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Department of Computer Science

COS 730 Assignment 1

X10 Home Automation

1. Research X10 home automation

X10 is a communication protocol primarily used for home automation. Developed in 1974 by Pico Electronics [2], X10 was the first step to a practical illustration of home automation. It pioneered the field of home automation soon after its release. It basically enables electronic devices within a home to communicate with each other and the controllers through existing electrical wiring [1].

Communication Protocol: X10 operates on a simple and robust communication protocol. Commands are transmitted over the existing electrical wiring during zero crossings. When a command is sent, it is modulated onto the electrical power line at a 50/60 frequency and received by the intended X10-compatible device[3].

Devices: X10-compatible devices are installed in homes. These devices include light switches, lamp modules, appliance modules, motion sensors, security cameras, thermostats,etc[4]. Each X10 device has a unique address code that allows it to be identified and controlled individually or as part of a group[5].

Control Interfaces: Users can control X10 devices using various control interfaces, including [6]:

Remote Controls: allow users to send commands to X10 devices from anywhere within the home. Smartphones and Tablets: users can control X10 devices remotely over Wi-Fi or cellular networks that have a collaboration

with the latest communication protocols. Computers: X10 software applications running on computers provide advanced control and automation capabilities, allowing users to create schedules, macros, and customised automation routines.

Commands: X10 supports a variety of commands for controlling devices, including:

On/Off: Turn devices on or off remotely. Dim/Brighten: Adjust the brightness level of compatible lighting devices. All Lights On/Off: Simultaneously control all lights or devices in a specific group.

Timers: Schedule devices to turn on or off at specific times [6].

Macros: Create sequences of commands to automate complex tasks or scenarios[6].

Weaknesses contributed to x10 losing favour:

Interference: X10 communication can be susceptible to interference from other electrical devices and noise on the powerline, leading to reliability issues [7].

Range: X10's range may be limited by the quality of the electrical wiring in a home, and signal degradation over long distances can affect reliability [8].

Limited Bandwidth: X10's bandwidth is limited, which can restrict the number of devices that can be controlled simultaneously and the speed of communication [8].

Compatibility: Compatibility between different X10 devices and manufacturers may vary, leading to interoperability issues [8].

Lack of security: The doesn't have any encryption [8].

Low Performance: Due to range, bandwidth and interference [8].

Concurrent Commands: X10 concurrents signals had chance of degrading or loss of commands [9].

2. Software requirements specification

Introduction

X10 home automation was introduced by pico electronics with the vision of enhancing functionality and convience of home automations. The trivial tasks and control of home appliance, lighting ,home security systems ,etc could easily be automated and controlled by one device. X10 scope encompassed a

fully autotimated home systems that rely on Electrical wiring to ensure well-being and comfort. This scope includes software,hardware needed to completely automate homes [10]. The long term goals for x10 home automation was for a robust,affordable, user-friendly, reliable and convient for home owners. The X10 home automation serves as a time saving and convient system to home owners. Home owners have are freed from trivial tasks and scheduled events, x10 relieves owners by automating the scheduled events through triggers that complete the tasks for owners based on personalised configuration. The x10 is a robust protocol that helps communicate messages between controllers and modules but it has a couple of limitation, extension of cloud solution to remove x10 limitations will be the area of focus.

User Characteristics

- Homeowner status: Users should be responsible of property and have permission to install permanent setups and renters could have less permanent solutions.
- Interested in home automation: users are likely to be interested in smart homes and its potential benefit.Creates an expectation.
- Technically inclined to a certain level: users should be able to understand usage terms , maintainance manual and customisation manual.
- Physical attributes: Users should be able to operate the remote/device used to communicate with coontroller of the home system.
- Read : users should be able to read in order to be able to operate the home automation system efficiently.
- budget and affordability: users can be able to purchase upgrades for home systems to have new improvements and be compatible to other systems incase of any need of integration

User Story

Overview

X10 home automation user stories will be directed at the clients users. The client would be the actor that uses the application. In this effect it would be the actor who is trying to interact with the home automation system.

- Access Control
  - As a client I should be able to :
    - sign up on the application so that i can have my credentials and preference stored on the system
    - login into application in order to access my stored credentials and preferences
    - logout from application and have credentials securely preserved.
- User Management

  - As a client I should be able to :
    * view personalise configuation(preference and settings)
    * create on own person configuration (preference and settings) of the application
    * edit my personal details

- Schedule and command Management
  - As a client I should be able to :
    * create a schedule for my command
    * create a (macro) sequence of commands
    * edit and delete my schedules
    * edit and delete my macros

- Device Management
  - As a client I should be able to:
    * add my personal devices to control the home automation system
    * able to register new home automation components I add to the electrical wired system.
    * view/edit my device persmission

- Cloud-Based Monitoring System
  - As a client I should be able to:
    * view statistics on usage of the each component
    * view failure statistics of the home automation

- Logging and Reporting System
  - As a client I should be able to :
    * see the point failure for devices that failed
    * see the cause of failure
    * see summary of statistics of home automation (failures and usage metrics)

- Notification Management System
  - As a client I should be able to:
    * see notification of success of commands
    * see notification of failure of commands
    * see notification when the Schedule events take place
    * see notification of success of storage of schedules and macros

- Controller Management System

- As a client I should be able to :
  - turn on/off a device

Functional Requirements

Components :

Hardware Component (Assumption : Not to be too emphasised)

- Reciever
- powerline communication modules
- wireless modules
- sensors
- Transmitter

Software Components

- Notification Managements

manages notification based on signals of sent and recieved from devices

- Device Management

manages the device configuration for the home system

- User management (additional component)

stores relevant data that is needed to application to work for specific user

- Cloud Service (additional component)

provides cloud solutions that aid the home automation

- Logging and Reporting (additional Component)

helps track and produce report based on recorded tracking

- Schdule Management

helps manage and control any scheduled event/macros for home systsem

- Access Control System (additional component)

allows users to be identified

- Controller interface

enables communication between physical controllers and the devices

Functions of each component :

- **Notification Managements**

1. Remote
    (a) user able to see different led light in state change of devices
2. Smartphone
    (a) enable to see status of module
    (b) notified when devices fails or successful
    (c) popup message to devices that are faulty (additional)
    (d) notified when scheduled commands are about to be executed

- **Device Management**

1. add/remove PDA devices onto controller interface
2. remove and edit permission of devices on controller interface
3. registerating house address of devices newly connected to electrical wiring circuit

- **User management**

1. Create/store credentials
2. /Create/store device address
3. store default and customised schedules
4. Create/store user preferences and settings
5. backup and restore personalised feature settings

- **Cloud Service**

1. analytics
    (a) insights on usage of home system (frequently used and unused)
    (b) check frequent failures
2. Security and Storage
    (a) store information in cloud
    (b) monitoring any data breaches

- **Logging and Reporting**

1. track users footprint throughout applications
2. detect point of failure and cause of failure
3. auditing the system due to some breach

4. create comprehensive reports for dashboard

- **Schedule Management and Command Management**

1. create schedule
2. store schedule
3. create macros

- **Access Control System**

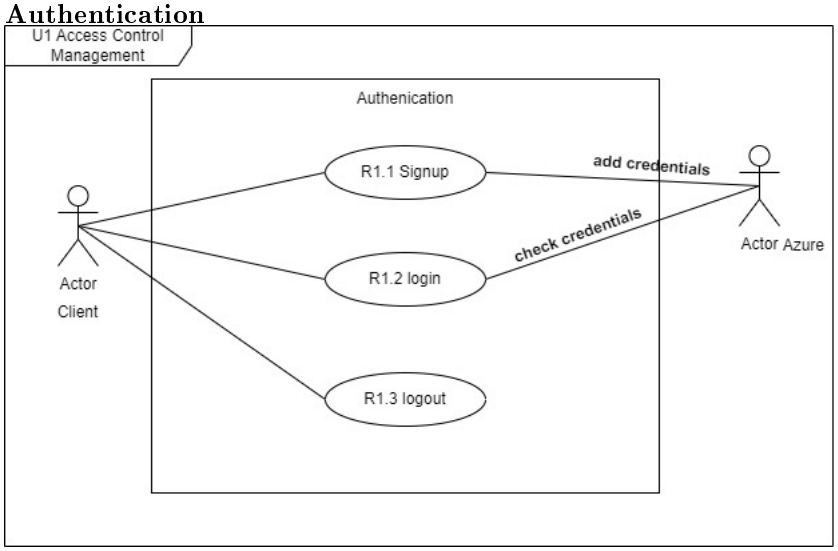
1. authentication
   (a) login
   (b) signup
   (c) logout
2. authorisation
   (a) verify user is granted permission for specific commands

- **Controller interface management**

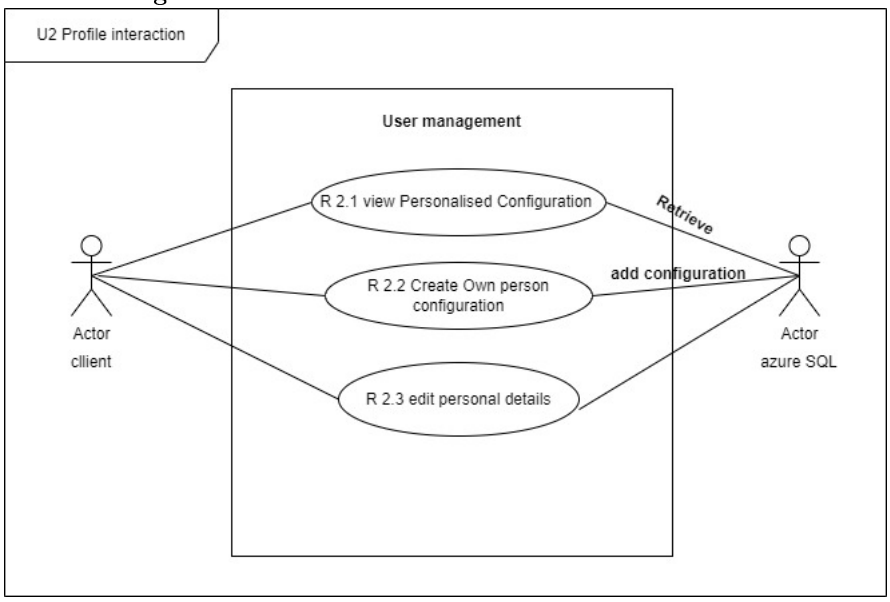
1. switching on home devices
2. switching off home devices
3. selecting devices to control
4. register device/remote to control devices

Use case diagram :

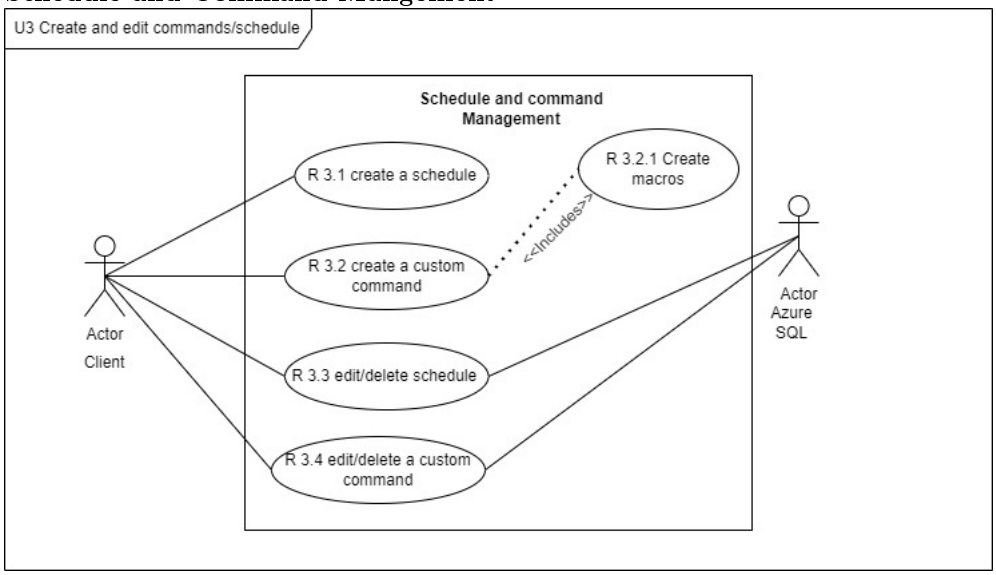
Authentication



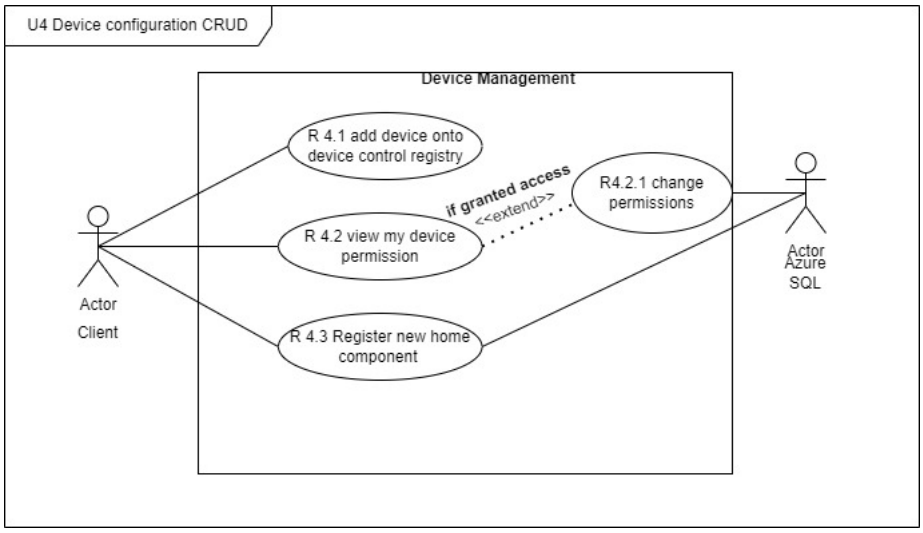
User Management



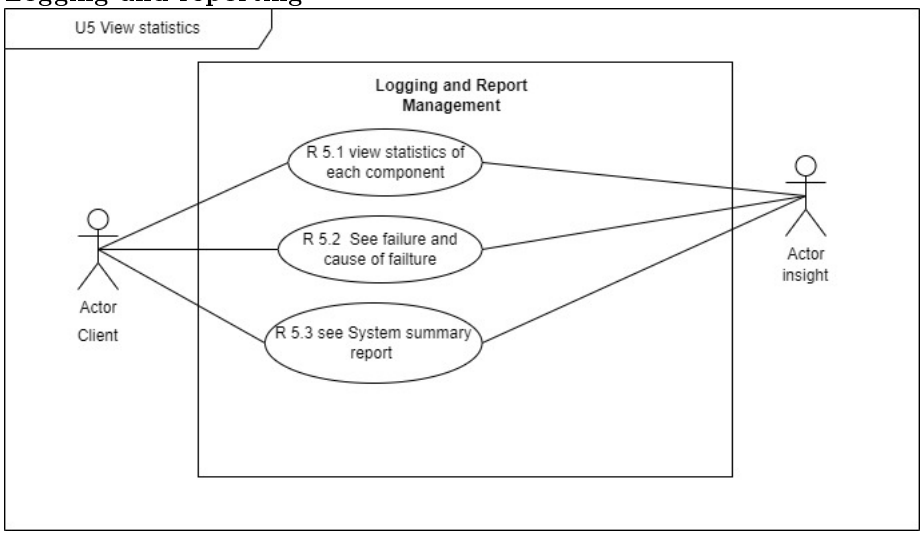
Schedule and Command Mangement



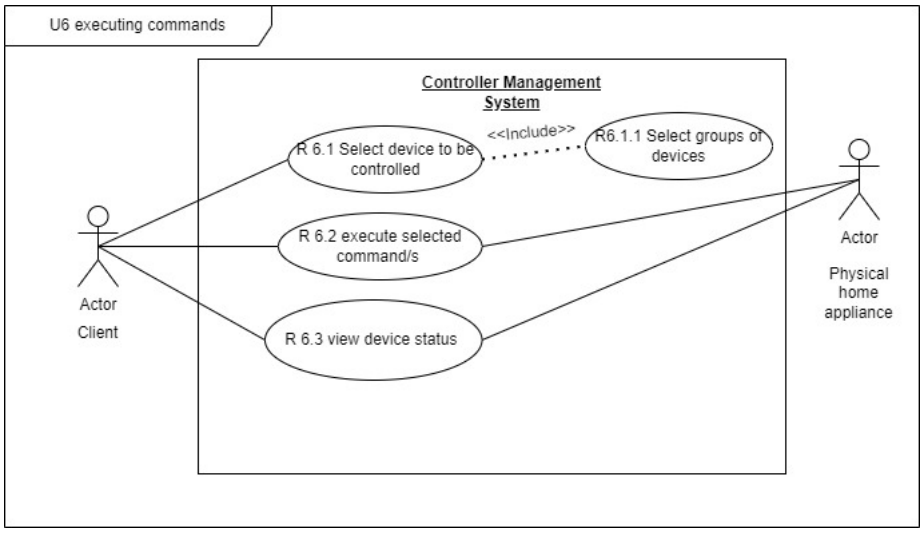
Device Management



Logging and reporting



Controller Management



Traceability Matrix :
Functional Requirement vs Subsystem

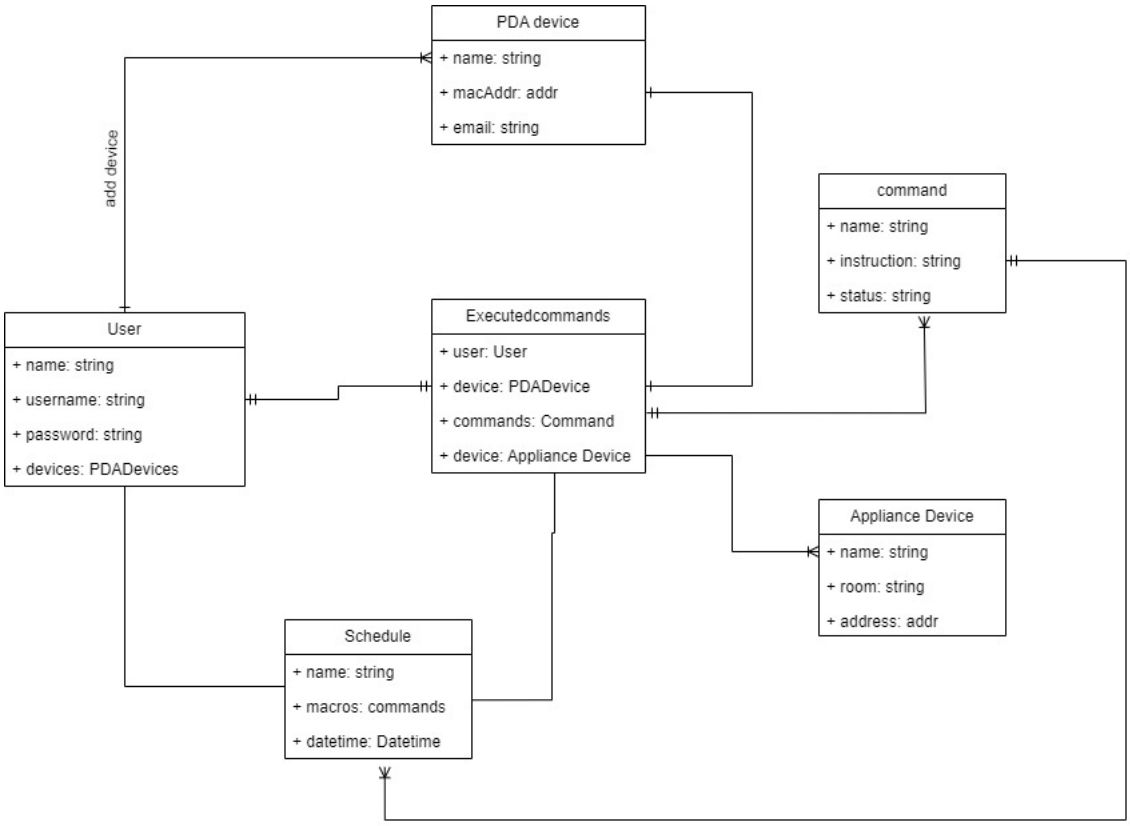
Requirement vs Subsystems							
	user management	access control	device management	cloud service management	logging and report	schedule and command	controller management
R1.1		X					
R1.2		X					
R1.3		X					
R2.1	X						
R2.1	X						
R2.2	X						
R2.3	X						
R3.1						X	
R3.2						X	
R3.2.1						X	
R3.3						X	
R3.4						X	
R4.1			X				
R4.2			X				
R4.2.1			X				
R4.3			X				
R5.1				X	X		
R5.2					X		
R5.3					X		
R6.1							X
R6.1.1							X
R6.2							X
R6.3							X

Quality requirement vs Subsystem

Requirement vs Subsystems							
	user management	access control	device management	cloud service management	logging and report	schedule and command	controller management
Performance				x		x	x
Interoperability		x	x				x
Security	x	x		x	x		
Usability	x		x				x
Modifiability	x		x	x			

Component Domain model diagram

x

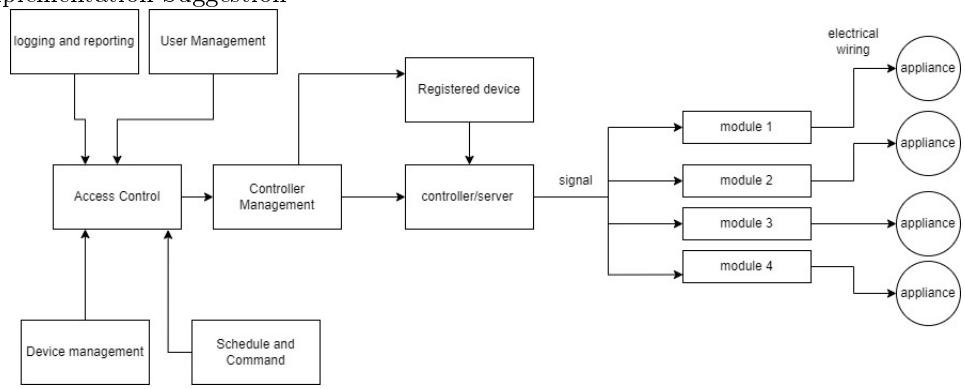


High level non-functional requirements

- Performance
  - home automation system will work efficiency if concurrent commands can be performed.This would save time for the home owners this also indirectly increases the usability (user friendly).
- interoperability
  - home automation system software should be able to be used on different devices (computer,smart phones and remotes) in order to accomodate range of users and their specific requirements.
- Security
  - home automation needs to encrypt its data transferred between the parties. This information can be sensitive and lead to vulnerabilities. Authentication of users is vital to confirm credentials and allow only users that have valid credential to control home automation components. Vulnerability detection can reduce number of successful attacks.
- Usability
  - home automation has an intent of being in every household , the software should have a easy learning curve , lead by intiution. Users should be able to use software within 5 minutes.

- modifiability
  - home automation system have a long life span the software should be easily modifiable in order to integrate new components on top of the old software. Build systems that a decoupled so changes can easily be made

Implementation Suggestion



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