Integrating Socially Assistive Robot (SAR) and Smart Home to Support Caregiving of Individuals with Dementia Disease

2019 Summer Report

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The Problem

How to Taking good care of People with Dementia:

- Health
- Well-being
- …

Family member experience Care Burden

Or

$50,000 / year for a home health aide

$100,000 / year for a 1bd nursing home

The Problem

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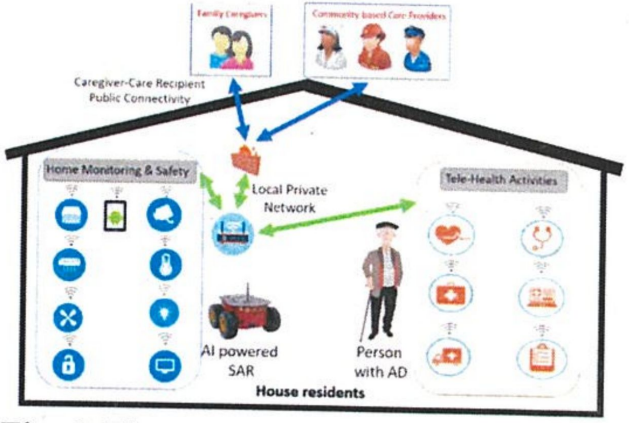
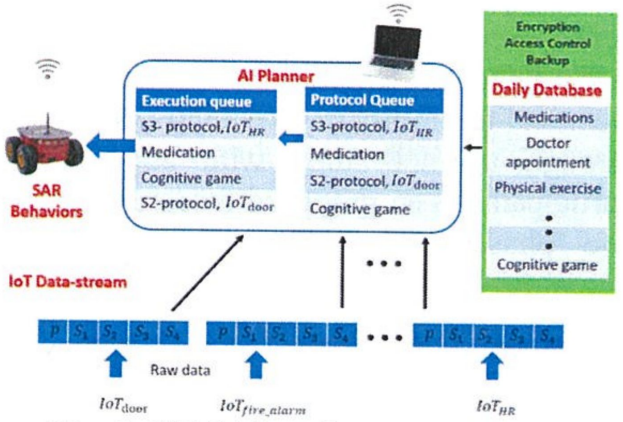
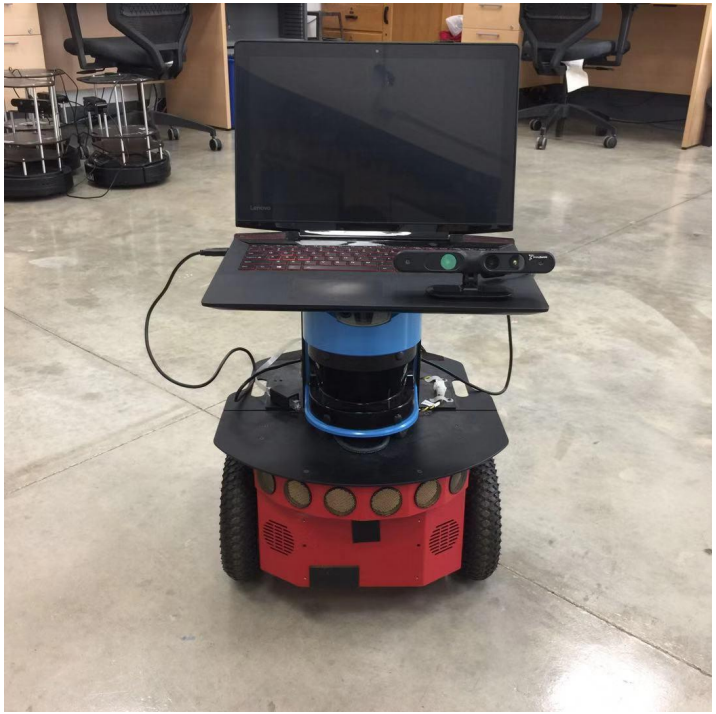
Can robot and current available technologies help?

Smart Home Design





The Robot



The Robot

Ros Nodes:

- Mapping and Localization: gmapping, amcl
- Auto Navigation: move_base
- Face Module: face-detector, face_recognition
- Task Planning: ROSPlan
- Action Service Nodes
- Executive

The AI Planner

ROSPlan:

- PDDL
- Interfaces available for many planners

We use:

- PDDL 2.1
- Contigent-FF

The AI Planner

SHR Domain:

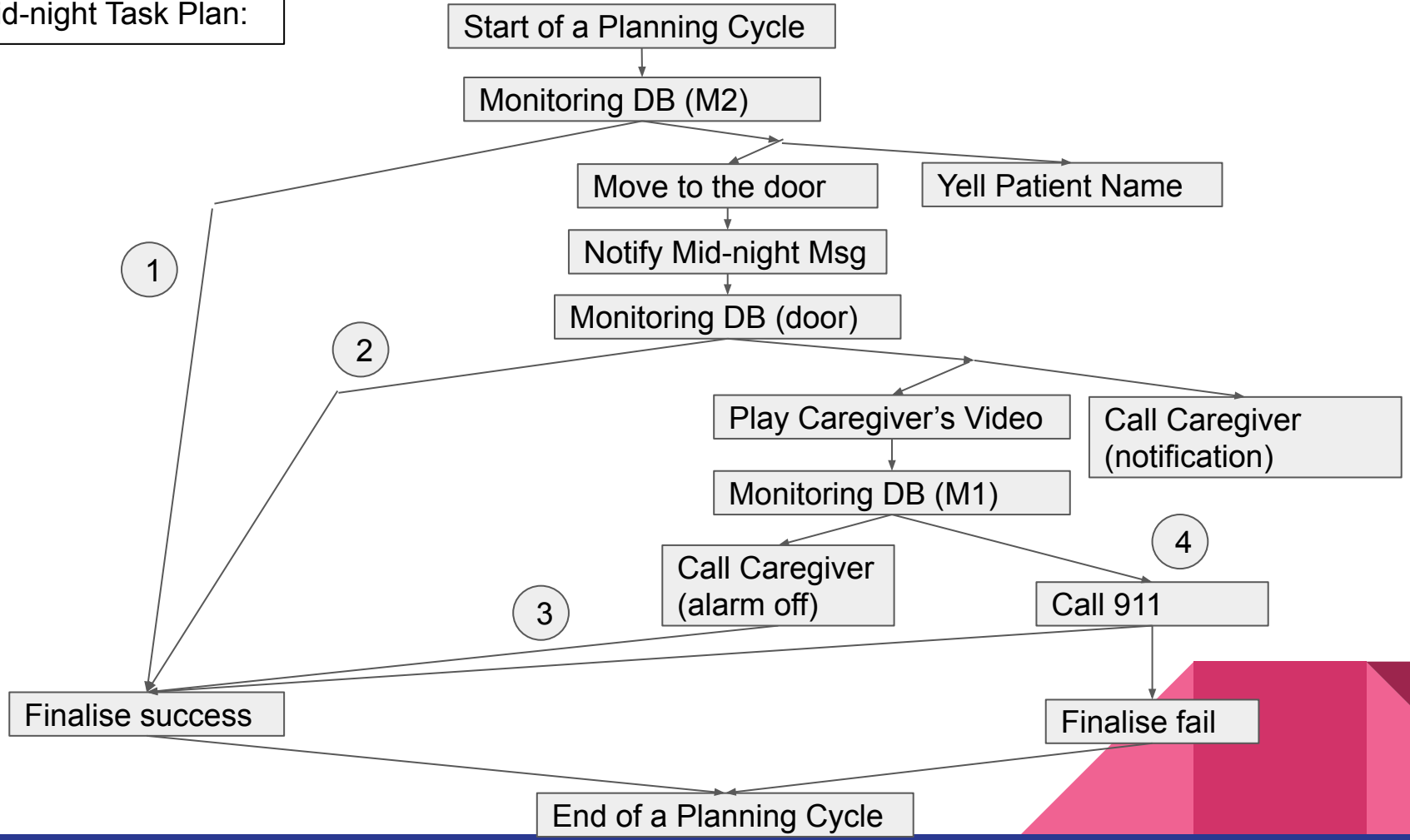
```
(define (domain shr_contingent)

(:requirements :strips :typing :disjunctive-preconditions)

(:types
        landmark
        robot
        message
        sensor
)

(:predicates
        (robot_at ?v - robot ?lm - landmark)
        (is_home ?lm - landmark)
        (notified ?msg - message)
        (message_at ?msg - message ?lm - landmark)
        (is_on ?ss - sensor)
        (is_off ?ss - sensor)
        (available_to_check_s ?ss - sensor)
        (sensor_after_notified ?ss -sensor ?msg - message)
        (is_safe)
        (is_not_safe)
)
```

```
;; Move to any landmark, avoiding terrain
(:action moveto_landmark
        :parameters (?v - robot ?from ?to - landmark)
        :precondition (robot_at ?v ?from)
        :effect (and
                (robot_at ?v ?to)
                (not (robot_at ?v ?from)))
)

;; Notify message at landmark
(:action notifyAt
        :parameters (?v - robot ?lm - landmark ?msg - message)
        :precondition (and
                (robot_at ?v ?lm)
                (message_at ?msg ?lm))
        :effect (and
                (forall (?ss - sensor) (when (sensor_after_notified ?ss ?msg) (available_to_check_s ?ss)))
                (notified ?msg))
)

;; check if sensor ss is on
(:action check_sensor_on
        :parameters (?ss - sensor)
        :precondition (available_to_check_s ?ss)
        :observe (is_on ?ss)
)
```

Mid-night Problem:

```
(define (problem task_conditional)
(:domain shr_contingent)
(:objects
    door home - landmark
    pioneer - robot
    midnight_warning - message
    leaving_house - message
    doorss - sensor
)
(:init
    (robot_at pioneer home)
    (is_home home)
    (message_at midnight_warning door)
    (sensor_after_notified doorss midnight_warning)
    (unknown (is_on doorss))
    (unknown (is_off doorss))
        (oneof
                (is_on doorss)
                (is_off doorss)
        )
    (is_not_safe)
)
(:goal (is_safe)
)
)
```

Mid-night Task Plan:



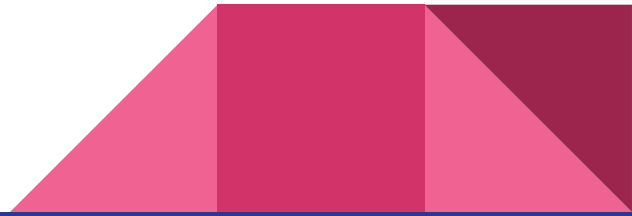
Result

Tested with Actor Patient and Caregiver:

- Midnight scenario with 4 situation - all success
- Medication scenario with 4 situation - all success

Sep 21:

- Invite Real Caregivers to try it



Future work

Online planning deal with uncertainty:

- Adaptive replanning with nested contigent planner

LayUser-Friendly Design:

- domain knowledge engineering for PDDL