**Concept Definitions**

In order to develop the concept definitions, we must first revisit the description of the use cases to identify interactions between actors and the system. We will then identify the internal concepts and classify them into ‘Know’ and ‘Do’ concepts.

**Boundary Concepts**

We begin by analyzing specific actors and their interactions with the system. In our case, the specific actors are human users and the system includes the software and hardware. The first set of responsibilities is as follows:

* R1: Login to user account (UserLogin)
* R2: Logout of user account (UserLogout)
* R3: Add user account (AddUser)
* R4: Remove user account (RemoveUser)
* R5: Add a device to the system (AddDevice)
* R6: View device status (ViewStatus)
* R7: Turn audio device on (AudioOn)
* R8: Turn audio device off (AudioOff)
* R9: Control audio volume (VolumeControl)
* R10: Turn lights on (LightOn)
* R11: Turn lights off (LightOff)
* R12: Control light brightness (BrightControl)
* R13: Turn on voice control with a specific key phrase (VoiceUnlock)
* R14: Turn off voice control with a specific key phrase (VoiceLock)
* R15: Create user account (CreateUser)
* R16: Delete user account (DeleteUser)
* R17: Send alerts to a specific user’s mobile device when a number of consecutive failed login attempts are made in a short amount of time (AlertUser)
* R18: Provide audio and visual feedback when user touches system controls (UserFeedback)

**Internal Concepts**

Now that interactions between users and the system have been identified, we analyze interactions between components of the system. These internal interactions can be split into ‘Know’ and ‘Do’ concepts. The set of ‘Know’ responsibilities are as follows:

* R19: Keep record of device statuses in database (RecordStatus)
* R20: Keep database of users and the respective login information of each user (StoreUserLogin)
* R21: Monitor lock status of locks around the home (MonitorLock)
* R22: Keep a record of home access attempts (RecordAccessAttempts)

The set of ‘Do’ responsibilities are as follows:

* R23: Add devices to database (AddDatabaseDevice)
* R24: Remove devices from database (RemoveDatabaseDevice)
* R25: Retrieve information about a device from the database (GetDeviceInfo)
* R26: Display device information on a screen in the appropriate section (DisplayDeviceInfo)
* R27: Update device status in database (UpdateStatus)
* R28: Send and receive signals between Arduino and server (SignalTransaction)
* R29: Sound buzzer when door opens (BuzzerOn)
* R30: Silence buzzer when door closes (BuzzerOff)

Many of the aforementioned responsibilities can be classified as part of a larger concept. Concepts for the home automation system will include the following:

* AccountAccess (R1, R2)
* AccountManagement (R3, R4, R15, R16)
* DeviceManagement (R5, R6, R28)
* DeviceControl (R7, R8, R9, R10, R11, R12, R13, R14, R28, R29, R30)
* UserMachineInteraction (R17, R18, R26)
* DatabaseManagement (R19, R20, R21, R22, R23, R24, R25, R27)

Each responsibility was broken down such that it could be implemented with a single program. The responsibilities were then categorized in a single concept. It is important to note that we assigned R28 to two concepts, while all remaining responsibilities were mapped to a concept only once. R28 is an important link between the hardware and software interface, which is why it needs to be mapped twice. This discussion of concepts is summarized in the following figure.