

KATHMANDU UNIVERSITY

A TERM PAPER ON

AUTOMATA THEORY AND FORMAL LANGUAGES

COMP[322]

Assistive Domotics

LOGICAL DESIGN OF AUTOMATED HOME AND MOVEMENT OF
WHEELCHAIR IN A SMART HOME

Submitted by:
Sanjog SIGDEL
CS IIIrd year
Roll No: 57
sigdelsanjog@gmail.com

Submitted to:
Mr. Sushil NEPAL
Course Instructor
Department of Computer
Science and Engineering

January 5, 2015

Contents

1	Introduction	1
1.1	Background	1
1.2	History of Assistive Domotics	1
1.3	Objective	2
2	Discussion	3
2.1	Machines for Assistive Automation	3
2.1.1	A Home Robot	3
2.1.2	Assistive Bed	4
2.1.3	Matilda a Smart Home	4
3	Designs in Smart Home	6
3.1	Design of Automated Door	6
3.1.1	Scenario	6
3.1.2	State Definition	6
3.1.3	Context Diagram	7
3.1.4	Transition Table	7
3.1.5	Transition Diagram	8
3.2	Design of Wheelchair Friendly Smart House	8
3.2.1	Scenario	8
3.2.2	State Definition	8
3.2.3	Transition Table	9
3.2.4	Transition Diagram	9
4	Conclusion	10

List of Figures

2.1	Information home robots used in Assistive Automation project. The wheeled Rolloottori on the left and the ball shaped Rollo on the right.	3
2.2	Bedroom of another apartment in Toimiva koti(TK) (Func- tional Home)	4
2.3	Matilda a Smart Home	5
3.1	Context Free Diagram of Automated Door	7
3.2	Transition Diagram of Automated Door	8
3.3	Transition diagram for movement of wheelchair	9

List of Tables

3.1	Transition Table of Automated Door	7
3.2	Transition Table illustrating the movement of wheelchair . . .	9

Chapter 1

Introduction

Assistive technology is the form of home automation which includes assistive, adaptive, and rehabilitative devices for people with disabilities and also includes the process used in selecting, locating, and using them.

1.1 Background

Microsoft Corporation's C.E.O. Steve Ballmer once said "The number one benefit of technology is that it empowers people to do what they want to do. It lets people be creative. It lets people be productive."¹ "The US Census Bureau has projected that by 2010 13% of the population will be 65 or older (Cheek 2005). The bureau has also projected that by 2030 there will be 9 million Americans older than 85."² Providing the physical facilities of health and security personnel will be a tough task because the cost will be massive. So automated machines will be the best cost effective alternative.

1.2 History of Assistive Domotics

Today every embedded device are automated to some extent in order to ease the users. Nikola Tesla's design of first remote-controlled boat(1785 A.D) is the first known automated device in history.Mentioning about home automation in the early 1930s World's Fair models fictional were exhibited in order to excite the spectators. Then the invention of Complex Number Calculator (CNC) in 1940, mouse in 1964, Mac OS in 1984, first wireless system in 1989 are other different development in automation.In 1984, home automation technology spreads to garage doors, security systems, infra-red control , fibre optics and many more. Likewise a separate section named as *assistive domotics* was started and it emphasized the development of automated appliances for the elderly and disabled people.

¹http://www.brainyquote.com/quotes/authors/s/steve_ballmer.html

²http://en.wikipedia.org/wiki/Home_automation_for_the_elderly_and_disabled

1.3 Objective

Following are the objectives behind choosing the topic 'assistive domotics' :

1. To study the areas of application of assistive domotics.
2. To study the feasibility of machines designed using the principle of assistive domotics.
3. To design a model that will be useful in assistive home automation.

Chapter 2

Discussion

Generally, purpose of automation i.e. reducing time, human effort and achieving our goal in least cost. In other words we can say every machine is an automated device which reaches certain finite states after some input instruction are passed to them.

2.1 Machines for Assistive Automation

In terms of assistive or home automation for elderly and disabled people we can find various machines developed. We will put light on some of those automated device below.

2.1.1 A Home Robot



Figure 2.1: Information home robots used in Assistive Automation project. The wheeled Rollootti on the left and the ball shaped Rollo on the right.

A home robot is a mobile device for moving about, performing tasks such as vacuuming, measuring, communicating, fetching objects etc. This device is useful for the elderly people who have problem with ageing and back pain. Many of their daily activities will be solved by this home robot. ¹

2.1.2 Assistive Bed

Assistive bed is an externally monitored machine speciall designed for elderly and disabled people with spinal cord disabilities or paralysis. This device functions when the user rests in the bed, the string like structure will expand and contract calculating the mass weighed by it.



Figure 2.2: Bedroom of another apartment in Toimiva koti(TK) (Functional Home)

2.1.3 Matilda a Smart Home

The University of Florida has built a 500-square-foot (46 m²) smart house that is designed to assist and to provide medical care to "Matilda", a life size mannequin (Ascribe 2003). The house implements devices including a microwave that recognizes entries and automatically determines how long to cook them and devices to track the individuals location within the home. The house also uses devices to detect water on the floor and a camera that allows the person to view who is at the door and let them in using a cell

¹Toimiva koti (TK) (Functional Home), A research project carried out by Automation Technology Laboratory (AUT) of Helsinki University of Technology (TKK)

phone. The smart house at the University of Florida relies on a centralized computer network to deliver electronically coordinated assistance .²



Figure 2.3: Matilda a Smart Home

²Ascribe Newswire. University of Florida Smart Home Demonstrates Concept of Automated Elderly Help and Care. Ascribe Newswire: Health. 2003 29 November: 1-2.

Chapter 3

Designs in Smart Home

The development of home automation is in its early stage. Many researches in the field of automation is going on. There are obstacles in building a completely automated system. None of the existing system in the world are completely automated by itself. The main reason behind it is machine needs external factors like human, electricity to begin its function.

3.1 Design of Automated Door

3.1.1 Scenario

A security code must be entered in order to open the door and enter inside the house. Same scenario is represented below with the help of context diagram and transition diagram.

3.1.2 State Definition

Here automated door is deterministic in nature and the system consists of three states

$$Q = \text{MainDoor}, \text{PasswordCheck}, \text{MainHall},$$

two input symbols authorised as '1' and unauthorised as '0' i.e.

$$\Sigma = 0, 1$$

starting state q_0 is MainDoor i.e.

$$q_0 = \text{MainDoor}$$

and final state F is MainHall i.e.

$$F = \text{MainHall}$$

A transition table of illustrating the states involved while entering to main hall is represented below.

3.1.3 Context Diagram

Below illustrated context free diagram clearly shows the working mechanism of a automated door.

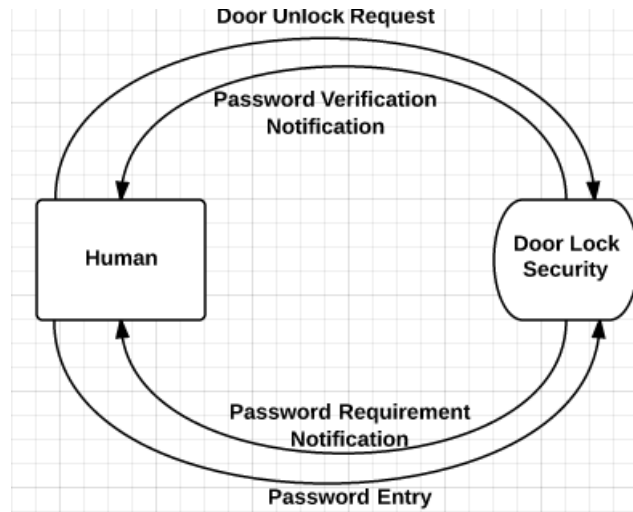


Figure 3.1: Context Free Diagram of Automated Door

3.1.4 Transition Table

Transition table is shown below:

δ	authorized (1)	unauthorized (0)
\rightarrow MainDoor	PasswordCheck	MainDoor
PasswordCheck	MainHall	MainDoor
\star MainHall	MainHall	MainHall

Table 3.1: Transition Table of Automated Door

3.1.5 Transition Diagram

Transition diagram is shown below:

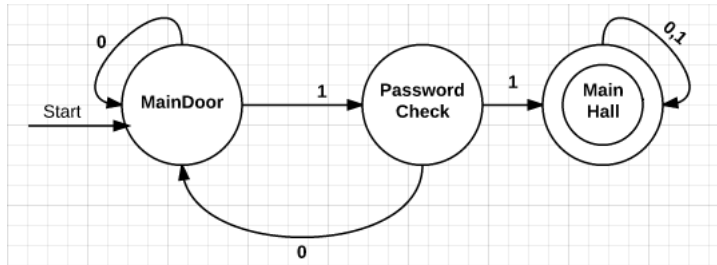


Figure 3.2: Transition Diagram of Automated Door

3.2 Design of Wheelchair Friendly Smart House

3.2.1 Scenario

Let us assume a man using wheelchair is on his home's corridor of ground floor. Now the design of simulated environment of his moves inside the home is illustrated below with the help of transition table and transition diagram.

3.2.2 State Definition

Here movement of wheelchair is non deterministic in nature because the person has different choices for the movement of wheelchair from the corridor i.e. he can move his wheelchair to the kitchen or bathroom or bedroom. The system system consists of six states

$$Q = \text{corridor, kitchen, bathroom, secondfloor, lift, ladder,}$$

two input symbols rightmove as '1' and nomove as '0' i.e.

$$\Sigma = 0, 1$$

Starting state q_0 is corridor i.e.

$$q_0 = \text{corridor}$$

and and set of final states F are kitchen, bathroom, secondfloor i.e.

$$F = \text{kitchen, bathroom, secondfloor}$$

A transition table of illustrating the states involved bt the movement of the wheelchair is represented below.

3.2.3 Transition Table

Transition table is shown below:

δ	rightmove (1)	nomove (0)
\rightarrow corridor	{lift, ladder, kitchen, bathroom}	corridor
lift	{corridor, secondfloor}	lift
* secondfloor	lift	secondfloor
ladder	ladder	ladder
* kitchen	{bathroom, corridor}	kitchen
* bathroom	kitchen	bathroom

Table 3.2: Transition Table illustrating the movement of wheelchair

3.2.4 Transition Diagram

Transition diagram is shown below:

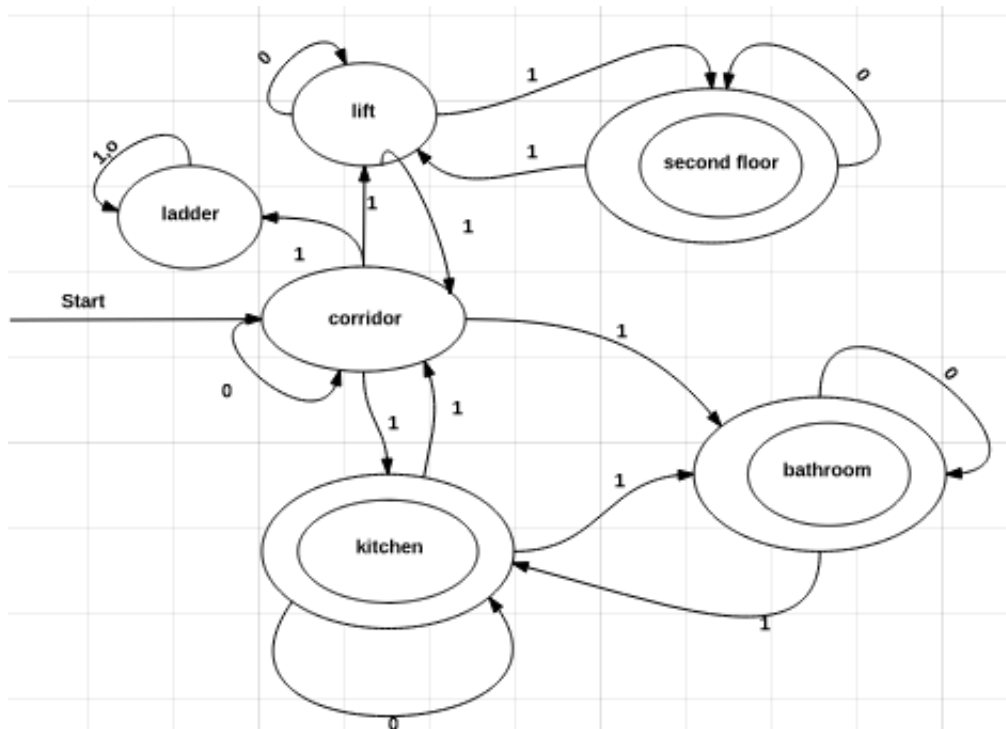


Figure 3.3: Transition diagram for movement of wheelchair

Chapter 4

Conclusion

Finally we come to know the areas covered by assistive domotics. Research are being carried out in different sectors of assistive home automation some of which were explained above. But yet assistive domotics is in its earlier phase. Since the machines with automated mechanism are costly and are not easily affordable. Having a smart automated home will benefit the elderly and disable people.

Bibliography

- [Kya13] Othmar Kyas. *How To Smart Home*. Key Concept Press e.K., Wyk, Germany, 2013.
- [Sha00] William Shakespeare. Taming of the shrew. *POWS*, pages 1–10, 1600.