Towards a Comprehensive Chore List for Domestic Robots

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ABSTRACT

We present an analysis of household chore lists with an eye towards building a comprehensive tasks lists for domestic robots. We identify the common structures of cleaning and organizing tasks, and characterize properties of their targets. Based on this analysis, we discuss the necessity for end-user programming of domestic robots at different levels.

Categories and Subject Descriptors

I.2.9 [**Artificial Intelligence**]: Robotics; H.1.2 [**Models and Principles**]: User/Machine Systems

Keywords

Domestic robots, robot tasks, end-user programming

1. INTRODUCTION

Many areas of robotics research are motivated by the vision of multi-purpose domestic robots that undertake house chores. We are seeing more and more successful demonstrations of robots performing tasks like setting a table [1] or folding laundry [3]. However, these efforts focus on individual tasks independently, without concern for the broader scope of tasks for domestic robots. In this paper, we set out to create a comprehensive list of tasks that robots could do in the home. We believe that this effort will have several important contributions. A comprehensive list will highlight task domains that are in high demand, but have not been the focus of previous efforts. Analysis of large scale task list will allow the discovery of common patterns across different tasks. This, in turn, can help us develop methods that work across different tasks, instead of being task-specific. The list can serve as a benchmark for broader research areas that are the basis of general-purpose domestic robots. This includes planning, mobile manipulation, Learning from Demonstration and Human-Robot Interaction.

Previous work has implicitly or explicitly contributed to building such a list. Different sources of information for enumerating tasks include ICF (International Classification of Functioning) [2], ADL (Activities of Daily Living) [5], interviews with people in their homes [4] and surveys [6].

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- ☐ Clean the shower & tub
- ☐ Wipe window sills
- ☐ Dust furniture
- ☐ Vacuum
- ☐ Wipe bathroom sink
- ☐ Pick up toys
- ☐ Put dirty clothes in hamper
- ☐ Unload the dishwasher
- ☐ Make the beds
- ☐ Do laundry
- ☐ Put clean laundry away
- ☐ Empty small trash cans
- ☐ Make lunch

Figure 1: A sample chore list.

In this work, we propose using so-called *chore lists* as the basis of a task list for robots (Fig.1). Chore lists are used for the management of housekeeping tasks and division of labor among household members. They are created and customized by these members, and they reflect the needs, preferences and rules of the household. As a result, they are valuable in highlighting the robotic capabilities that would be most useful for future users of domestic robots.

2. METHODOLOGY

Chore lists used in this work are obtained from the world wide web, by searching different combinations of the keywords *house, household, housekeeping* and *task, chore, work* in a popular search engine. The lists are preprocessed to separate each task as an individual item. For instance, the first item on the chore list in Fig. 1 becomes two items; *clean the shower* and *clean the tub*. Tasks that are less frequently needed (*e.g.,* changing light bulbs), are outdoors (*e.g.,* gardening chores), or irrelevant for domestic robots (*e.g.,* personal hygiene) are removed. Then all lists are unified by identifying items that correspond to the same task but are worded differently. Finally, we identify an *action* and a *target* corresponding to each task. These are the *verb* (*e.g.,* clean, wipe, dust, vacuum) and the *subject* (*e.g.,* shower, bathroom, desk, kitchen floor) associated with each item in the chore list. In addition, we determine a set of *task categories* that cover the range of tasks observed in the lists and that are characteristically different from one another. Each task in the lists is then assigned to a category.

3. FINDINGS

We collected 25 distinct chore lists, with an average of 35.4 (SD=20.9) items per list. After filtering and unifying the lists, we are left with a combined list of 884 different

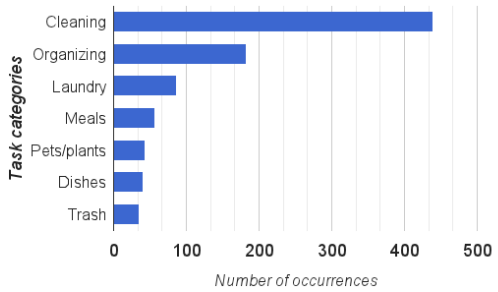

Figure 2: Distribution of chores across task categories.

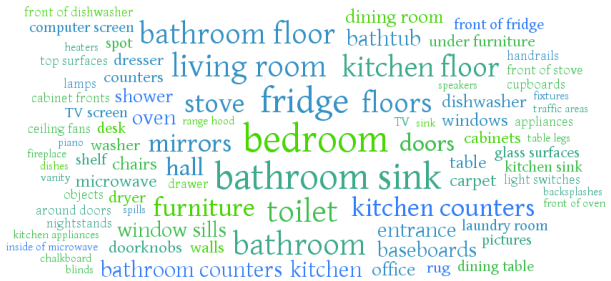

Figure 3: Word cloud of targets for cleaning actions such as wipe, vacuum, dust, sweep or mop.

task instances[1]. Fig. 2 shows the distribution of the tasks into seven categories.

We observe that cleaning tasks dominate chore lists, comprising 49.8% of all chores. About 95% of cleaning tasks involve one of the following verbs: *clean* (28.4%), *wipe* (15.4%), *vacuum* (13.1%), *dust* (12.8%), *wash* (7.8%), *sweep* (7.1%), *mop* (5.3%) and *scrub* (3.4%). These actions correspond to applying a tool (*e.g.,* sponge, wet wipe, piece of cloth, Dustbuster, Windex, Swiffer) on a specified surface. The target surfaces for cleaning actions are specified through a range of references, summarized in Fig. 3. A majority of these (97.5%) refer to a stationary location inside the house. These include rooms (19.5%) or their floors (8.5%) (*e.g.,* kitchen, bathroom, bedroom), stationary appliances (16.8%) (*e.g.,* fridge, stove, TV), stationary furniture (8.3%) (*e.g.,* dressers, tables, shelves) or other things that are attached to the house (34.5%) (*e.g.,* countertops, sinks, window sills).

In contrast to cleaning, organizing tasks often involve reconfiguring movable, articulated, or non-rigid items in the house. Most common verbs to specify organizing tasks are *straighten* (25.7%), *pick up* (18.0%), *put away* (9.3%), *organize* (7.6%), *tidy* (5.5%) and *clear* (4.9%). In 57.1% of organizing tasks the objects to be reconfigured are explicitly specified through a category name (*e.g.,* toys, shoes, CDs, groceries, clutter). Other times, the objects to be organized are implicit, but they are specified through a room (20.3%), a closed volume (15.4%) (*e.g.,* fridge, pantry, closet) or a surface (7.1%) (*e.g.,* counters, desk, shelf) that contains them.

4. DISCUSSION

There is a diverse set of chores that robots can carry out in the home, however, tasks within a certain category exhibit similar structures that can be exploited while implementing robotic capabilities for these chores. We observed that most cleaning tasks consist of *applying a tool on a specified surface*, and organizing tasks consist of *reconfiguring movable, articulated or non-rigid items* in the home. The two categories largely differ in terms of the skills they require. Each cleaning task requires a different tool-use skill, whereas most organizing tasks can be accomplished with a *pick-up-and-place* skill, given reliable perception of target objects.

One of our motivations in creating a comprehensive task list for domestic robots, is to identify task components that require end-user programming. Although a lot of the functionality for doing house chores can be built in, end-users will need to program their robots at different levels. The operation of a robot will drastically differ from home to home, based on the users' preferences and the features of the home.

Before all, users will need to activate or deactivate different functionalities. For each activated functionality, users will need to specify a schedule (*e.g.,* make all beds at 10am every morning) or trigger conditions (*e.g.,* empty the trash when it is full). Many tasks will also require the user to specify targets for robot actions. For instance, a user could specify certain rooms or indicate regions of the floor that they want vacuumed daily.

For human-robot communication about task targets, it is essential for users to have a shared representation of the house with their robots. User programming is again crucial for obtaining such shared representations. This includes naming rooms of the house, indicating locations of common appliances and tools, indicating dedicated locations of movable objects or annotating parts of the environment for certain tasks. For certain tasks users might also need to specify the duration, number of repetitions, or completion conditions of the task. There are also a number of opportunities for programming by demonstration in these task domains. For instance, end-users might demonstrate the use of unknown cleaning tools or the operation of appliances that may differ across households.

[1]Dataset available at `hri.willowgarage.com/robotchores`

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