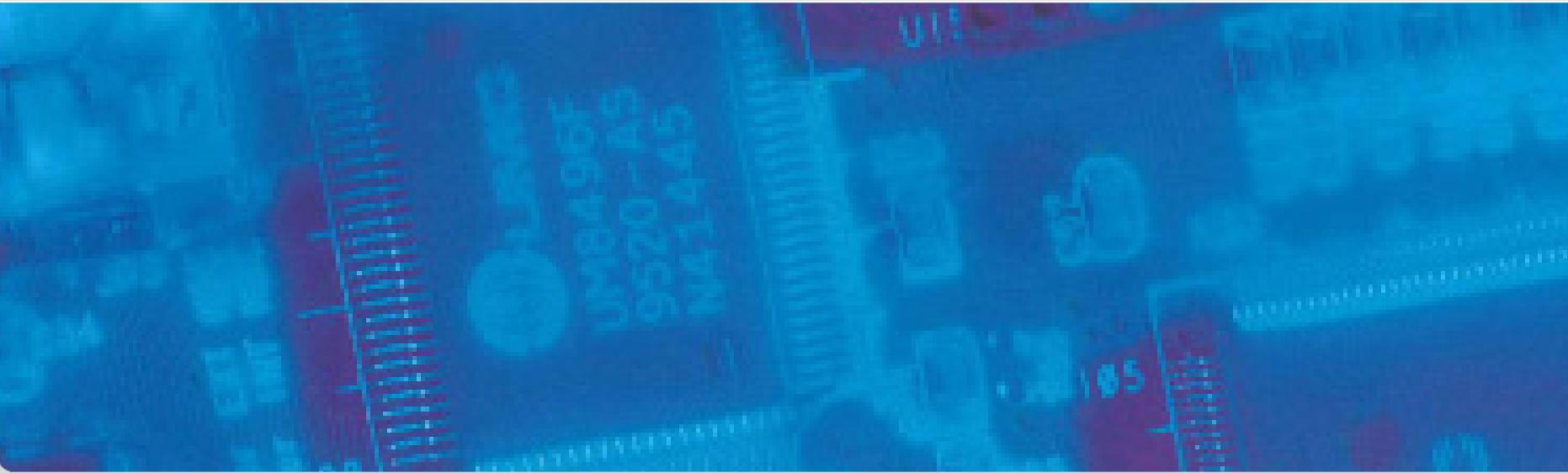


Design and Implementation of an IoT-based Control Device for an off-the-shelf Coffee Machine

Karim Ben Ammar

CES – Chair for Embedded Systems



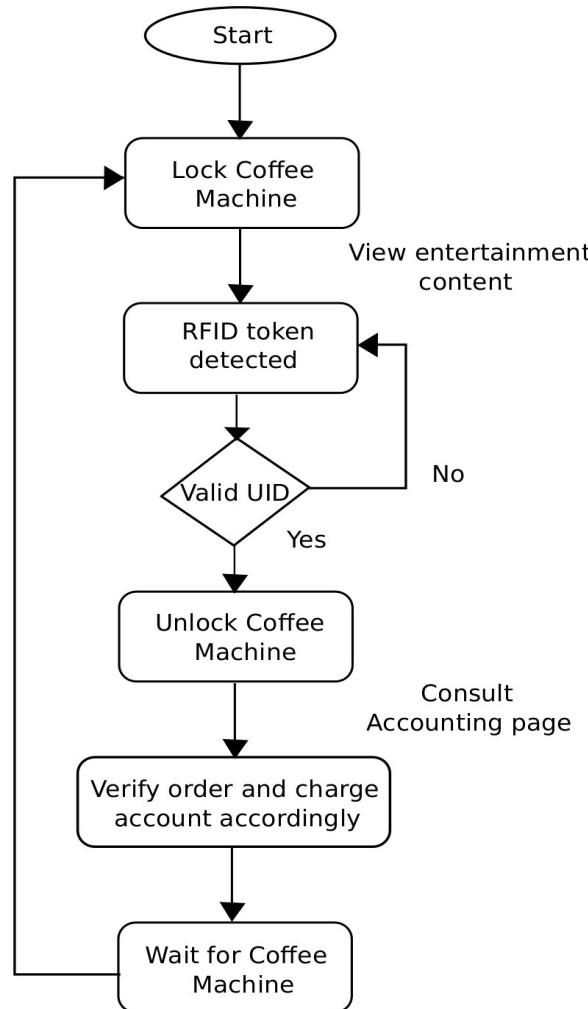
Outline

- Motivation
- Design/Implementation
- Challenges
- Conclusion

Motivation

- Limit usage to authorized users
 - Prevent money loss due to miscounting the tally sheets or users forgetting to write down their transaction, etc
 - The coffee machine may present an unusual behaviour
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- Solution: **Automated Control System**
 - Allow access only to authorized users
 - Automatically detect the user's choice and charge him accordingly
 - Keep track of the coffee machine's behaviour

Motivation : Workflow



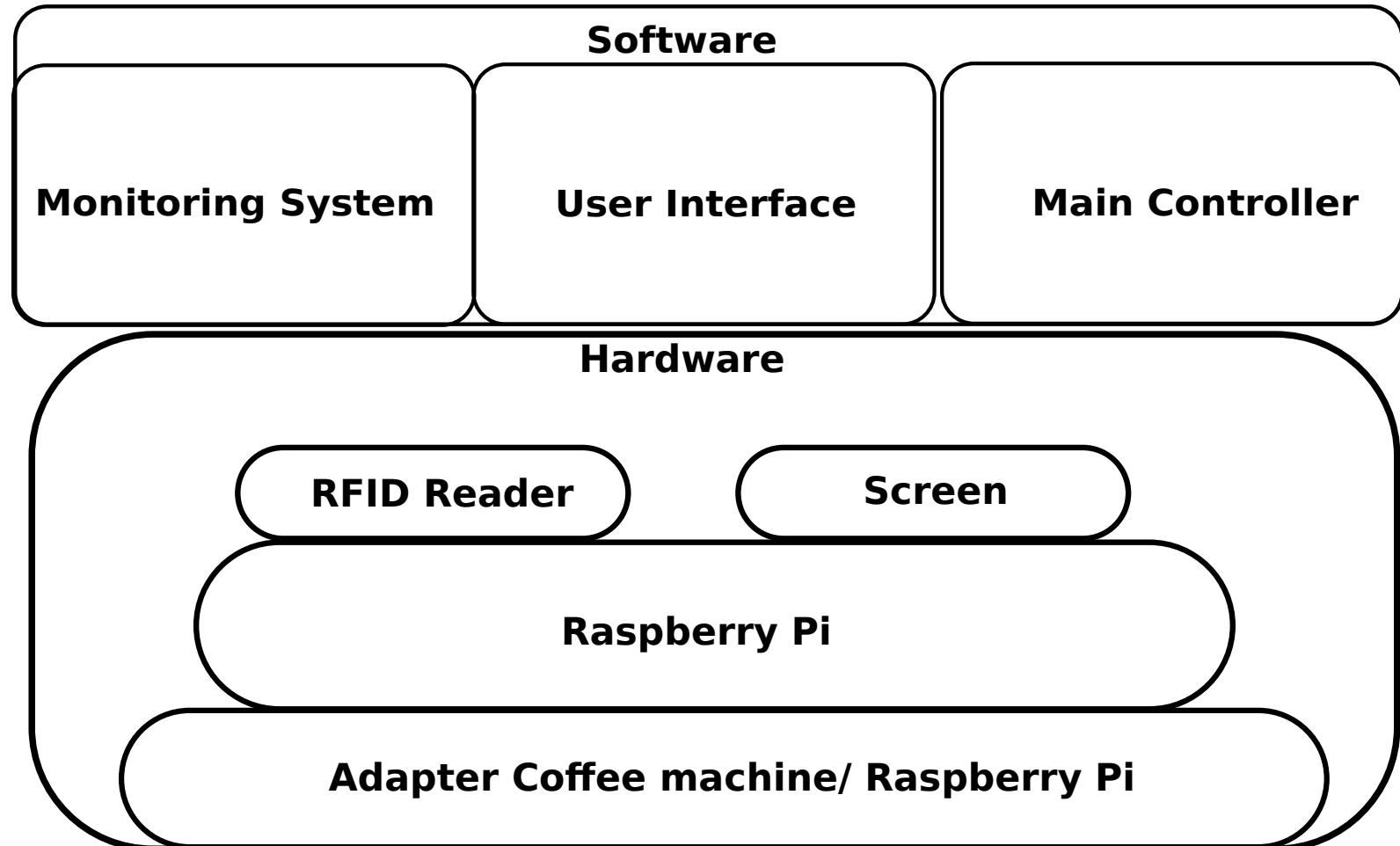
Design/Implementation

The system should :

- Lock the coffee machine until a valid RFID token is provided
- Automatically detect the state of the coffee machine
- Charge the user independently of the server's state
- Continuously monitor the coffee machine's behaviour and log it for future analysis

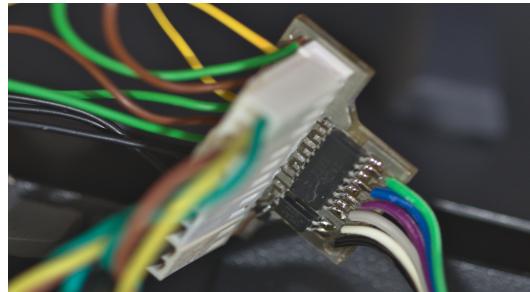


Design/ Implementation



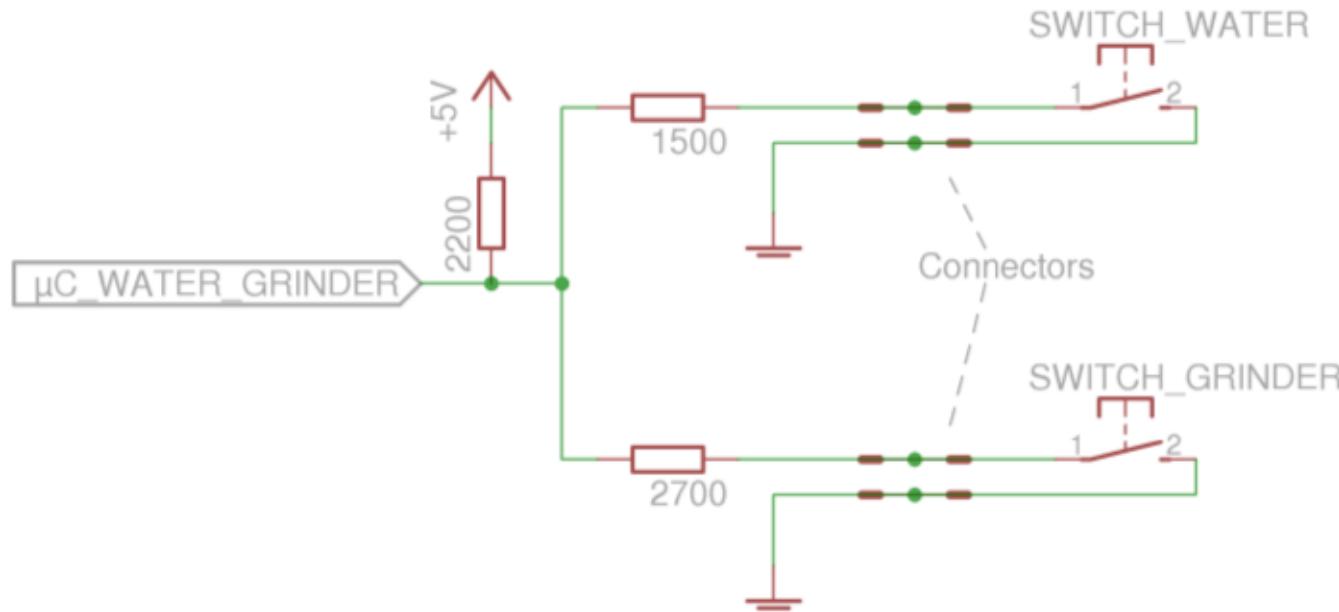
Hardware

- Raspberry Pi
- Official 7" touch screen
- Joy-IT RFID Module
- Custom PCB



Adapter Coffee machine/ Raspberry Pi

- Capture all the sensor's output
- Simulate the water level sensor (Lock/Unlock mechanism)



Tasks of the Raspberry Pi

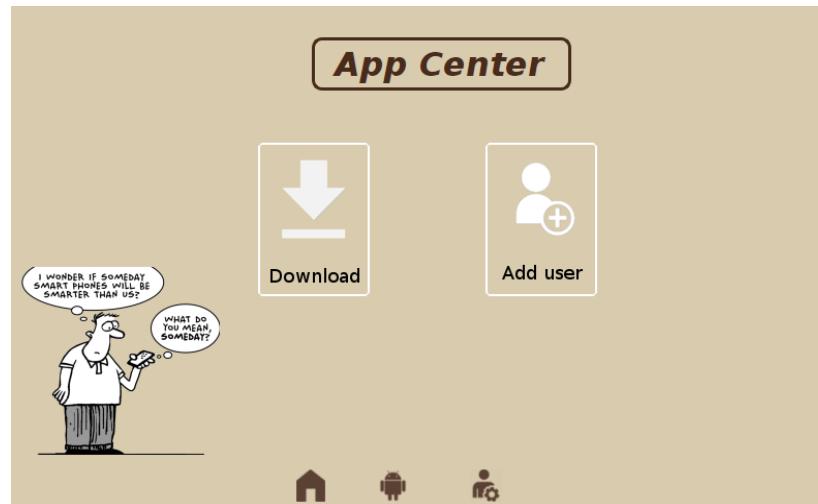
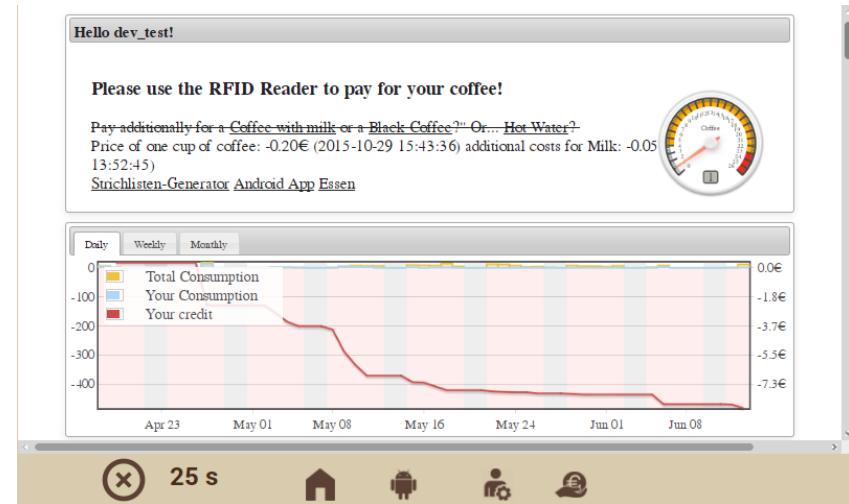
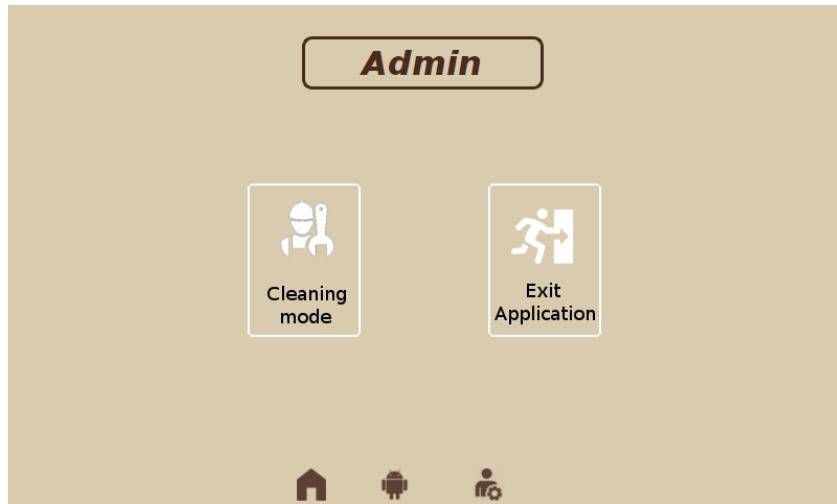
- Continuously listen to the RFID Reader
 - Update the entertainment content
 - Manage every transaction
 - Log the behaviour of the coffee machine
 - Listen for incoming HTTP requests from the Android app
-
- We can divide the system in 3 main parts : User interface, Main Controller, and Monitoring system

Software: User interface

- Provide entertainment content
- Show the accounting page of the current user
- Display the user's informations & order
- Milk choice

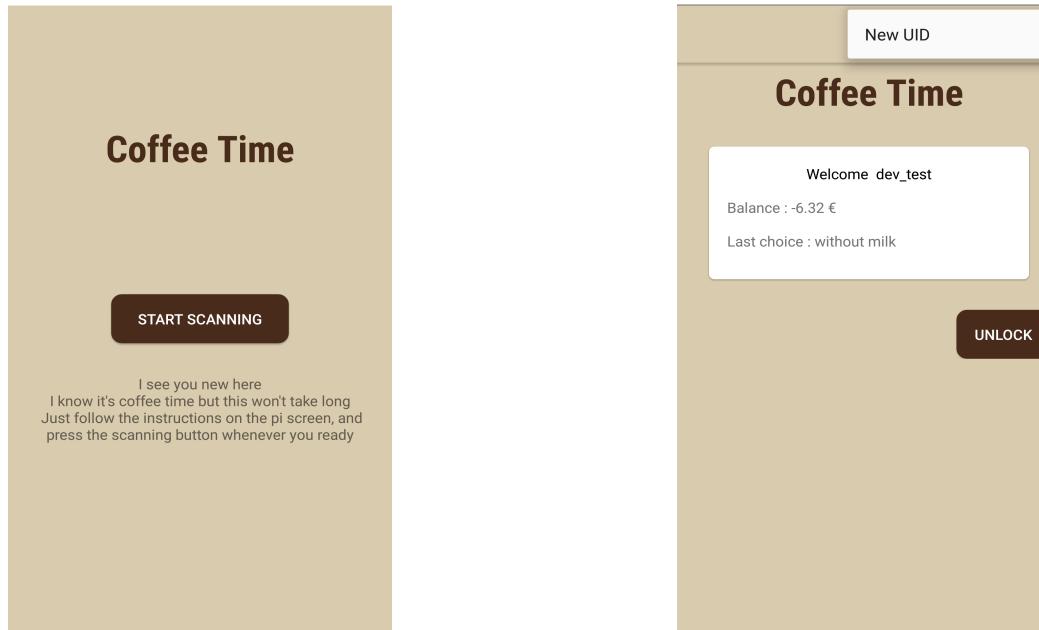


Software: User interface



Software: User interface

- Use a smartphone as an identification mechanism
- Manage between the 2 identification processes



Software: Main controller

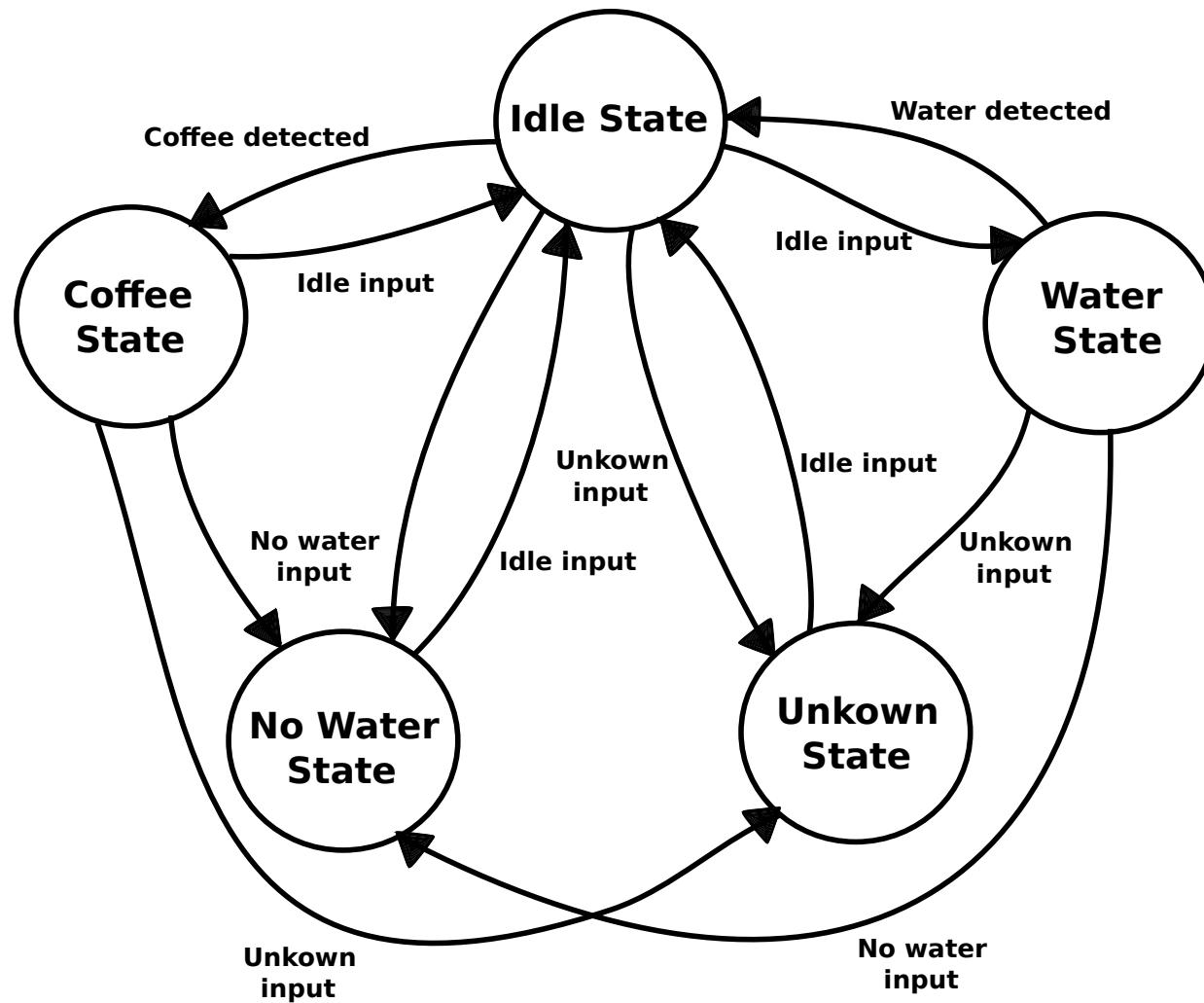
- Communication with the server : Get user information (Name & Balance) / Forwarding the user's order to the server
- Lock/Unlock the coffee machine + Buzzer
- RFID reading
- Daily check up :
 - Download the daily entertainment content
 - Forward any offline transaction to the server

Software: Monitoring System

- Continuously read from the coffee machine's sensors
- Generate the machine's corresponding Finite state machine (FSM)

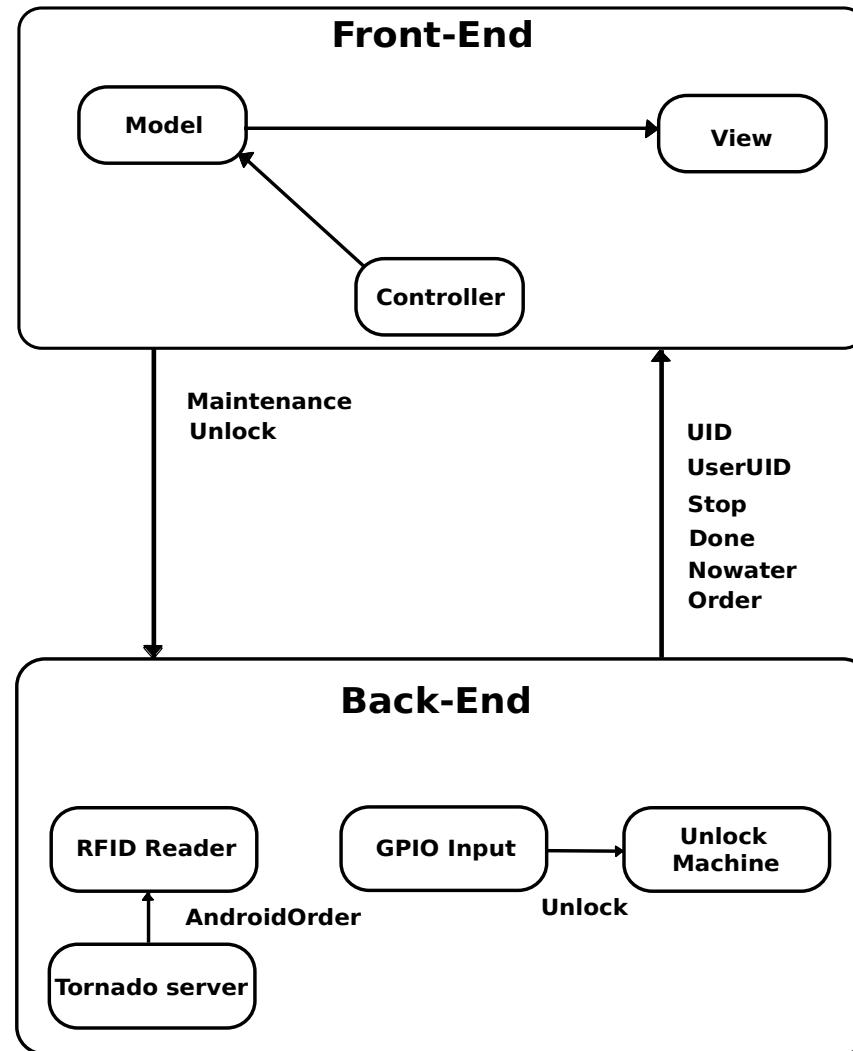
- Configuration :
 - Config file : Sensors name and pin number
 - States folder : Different sensors input for each state in a seperate file
 - Run the program

Software: FSM



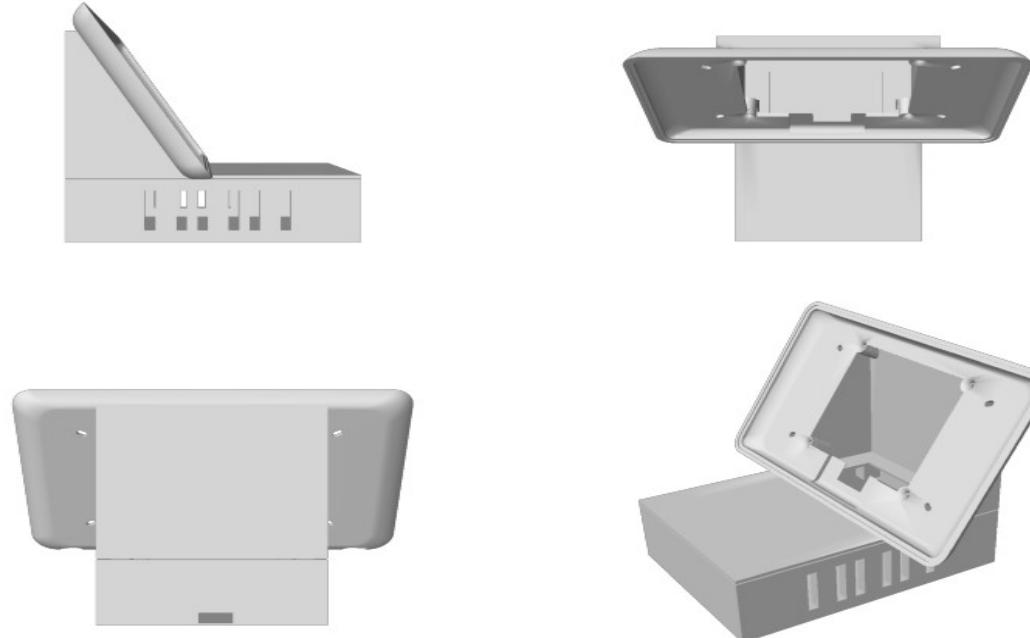
Process communication

- Shared memory
- Sockets
- Pipes
- Text files



3D Case

- Printed with *Formlab's Form 2*
- Modeling : Blender
- The whole case is composed from 3 separate parts
- Printing Time for each part : 15h.30min



Challenges

- No threads possible : separate processes
- No stable input detected
- Blocking Firewall
- Failing RFID Reader

Conclusion

- We created an automated control system that can be easily plugged to a coffee machine
- RFID Tokens based authentication system
- Smartphone based authentication system
- Offline mode
- Entertainment content
- Automated order detection -> charging the user accordingly
- Monitoring the coffee machine's behaviour, logging, etc
- Sound based state detection ?

Thanks you for your
attention !