Supporting Long-Term HRI Through Shared Family Routines

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ABSTRACT

Technical and practical challenges in human-robot interaction (HRI) research often involve facilitating sustained long-term interactions, fostering engagement with multiple individuals, and taking place in-the-wild. The home environment embodies all three challenges, as multiple family members regularly engage with technology at home. In our research, we take a family-centered approach to understand, design, and evaluate how social robots can take part in setting and maintaining family routines to support long-term HRI. In our prior work, we conducted participatory design sessions with children and families to understand their preferences for having social robots in their *home*. We then designed interactions for robot-facilitated *routines*. Finally, our future work will include field studies investigating how robot-facilitated routines can support *long-term* engagement in family-robot interactions and facilitate connections.

CCS CONCEPTS

• **Human-centered computing → Field studies**; **Interaction design theory, concepts and paradigms**.

KEYWORDS

social robots, long-term, in-home, multi-party, child, family

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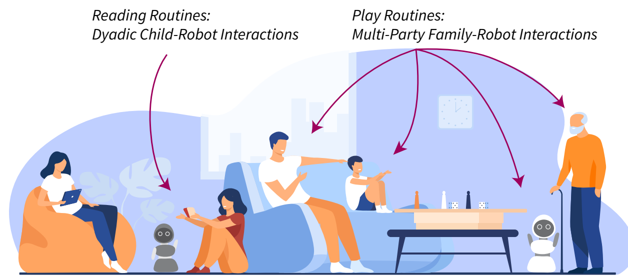

Figure 1: Examples of robot-facilitated family routines.

1 INTRODUCTION

Long-term interaction [2, 25], adaptation [36], and personalization [17, 24] have long been challenges in human-robot interaction and child-robot interaction. To overcome barriers to successful long-term human-robot interaction, there is a need to take robots out of the laboratory and to the real world where users can naturally interact with robots [19, 35]. Applications of robotic interventions in-the-wild have shown promise of supporting children's learning [3] and therapy [9] in real-world contexts such as schools [30, 37], hospitals [35], and homes [20]. Furthermore, research in family studies shows that *family routines and rituals* can help improve family relationships and connection-making [12]. They can help children build resilience and buffer stress through major life transitions such as a global pandemic [1], moving to a new city, having parents going through a divorce, or dealing with grief [11].

Such routines emerge, develop, and change in close relation with different kinds of everyday technologies in the home [8, 14]. However, families often experience tensions between the *need for setting* and the *difficulty of maintaining* routines. Technology-mediated solutions such as reminders from a shared family calendar [29, 31] or a verbal notification from a smart assistant [4] can help but are easy to ignore or miss. Social robots, however, are physically embodied agents that can serve the role of a friendly coach that can roam over to a child's room and provide adaptive and personalized interventions to motivate routines for exercising [15] or cleaning [13]. Robots can convey excitement to help set a new routine for bedtime and sleep hygiene [40] and have consistent engagement with families through verbal, non-verbal, and behavioral interactions to help maintain their routine in the long-term.

In our work, we aim to expand the field's understanding of these broader challenges for long-term interaction in HRI. To do this, we take a family-centered approach to understand, design, and evaluate robotic systems tailored to support interactions between families and robots. We use participatory research methods [10], conduct field studies at homes, and use the Misty robot [34] platform. Our overarching goal is to demonstrate that *social companion robots embedded into the home can enable long-term interactions through facilitating family routines*. We ask the following research questions:

Completed Work
- (Understand) What are the preferences of families for having a social robot in their home?
- (Design) What are the design considerations for robot-facilitated family routines?

Current and Future Work
- (Evaluate) How can robot-facilitated family routines support long-term engagement in family-robot interactions?

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2 UNDERSTAND: FAMILY PREFERENCES FOR IN-HOME SOCIAL ROBOTS

In our prior work [5], we explored families' preferences for an in-home social robot through participatory design sessions. We identified three key insights. First, families expected robots to have two **roles** in the home: a *companion* and an *assistant*. As a companion, the robot should serve as a playmate, reading companion, or confidant. As an assistant, the robot should provide information in daily tasks, such as cooking or doing homework. Second, families expected the robot to be included in **group interactions** and were enthusiastic about having engaging activities with a robot. For example, families expected a playmate robot to be an active participant in family game nights, dance, or sports. However, some parents refuse to use the robot during family dinners. Third, families expressed **privacy concerns** for how a robot should manage sensitive information shared in conversations. Discussions about private and group conversations between members, such as a parent and a child, raised concerns about the robot's unintended capacity to share private information with other members, e.g., a grandparent. Parents sought to have control over the robot without compromising trust with their children. These findings emphasize the need to consider broader factors such as family dynamics, relationships, and characteristics when assessing robot acceptance in the home.

3 DESIGN: ROBOT-FACILITATED ROUTINES

Given these findings, our recent work focused on designing robot-facilitated routines that could support long-term adoption of routines, including (1) care-taking, (2) play, and (3) reading.

Care-Taking Routines. Caring for an interactive agent by comforting [23] or teaching [39] can help form stronger connections and facilitate positive outcomes, including improvements in mental health in adults [23] or support learning gains in children [39]. Inspired by these findings, in our recent work [6], we explored how children chose to incorporate a social robot into their daily routines. In their *morning routines*, children included care activities such as waking up the robot and getting it ready for the day by charging, cleaning, or exercising together. In their *nighttime routines*, children discussed care obligations such as preparing the robot's bed and having shared bedtime activities such as reading or listening to music together. As a part of their *recreation routines*, typically for weekends, children discussed collaborative responsibilities such as preparing and tidying up the area for robot-facilitated games.

Playful Routines. Family playtime with a social robot can be facilitated through *"verbal activities, reading stories, or playing cards"* [21], also echoed in our prior work [5]. To explore this, in our recent work [22], we conducted a technology probe study (e.g., [16]). We delivered a Miko robot [28] to children's homes and asked them to record their first interactions. Here, we observed children's experiences of meeting a robot for the first time at their home. We found that children preferred to begin with robot-facilitated activities including dancing together, doing yoga, or playing songs.

Reading Routines. Interactive read-aloud sessions with children can support improved reasoning skills, and build stronger interpersonal skills and connections [26]. Given this motivation, we designed a fully autonomous reading companion robot and deployed it in 16 children's homes for a study that lasted a month. In this long-term study [7, 27], children regularly read aloud to the Misty robot [34] as part of their routine. In the reading sessions, the robot responded with interactive comments about the book to promote interest in reading. We observed that family members, such as siblings and parents, were enthusiastic to indirectly take part in the routine between the child-robot pair. We found that most children *adopted* the robot and continued sustained use. However, some *adapted* and changed the interaction mechanics to their own preferences, some were *interrupted* by external disruptions, and some lost interest and *discontinued* using the robot.

4 EVALUATE: LONG-TERM ENGAGEMENT IN FAMILY-ROBOT ROUTINES AT HOME

So far, our work has identified routines that families found important for an in-home robot. Next, we will translate these insights to (1) co-design a family-robot integration plan and (2) evaluate how family-robot shared routines can support long-term engagement. We will conduct a *case study* including three families with at least one child aged 8-12. The studies will take place at family homes.

Family-Robot Integration Plan. Crafting a "Family Media Use Plan" [32] can support open family communication and implementation of consistent rules about media use. Inspired by this, we will work closely with families to craft a *family-robot integration plan (FRIP)* that fits their needs for setting and maintaining routines. For this, we will first collect survey metrics such as family routines inventory [18] and parenting styles [33] as a baseline. These surveys will help identify the frequency, quality, enjoyment, and significance of their routines, the motivators and challenges in setting and maintaining them, and the connections formed around them. Second, we will conduct child-led home tours (e.g., [38]) to allow families to describe current routines and set any boundaries for a robot's use in their home. Third, we will collect self-reported video diaries capturing families' engagement in their shared routines. We will then consolidate these insights and propose a personalized FRIP consisting of design requirements developed for family-robot routines. Families will have the opportunity to customize their FRIP through iterative co-design sessions. Finally, we will translate these design insights to develop interactions for an autonomous in-home companion robot that will help set and maintain family routines to sustain long-term use. We will seek feedback from families regarding the robot's role in joining the family dynamic.

Long-Term Evaluation. To evaluate the effectiveness of this integration plan, we will conduct a long-term field study with each family. The FRIP will help determine the logistics of the deployment (e.g., duration) as well as the robot features and behaviors. Within each family, we will measure the robot's ability to support long-term interactions through: (1) *behavioral metrics* capturing changes in the frequency of family members' engagement in shared routines, identified through interaction logs, and (2) *subjective metrics* to identify motivators and challenges in setting and maintaining robot-facilitated routines, collected through weekly surveys and semi-structured interviews, and (3) pre-test and post-test *comparisons* to evaluate the effectiveness of the intervention.

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