CS2310 – Exercise #2

Nikolaos Romanos Katsipoulakis

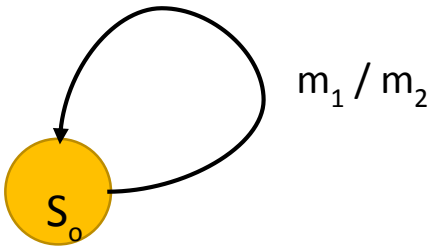
(a) Draw state-transition diagrams to define graphically the three index cell types.

Before I present the state transition diagrams for each component of the system, I have to present the message and action codes that are used in this system:

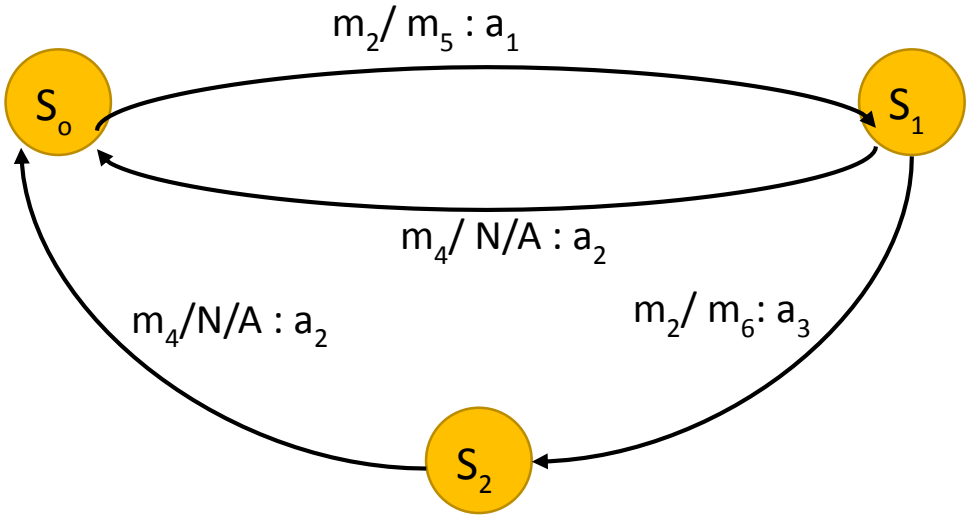
Message Index	Text
m_1	Patient Gesture
m_2	Patient Needs Help
m_3	Patient replies
m_4	Patient attended
m_5	Call patient
m_6	Visit patient

Action Index	Action
a_1	go into alert state
a_2	go into normal state
A_3	go into danger state
a_4	Call patient
a_5	Jump in ambulance

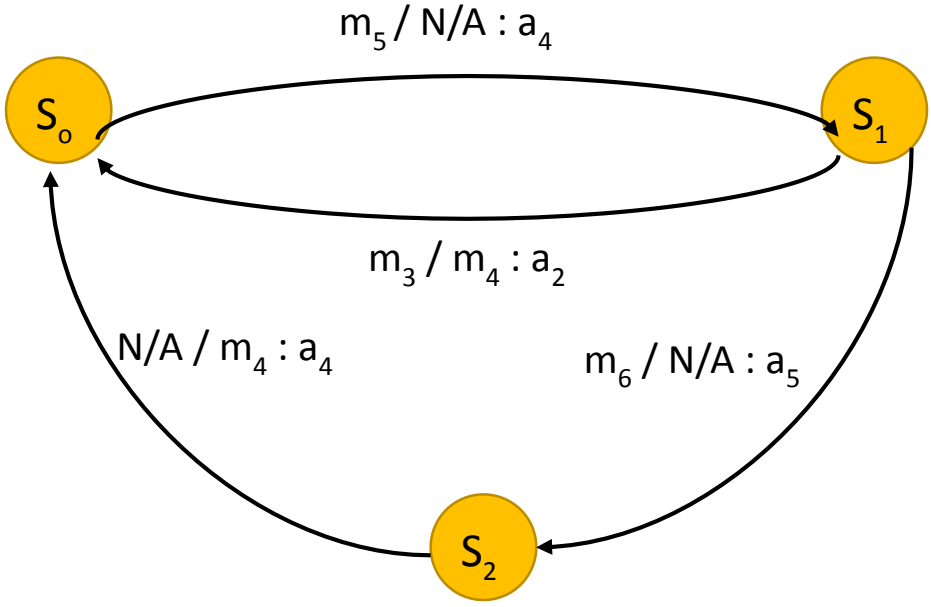
As we can see in the Message Index Table, a number of messages are going to be used among the three components of the system. These message codes will be used in the state transition diagrams of this system. Similarly, in the Action Index Table we can see the different codes of actions taken by components of the system. Now that we have established the messages and the actions send/performed by the system, we can take a look at the state diagrams.



Above, we can see the State Transition Diagram for the Gesture Recognition index cell. As we can see, the gesture recognition is stateless (or it has only one state), since it is only responsible for notifying the Emergency Manager Index Cell, every time it receives a patient gesture. Next, we have the state transition diagram of the Emergency Manager Index Cell:



As we can see, we have a more complicated state transition for the state transition diagram of the Emergency Cell Index. At this point I have to mention that I use an extra transition from S_1 to S_o (also for S_2) so that the Emergency Manager can return to its normal state, after attending a patient. Let us take a look also at the transition state diagram of the Homecare Staff Index Cell:



The state transition diagram for the Homecare staff is similar to the Emergency Manager Index Cell. However, we can see some differences in the messages exchanged.

(b) Specify the three index cell types formally using mathematical notations ic = (X, Y, S, s_o, A. t_{max}, f,g)

Let us start from the mathematical notation for the Gesture Recognition Index Cell:

- X = {m_1}

- Y = $\{m_2\}$
- S = $\{S_o\}$
- A = {N/A}
- f($\{m_1\}$, s_o) = 1, otherwise returns 0
- g($\{m_1\}$, s_o) = (Emergency Manager Index Cell, m_2, s_o, N/A)

I have to mention that "N/A" above stands for the empty set. Therefore, I have denoted that the Gesture Recognition Index Cell does not perform any actions (I assume that messages do not count as actions). In a similar fashion, we can continue with the definition of the Emergency Manager Index Cell:

- X = $\{m_2, m_4\}$
- Y = $\{ m_5, m_6 \}$
- S = $\{ s_o \}$
- A = $\{ a_1, a_2, a_3 \}$
- f($\{m_2\}$, s_o) = 1, f($\{m_4\}$, s_1) = 1, f($\{m_2\}$, s_1) = 1, f($\{m_4\}$, s_2) = 1, 0 otherwise
- g(($\{m_2\}$, s_o) = (Homecare Staff, m_5, s_1, a_1), g($\{m_4\}$, s_1) = (N/A, N/A, s_o, a_2), g($\{m_2\}$, s_1) = (Homecare Staff, m_6, s_2, a_3), g($\{m_4\}$, s_2) = (N/A, N/A, s_o, a_2)

We can see that state changes for each Index Cell are defined as actions. Finally, we can see the mathematical definition of the Homecare staff Index Cell:

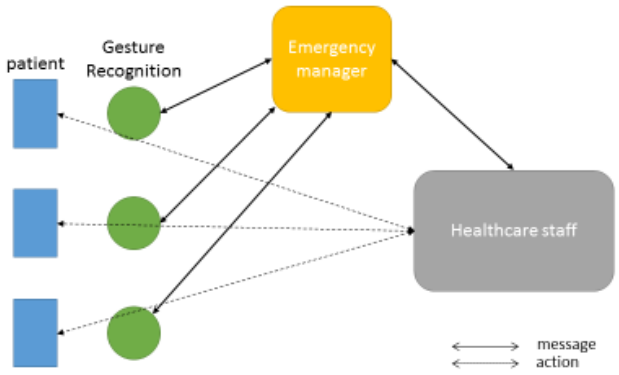
- X = $\{m_5, m_3, m_6\}$
- Y = $\{m_4\}$
- S = $\{s_o\}$
- A = $\{ a_4, a_2, a_5 \}$
- f($\{m_5\}$, s_o) = 1, f($\{m_3\}$, s_1) = 1, f($\{m_6\}$, s_1) = 1, f($\{m_4\}$, s_2) = 1, 0 otherwise
- g(($\{m_5\}$, s_o) = (N/A, N/A, s_1, a_4), g(($\{m_3\}$, s_1) = (N/A, m_4, s_o, a_2), g(($\{m_6\}$, s_1) = (N/A, N/A, s_2, a_5), g(($\{m_4\}$,s_2) = (N/A, m_4, s_o, a_2)

(c) Draw a diagram showing three multimedia interfaces (webpages such as doc-1, ..., doc-3) enhanced with the index cells to illustrate how these index cells work together to form an active index system.

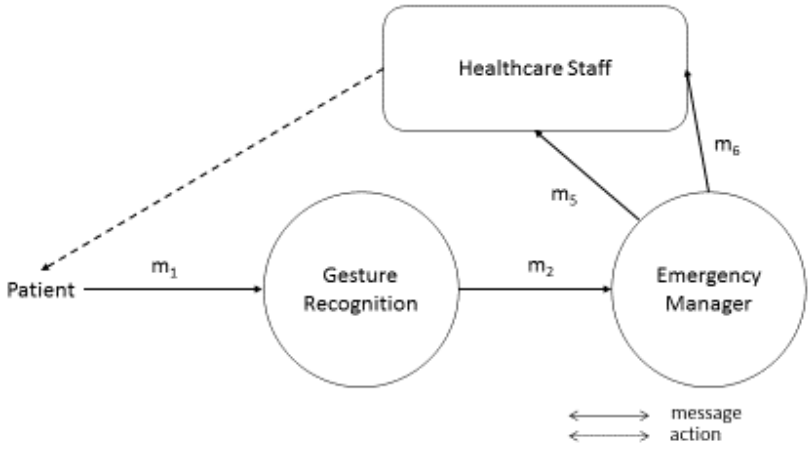
The multimedia interfaces of each component are an important part of each component for the Homecare system. They define the interaction interface between the environment and the underlying software implementing the logic of the application. I have assumed that three different interfaces are going to be used in each component.

In detail, the Gesture Recognition component will consist of a sensor network, managed by a data stream management system for capturing movements. The stream processing is needed so that machine learning algorithms are executed online for capturing distress signals from the patient. Turning to the Emergency Manager Index Cell, it is going to need to Publisher-Subscriber interface for receiving information from the sensor network, and producing notification messages for the Homecare Staff. This implies that the Emergency Manager needs to provide a communication interface for the other components, along with a GUI dashboard for administration/maintenance tasks. Finally, the Homecare Staff Index cell needs to provide a visual representation of the ongoing patient cases. This translates to a web Interface viewable from a variety of mobile and stationary devices (i.e. workstations, tables, mobile phones etc)

In order to understand thoroughly the specifications of each component, first, we need to take a look at the Active Index System Diagram as a whole:

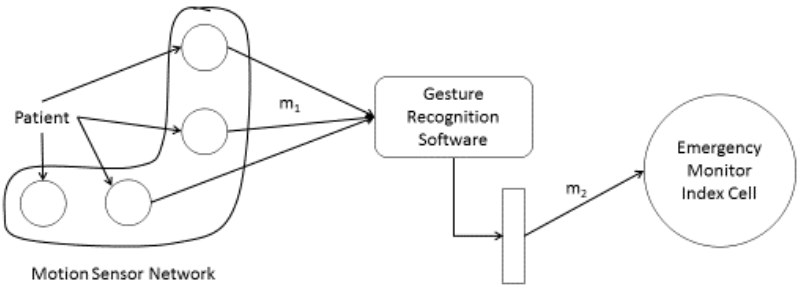


Therefore, we can see that different interfaces need to exist in each component. Special attention needs to be given to the Emergency Manager Index Cell. It is clear that the manager plays a Coordinating role in the whole process. This fact becomes more apparent through the workflow diagram:

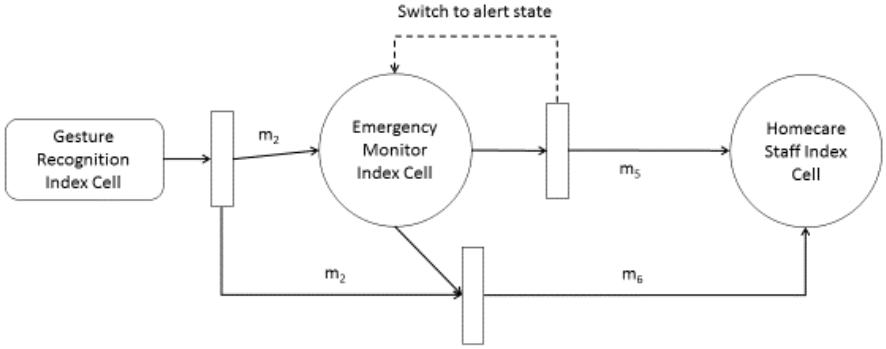


Data Flow Diagram

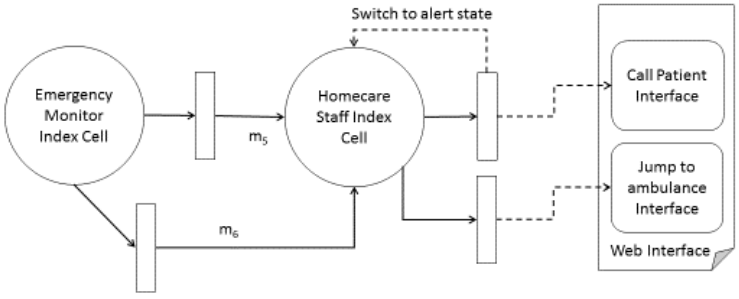
Now that we have captured the interfaces needed for each component, we can present the diagrams for each one of them. In the three Index Cells pictures below, each cell is connected with the consecutive index cell diagram. Due to space limitations, I had to break them down into three diagrams.



Motion Sensor Interface in collaboration with the Gesture Recognition Software (Index Cell)



Message Passing Interface of the Emergency Monitor (Index Cell)



Web Interface of the Homecare Staff (Index Cell)

(d) Following the discussion on the concept of patterns, define more clearly the pattern(s) you have identified. If you feel the patterns you have identified are lacking in certain respect, you may replace them by some new patterns

Pattern: LookAfterSeniorCitizen(P, C, S)

Problem: How can I take care of senior citizen in help?

Context: Figure out a way of taking care a senior citizen, which stays in his home

Solution: Recognize an emergency gesture, communicate with the emergency manager and send help to the patient

Pattern: CaptureEmergencyGesture(P, C, S)

Problem: how to recognize an emergency gesture from the patient?

Context: The emergency gesture should fit a profile of distress signal and will be captured by a motion sensor

Solution: Recognize a gesture using a network of motion sensors in collaboration with data stream management system

Pattern: NotifyEmergencyManager(P, C, S)

Problem: how to notify the emergency manager on time?

Context: The data stream management system will have internet connection that will allow it to push notifications to the emergency manager

Solution: The data stream management system will produce notifications that will be directly sent to the Emergency Manager (a database management system would not work in this case, because the emergency manager would have to poll the database in different timestamps. Therefore, an emergency would not be captured on time).

Pattern: AidThePatient(P, C, S)

Problem: how to aid a patient in need of help?

Context: The ambulance should be at the patient's place no more than 10 minutes after the distress signal. Also, if the patient does not reply on a call, the homecare staff should also send an ambulance.

Solution: The emergency manager pushes notifications to the homecare staff and depending on the history of a patient will either trigger a call or a visit to the patient.

(e) A visual specification of the identified pattern(s) should be included, using for example visual grammar rules. Remember Alexander's dictum: "If you can't draw a picture of it, it isn't a pattern.")

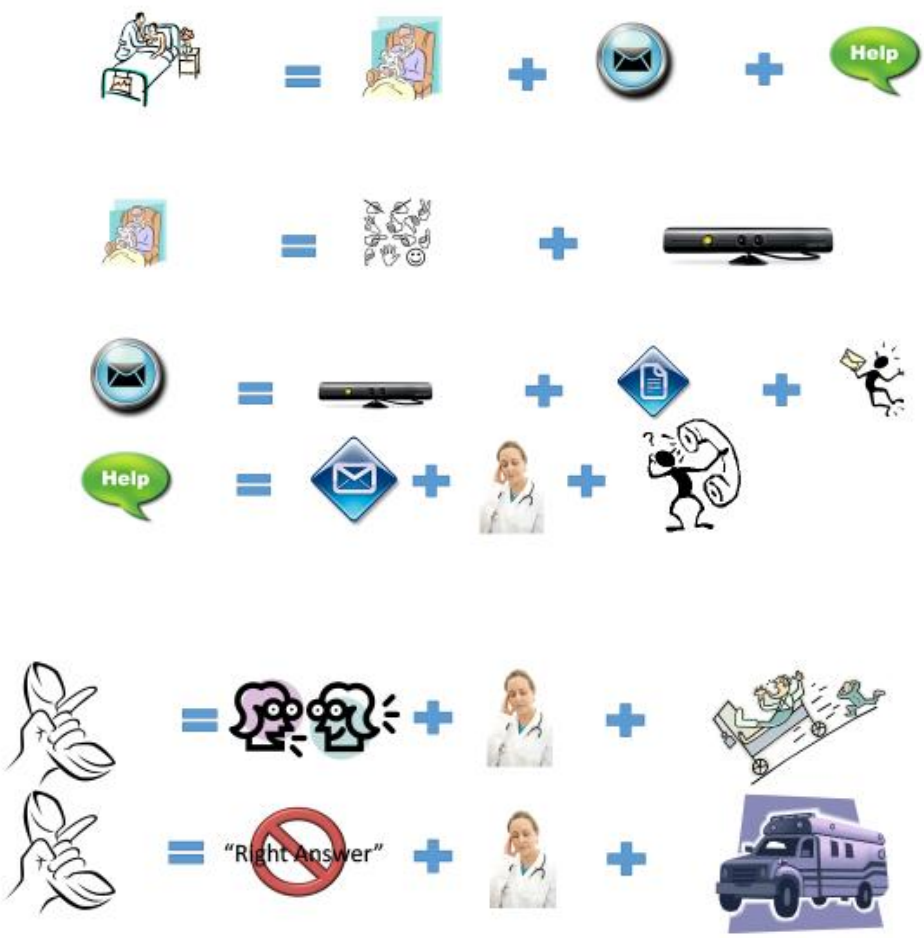
Through the theory of visual grammars, we will have to come up with a formal definition of the form G = (N, X, OP, s, R). G stands for grammar, N is the set of nonterminal symbols, X is the set of terminals (icons), OP is the set of spatial/relational operators, s the initial state (symbol), and R is the set of rules for changing/progressing states.

The set of nonterminal symbols consists of the following:

Starting from left to right, the names are: NotifyEmergencyManager, CaptureEmergencySignal, CallPatient, LookAfterSeniorCitizen, AidThePatient. Then, the set X consists of the following terminals:

Now, we also need to define the operators which are going to be the plus sign (+) and the equals sign (=). This way we can compose combinations of terminal icons to expand the non-terminal symbols. The initial non-terminal symbol is the patient:

Finally, the rules are the following:



The first rule initiates the scenario for taking care of a patient through gesture recognition. This breaks down to contacting the emergency manager for helping the patient. The second rule presents the way we gestures are captured (with a Kinect sensor), and the third defines the communication (push notification) with the emergency manager. The fourth dictates the call to the senior citizen (after the notification from the emergency manager, the homecare staff makes a call to the senior citizen) and the fifth and sixth define the cases where: a) the patient replies to the phone call (the whole system comes back to normal state), b) the patient does not reply and an ambulance needs to be sent.