+M}{A+O+M+I} \tag{1}$$

Features were categorized as:

- **Attractive** (Better > 0.5, Worse > -0.5): High satisfaction when present, no dissatisfaction when absent.
- **One-dimensional** (Better > 0.5, Worse < -0.5): Increased satisfaction with improved features, significant dissatisfaction if absent.
- **Must-be** (Better < 0.5, Worse < -0.5): Necessary features, dissatisfaction if absent, limited satisfaction when present.
- **Indifferent** (Better < 0.5, Worse > -0.5): Neutral user reaction regardless of feature presence.

3.3 Semi-Structured Interviews

To supplement survey findings, semi-structured interviews were conducted with representative respondents from Survey 2, particularly those strongly supportive of AI interaction or concerned about privacy.

Interview Objectives:

- In-depth understanding of user expectations or concerns regarding family emotional support and AI functionalities.
- Exploration of privacy boundaries and motivations for emotional sharing.
- Clarification of contradictions or divergent views from questionnaire responses.

Interview Guidelines:

- Evaluation of current family interactions (frequency of family meetings, communication).
- Opinions on digital memory management and emotional detection.

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- Conditions influencing willingness to share emotional states.

Each interview lasted 30–60 minutes, was audio-recorded, transcribed, and content-analyzed to identify recurring themes and key statements.

4. Discussion of Questionnaire and Interview Results

This section presents the statistical analysis of the aggregated data from the three questionnaire surveys, including key figures and Kano model results. The discussion concludes with identified main pain points and outlines directions for future work.

4.1 Statistical Analysis of Survey Data

4.1.1 Demographic Distribution

Participant counts for Survey 1, Survey 2, and Survey 3 were 22, 38, and 31, respectively. The gender and age distribution of these participants is detailed in Figure 2. While Survey 1 sampling encompassed a broad spectrum of age groups, Surveys 2 and 3 employed a more targeted recruitment strategy. This shift focused on cohorts projected to constitute the primary family units by 2040, specifically individuals currently aged 20-30.

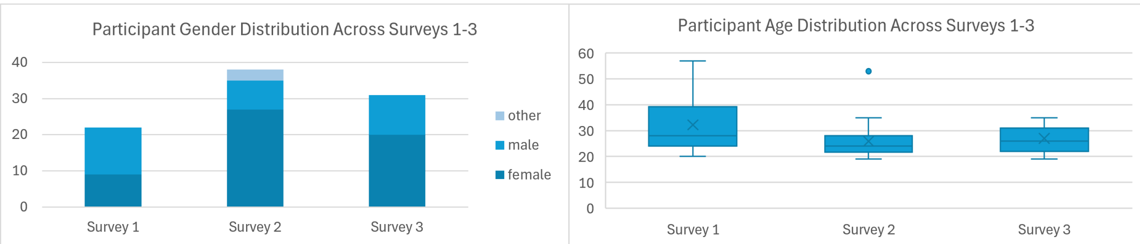

Figure 2: Participant Gender and Age Distribution Across Surveys 1-3

4.1.2 Kano Model Results for Surveys 1

Survey 1 consisted of 3 question pairs. The distribution of responses across the Kano categories for each question is presented in Figure 3. Key findings derived from this survey are outlined below: For Q1, maintaining family contact mostly falls into One-dimensional (O) answer, where better functionality increases satisfaction, though a few see it as a Must-be (M) answer , a basic need. Q2 shows most people (I=13) answer are indifferent to the ease of current media, suggesting it's not a major pain point. Q3 on memory sharing boosts satisfaction answer (Attractive or One-dimensional), with a minority viewing answer it as a Must-be (M).

Function	A	O	M	I	R	Q	Better	Worse	Type
(Q1) "Maintaining emotional connections with family is important."	3	9	2	8	0	0	0.55	-0.5	A (Attractive)
(Q2) "Expressing emotions through existing media is easy."	0	7	0	13	1	1	0.35	-0.35	I (Indifferent)
(Q3) "Recalling good times provides emotional support."	3	7	1	8	1	2	0.53	-0.42	A (Attractive)

Figure 3: Survey 1

4.1.3 Kano Model Results for Surveys 2

Survey 2 consisted of 8 question pairs . The distribution of responses across the Kano categories for each question is presented in Figure4. Key findings derived from this survey are outlined below:This survey expands to AI features like memory organization, emotion detection, deceased family memories, and privacy. Answers in One-dimensional (O) and Must-be (M) indicate missing features cause dissatisfaction, but many are indifferent (I) dimensions, showing limited interest in some AI aspects. Attractive (A) responses are few, with most leaning toward O or I answers.

Function	A	O	M	I	R	Q	Better	Worse	Type
(Q1) "Maintaining emotional connections with family is important."	1	11	3	22	1	0	0.324	-0.378	I (Indifferent)
(Q2) "I want to receive emotional support from family relationships."	2	15	5	16	0	0	0.447	-0.526	M (Must-be)
(Q3) "Recalling good times with family provides emotional support."	1	9	9	18	1	0	0.27	-0.486	I (Indifferent)
(Q4) "Sharing memories with family strengthens emotional bonds."	1	9	5	21	1	1	0.278	-0.389	I (Indifferent)
(Q5) "Knowing my family members' emotions helps maintain emotional connections."	1	9	4	23	1	0	0.27	-0.35	I (Indifferent)
(Q6) "A device that helps express emotions indirectly would improve communication."	0	2	4	30	1	1	0.056	-0.167	I (Indifferent)
(Q7) "Understanding memories of deceased family members increases my sense of identity."	0	7	2	27	2	0	0.19	-0.25	I (Indifferent)
(Q8) "I find AI-assisted memory organization and filtering appealing."	2	4	3	26	3	0	0.17	-0.2	I (Indifferent)

Figure 4: Survey 2

4.1.4 Kano Model Results for Surveys 3

Survey 3 consisted of 8 question pairs . The distribution of responses across the Kano categories for each question is presented in Figure5. Key findings derived from this survey are outlined below:Several features score nearly Attractive dimensions shows polarized views. Must-be (M) answer is rare, meaning few features are deal-breakers if absent; some questions have minor Reverse (R) or Questionable (Q) answers. Q3, “reviewing family memories,” stands out with 12 Attractive and 7 One-dimensional answers , a key highlight, while Q6, “emotion perception,” scores A=11, showing potential.

Function	A	O	M	I	R	Q	Better	Worse	Type
(Q1) "The system can store family moments and shared memories."	8	2	0	20	1	0	0.33	-0.07	I (Indifferent)
(Q2) "The system can automatically categorize memories and establish family rituals."	6	6	1	17	0	1	0.4	-0.23	I (Indifferent)
(Q3) "The system allows reviewing past family memories and rituals."	12	7	0	11	0	1	0.63	-0.23	A (Attractive)
(Q4) "The system shape a unique family tree based on shared memories and culture."	11	3	0	16	0	1	0.47	-0.1	I (Indifferent)
(Q5) "Forming a new family, the system generate a digital seed to continue memories."	5	3	1	20	0	2	0.276	-0.13	I (Indifferent)
(Q6) "The system can sense emotional fluctuations and respond through light or leaf movements."	11	3	0	17	0	0	0.452	-0.09	I (Indifferent)
(Q7) "Interacting with the system allows creating a digital persona for memory privacy management."	6	6	0	18	1	0	0.4	-0.2	I (Indifferent)
(Q8) "I believe the system can help strengthen family emotional bonds."	5	5	5	16	0	0	0.323	-0.32	I (Indifferent)

Figure 5: Survey 3

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4.2 Discussion of Main Pain Points and Needs

4.2.1 Gaps in Family Emotional Support

Synthesizing findings from the three surveys and semi-structured interviews, three primary pain points were identified: Insufficient Deep Communication: While using messaging apps for routine contact is common, users often feel awkward or uncomfortable discussing deeper issues like negative emotions or stress. Surveys 1 and 2 indicated that the desire for 'emotional support' or 'greater emotional expression' was rated as One-dimensional (O) or Must-be (M) by some, yet also Indifferent (I) by many, suggesting that realizing the potential of this aspect requires more refined usage contexts.

Privacy and Autonomy: In Surveys 2 and 3, a majority expressed significant concerns (rated M or I) about 'AI emotion detection' or 'automatic memory recording'. Some participants considered privacy a Must-be (M) requirement, stating that a lack of guarantees would severely undermine trust. Interviewees also emphasized the need for user control, specifically the right to 'turn off / delete' functions, to prevent excessive system interference or recording.

Sense of Ritual and Heritage: A considerable number of participants (rated A/O, especially in Survey 3) indicated that 'visualizing family memories, creating story videos, or ritualizing memories through the Memory Tree concept' would provide added appeal and enhance family cohesion. However, interviews revealed a current lack of suitable organization tools and platforms to enable continuous recording and review of family narratives.

4.2.2 Directions for Future Improvement

Based on the Kano analysis from the three surveys and feedback from user interviews, the following directions for future improvement are recommended:

Ensure Foundational Functions (Must-be): Prioritizing the refinement of both 'stable communication' and 'privacy protection' is crucial, as deficiencies in these areas (rated M) lead to significant user dissatisfaction. Examples include implementing end-to-end encryption, providing clear privacy setting interfaces, and ensuring stable cross-platform messaging and video communication capabilities.

Enhance Memory Management Efficiency (One-dimensional): Features like automatic archiving of photos and videos, keyword tagging, and support for rapid search and categorization can continuously increase user satisfaction (rated O). Some interviewees expressed positive expectations for 'AI efficiency', but failure to meet these expectations could result in negative reactions (rated O/M). Develop Attractive Features (Attractive): Data indicates that features like 'family ritual videos', 'AI emotional companionship', and 'Memory Tree shaping' are Attractive (A) or close to A for specific segments, offering significant potential satisfaction gains. However, these also registered as Indifferent (I) for many. Consider small-scale pilot implementations combined with targeted scenario-based marketing to identify interested user groups.

Respect Personal Privacy and Autonomy: The mix of high Indifferent (I) ratings and some Must-be (M) ratings regarding privacy issues highlights the need for flexible user controls (e.g., toggles for emotion detection, memory uploads), allowing users to customize settings according to their needs. Similarly, incorporating user control mechanisms within ritualization features and AI memory management is recommended to prevent resentment caused by excessive system automation.

5. System Design

5.1 Speculative Design and Contextual Design

This study adopts a speculative design approach to explore how emerging AI technologies can address the emotional and social challenges resulting from evolving family structures in the future. Central to this exploration is the Memory Tree system, an interactive concept designed to foster emotional connection and support between generations and geographies.

5.2 The Three-Step Process of Speculative Design

Guided by The Young Designer's Guide to Critical and Speculative Design[1], our design process followed three key steps: context definition, scenario creation, and system functionality design.

5.2.1 Step 1: Define a Context for Debate

We initiated the design by asking: What will 'family' look like in 2040? This future-oriented context was shaped through interviews, surveys and trend forecasting, focusing on how demographic shifts, mobility, and technological developments can redefine family relationships. The goal of this stage was to frame plausible future scenarios and establish a foundation for critical design exploration.

5.2.2 Step 2: Ideation, Problem Framing and Scenario Creation

In this phase, we constructed a future scenario in which an AI-driven memory system (Memory Tree) enhances emotional support and strengthens family bonds. Using Scenario-Based Design[2], a user-centered methodology that facilitates empathy-driven exploration, we created four speculative use cases to illustrate how the system could be integrated into daily family life.

1. Growth of digital plants: A New Way to Materialize Memories Xiao Rong's family remains emotionally connected through the Memory Tree. Today, he uploaded a video of Xin Xin's school speech, causing the tree to grow a new branch. Viewing from afar, Fang Fang smiled proudly as she watched Xin Xin's confident performance.

2. Biometric Technology: Emotional Interaction and Response After her speech, Xin Xin expressed disappointment that she did not win the first place. The Memory Tree sensed her mood, glowed gently, and swayed to comfort her. It also saved the emotional moment in her personal memory archive.

3. Preserving Digital Family Identity and Heritage During the Winter Solstice, the family gathered to enjoy Xiao Rong's tangyuan, made from a citrus-infused ancestral recipe. While cooking, he projected photos of their old family orchard through the Memory Tree. Laughter and stories were shared and the tree archived the entire experience.

4. A Warm Winter Solstice: A Visual Symbol of Tradition Every winter solstice, the family adds new memories to the Memory Tree. Over time, these memories become glowing fruits, visual markers of shared tradition. Upon seeing them, Xiao Rong is reminded of the enduring warmth of family love.

5.2.3 Step 3: Materialize the Scenario to Provoke Reflection

This step is not merely to envision a technological artifact, but to provoke reflection and dialogue about the emotional landscapes of future homes. As we approach 2040, increasingly diverse family structures, marked by solo living and cross-regional separation, raise pressing questions about the role of technology in sustaining emotional connection. How might systems like the Memory Tree preserve intimacy and cohesion across physical and generational distances? Can traditional rituals be meaningfully digitized and passed on to bridge past and future? With the rise of emotional AI, can systems offer empathetic support - especially for vulnerable groups like children and the elderly - while respecting personal boundaries? Furthermore, how can memories be securely stored and shared across generations without compromising privacy? As emotion-sensing technologies face skepticism, how can we design trust, reduce intrusiveness, and communicate emotional value clearly enough for users to welcome such systems into daily life? These questions are not only technical challenges, but prompt a deeper reflection on how design can help imagine intimacy, empathy, and cultural continuity in the evolving context of family.

The Memory Tree system serves as a digital interactive platform that supports emotional interaction, memory preservation, and the intergenerational transmission of family culture. Inspired by the universal symbolism of trees—representing life, growth, and familial continuity—the Memory Tree functions as a metaphorical and functional anchor. In many cultures, the roots of a tree represent ancestry and history, while its growing branches symbolize future prosperity. Building upon this duality, the system is designed around four key pillars. First, it visualizes and transmits memory by digitizing life moments into modular building blocks that grow into a personalized tree structure, allowing memories to be inherited by future generations or shared as symbolic "digital seeds" with new family units. Second, it fosters emotional interaction and companionship through biosensory technologies, such as voice tone analysis and facial expression recognition, allowing the tree to detect emotional changes and respond empathetically through subtle ambient behaviors such as glowing, leaf movement, or sound. Third, it ritualizes family culture by automatically categorizing meaningful events—such as holiday gatherings or ancestral recipes—and transforming them into recurring visual symbols, reinforcing emotional bonds and cultural identity. Lastly, it strikes a balance between privacy and sharing by employing digital personality modeling to distinguish between personal and collective memories, ensuring privacy while enabling meaningful and secure inter-family exchange. More than just a memory archive, the Memory Tree is envisioned as a living, evolving medium for emotional connectivity and cultural continuity, embedding affective intelligence into symbolic, poetic interaction and redefining how families experience presence, empathy, and legacy in the digital age.

5.3 System Function Modules

5.3.1 Memory Storage and Family-Specific Image Cohesion

Based on the findings of the above surveys, we developed a memory storage and family image cohesion module. This module digitally archives family memories and visualizes them through the evolving structure of the Memory Tree, which represents the unique identity of each family. Key functions include:

- Multimedia Memory Archiving: Family members can upload digital memories to the Memory Tree, where each memory is preserved as a modular digital element. These are displayed on dynamically projected floating branches that form the visual representation of the tree.

- Family Image Construction: As more memories are added, the Memory Tree grows and morphs, visually reflecting the richness of the family's cultural heritage and emotional bonds.

5.3.2 Emotional Companionship and Interactive Response

Drawing on these findings, we developed the Emotional Companionship and Interactive Response Module to enhance emotional connectivity between family members through biosensory feedback and artificial intelligence. Key features include:

- Emotion Sensing: By analyzing vocal frequency and facial expressions, the Memory Tree can detect the emotional states of family members.

- Emotional response: In response to detected emotions, the Memory Tree emits gentle light or induces subtle leaf movements to convey comfort and emotional presence.

This module employs AI-driven emotion recognition and natural language processing to interpret verbal and nonverbal cues in real time. It not only captures nuanced emotional fluctuations during family interactions, but also initiates timely, non-intrusive responses. In doing so, it fosters a sense of companionship and helps reduce the emotional distance between physically separated family members.

5.3.3 Memory Transmission and Visualization of Family Rituals

In response to these insights, we developed the Memory Transmission and Ritual Visualization Module, which enhances the continuity of family culture through the symbolic representation of memories and rituals. Key features include:

- Visualization of Rituals: The system automatically identifies and classifies significant family traditions, transforming them into visual elements. The Memory Tree presents these as glowing fruits on its branches, symbolizing treasured rituals and shared moments.

- Intergenerational Transmission: When a new family unit is formed, the Memory Tree generates digital seeds that encapsulate the core memories of the original family. These seeds are then integrated into the structure of the new family tree, ensuring that emotional and cultural traces are passed on.

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This module enables the transformation of digital memories into ceremonial formats, such as anniversary retrospectives, festive commemorations, and custom visual narratives. By integrating multimedia data with a chronological storytelling structure, it allows family members to collectively revisit important milestones, reinforcing emotional bonds and familial continuity.

5.3.4 Diverse Family Branches and Growth Continuity

When a new family is formed, the Memory Tree generates digital "seeds" that enable the continuity and evolution of original family memories within the newly established unit. This system not only supports the inheritance of emotional and experiential data, but also allows the maintenance of relationships with existing families. Thus, the memory lineage is not confined to a single family structure but can extend across multiple families, reflecting the fluid and evolving nature of contemporary familial bonds.

5.3.5 Digital Personality and Privacy Protection

We hypothesize that as families increasingly prioritize emotional support, future family configurations may encompass structures such as multiple parents co-raising a child, multi-origin families, families with varied motivations, and a new category of digitally mediated distant families. In response to these trends, we developed the Digital Roles module. This module generates digital personalities to manage both personal and collective family memories, ensuring a balance between individual privacy, emotional legacy, and data security, which is essential for maintaining user trust. Key functionalities include

- Digital Personality Shaping: Based on members' interactions and stored memories, the Memory Tree constructs individualized digital personalities capable of distinguishing between private and shared memories. This supports meaningful memory sharing while upholding privacy standards.
- Memory transmission: Upon the passing of a family member, the digital personality helps in curating and filtering memories suitable for transmission to future generations, preserving emotional continuity.
- User Control: Users can configure access permissions for their memories, granting them autonomy over how emotional and memory data are shared within the system.

5.4 System Architecture and Workflow

The diagram 6 illustrates the role of AI in our study by presenting the AI Memory System Workflow. The Memory Tree system transforms individual memories into interactive responses, cohesive representations of family identity, and digital personas, thus enhancing the overall quality of emotional support.

6. Conclusion & Future work

6.1 Conclusion

In response to the increasingly diverse and personalized family structures observed in 2040, we propose the "Memory Tree" AI system as an innovative solution to contemporary challenges

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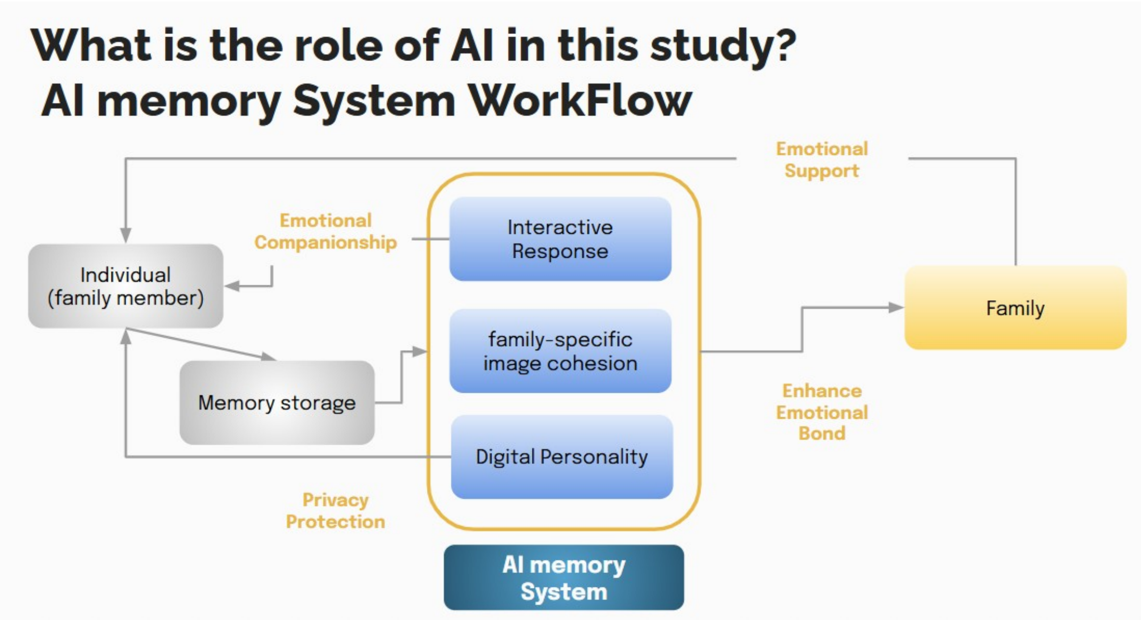

Figure 6: AI memory system workflow

in emotional connectivity. Using a central memory storage and visualization system, the system integrates emotion perception and protects personal privacy. Its goal is to establish a familial conduit that is palpable, enduring, and resonant between generations and geographical distances. Initial user tests and surveys indicate that the sharing and transmission of memories not only enrich users' familial belonging but also indirectly enhance the quality of emotional support. Throughout the design process, addressing user concerns regarding AI emotion perception and privacy infringement, we adopted the strategy of using "memories as emotional catalysts." This approach aims to provide flexible, indirect, and unobtrusive support while maintaining privacy expectations. It not only aligns with user privacy preferences but also reinforces the system's role as a custodian of familial emotional memories, presenting a novel paradigm for future family interactions.

6.2 Future work

Looking ahead, our research will further explore the potential of the Memory Tree system in improving family emotional support through four primary avenues. Firstly, we will refine the interactive design of the human-computer interface to enhance intuitiveness and emotional resonance, facilitating natural user-system communication. Secondly, to address the diversity of family structures resulting from globalization and cultural variations, we will enhance the AI's cultural adaptability to better align with diverse familial values and interaction norms. Currently, our goal is to broaden the application of the system in mental health by leveraging its capacity for gentle companionship and evocation of emotional memories as a supplementary tool for psychological support. Lastly, amidst the growing societal emphasis on digital memory preservation, we will dive into the legal and privacy implications of digital memory heritage, developing robust data management and authorization mechanisms to ensure intergenerational memory continuity while safeguarding individual rights. Through these ongoing improvements, our aim is to deepen the

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symbiotic relationship between families and technology in the coming years.

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