**TEMASEK POLYTECHNIC**

**SCHOOL OF INFORMATICS & IT**

**AY2018/2019 APRIL SEMESTER TERM 2**

**SPECIALIST DIPLOMA IN AI SOLUTIONS DEVELOPMENT**

# MACHINE LEARNING SOLUTIONS DEVELOPMENT (CAI1C02)

Project Report

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Temasek POLYTECHNIC | School of Informatics & IT

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# 1. Introduction

The report summarizes the design and implementation details of a chatbot client named "AskFM".

This chatbot allows facility managers/ engineers/ technicians to manage the equipment in a building using a chat interface to facilitate maintenance chores e.g. equipment monitoring/ control etc, thus providing a natural language querying interface for the system.

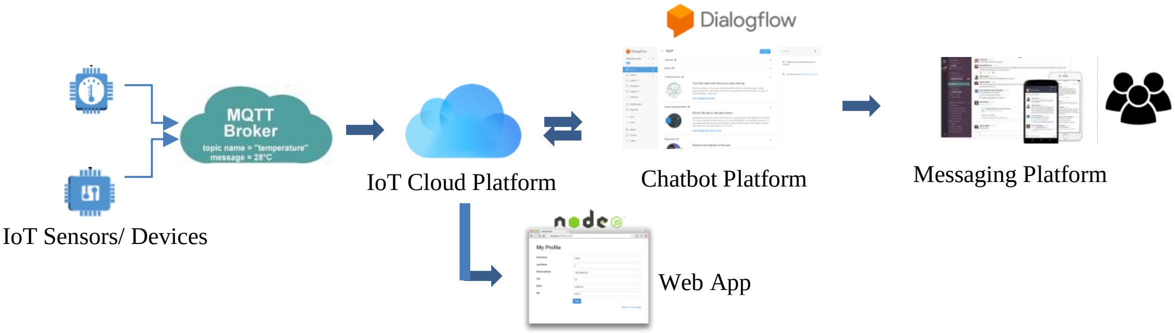


**Figure 1 – System Architecture**

This chatbot provides the following functions:

| s/n | Function | Description |
|---|---|---|
| 1 | Equipment Status Monitoring | Check the on/off status of the facility equipment e.g. AHU (Air Handling Unit), FCU (Fan Coil unit) etc. |
| 2 | Equipment Control | Turn on/ off the facility equipment |
| 3 | Equipment Scheduling | Schedule when the facility equipment will operate e.g. Daily from 8a.m. to 9p.m. |
| 4 | Thermostat Adjustment | Adjust the thermostat temperature setting for facility equipment in specific location of building |
| 5 | System Health Check | Check for unresolved faults in the facility equipment requiring attention |

**Table 1 - Chatbot Functions**

# 2. Scope

## 2.1 Intents

5 intents were created for each function identified for this chatbot, and are tabled below:

| s/n | Function | Intent | Parameters | |
|---|---|---|---|---|
| 1 | Equipment Status Monitoring | EquipmentStatusCheck | EqptName | Equipment Name |
| | | | EqptLocation | Location of equipment |
| | | | EqptParam | Equipment info requested |

| s/n | Function | Intent | Parameters | |
|---|---|---|---|---|
| | | | | e.g. run/stop status, temperature, humidity |
| 2 | Equipment Control | EquipmentControl | EqptName | Equipment Name |
| | | | EqptLocation | Location of equipment |
| | | | EqptCommand | Equipment start/stop command |
| 3 | Equipment Scheduling | EquipmentScheduling | EqptName | Equipment Name |
| | | | EqptLocation | Location of equipment |
| | | | SchStartTime | Start time of equipment |
| | | | SchStopTime | Stop time of equipment |
| | | | SchFrequency | Scheduling frequency e.g. daily, weekly etc. |
| 4 | Thermostat Adjustment | ThermostatAdjustment | EqptName | Equipment Name |
| | | | EqptLocation | Location of equipment |
| | | | SetTemp | Temperature Setting |
| 5 | System Health Check | SystemHealthCheck | EqptName | Equipment Name |
| | | | EqptLocation | Location of equipment |

**Table 2 - Chatbot Function/ Intent Mapping**

As can be observed from the table above, EqptName and EqptLocation parameters are used in all the intents. Training phrases are framed in order to solicit either the equipment name or location from the user entry.

## 2.2 Entities

To extract parameter values from the user, both system and developer entities are used. For direct parameter types e.g. temperature, time etc. system entities are used as listed in the table below:

| s/n | Parameter | Entity Type | Typical values |
|---|---|---|---|
| 1 | EqptName | @sys.any | FCU_L1_01 |
| 2 | EqptLocation | @sys.any | StarBucks, Let's Eat |
| 3 | SchStartTime | @sys.time | 9a.m. |
| 4 | SchStopTime | @sys.time | 10p.m. |
| 5 | SetTemp | @sys.temperature | 24C |

**Table 3 - Chatbot System Entity List**

For complex value extraction and to accommodate the myriad number of synonyms that map to the specific parameter value requested, developer entities are created as listed in the table below:

| s/n | Parameter | Entity Name | | Synonyms |
|---|---|---|---|---|
| 1 | EqptParam | EqptParam | Status | status, running, stopped, start |
| | | | Humidity | humid, stuffy |
| | | | Temperature | temp, hot, cold |
| | | | Schedule | sched, scheduling |
| 2 | EqptCommand | EqptCommand | Start | run, on |
| | | | Stop | off |
| 3 | SchFrequency | ScheduleFrequency | Daily | everyday, every day |
| | | | Weekly | every week |

| s/n | Parameter | Entity Name | | Synonyms |
|---|---|---|---|---|
| | | | Monthly | Every month, month |
| | | | Fortnightly | every 2 weeks, every other week |
| | | | Weekday | Week day, Mon to Fri |
| | | | Weekend | Non-working day, nonworking day, Sat and Sun |

**Table 4 - Chatbot Developer Entity List**

## 2.3 Process flow

All the intents provide direct answers to the user questions and do not require follow-up clarification with the user. The following figure illustrates the typical user interaction with the chatbot:

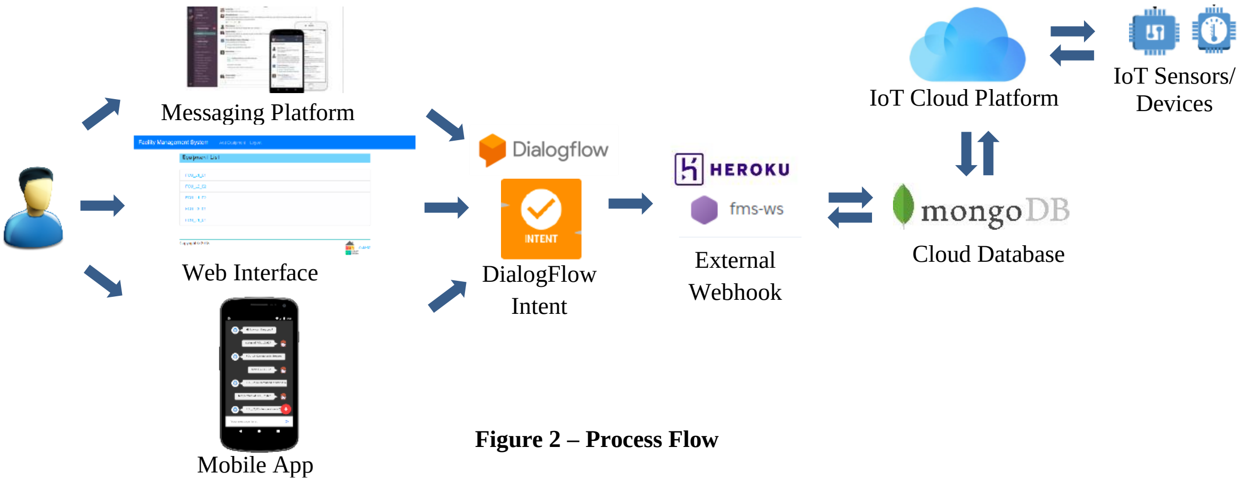


**Figure 2 – Process Flow**

The facility technician/ engineer can interact with the chatbot via multiple methods (web/ mobile app/ social messaging platform e.g. Slack/ Telegram). The corresponding intent is triggered based on the query sent and the request is fulfilled using an external NodeJS webhook hosted on the Heroku platform. The webhook retrieves/sends the equipment information/commands from/to a cloud database hosted on the Mongo DB Atlas platform. This cloud database interacts with the equipment using an intermediary IoT cloud platform (AWS/ Microsoft Azure) via restful API calls.

# 3. Status

## 3.1 Assumptions

The scope of the facility management system is limited only to ACMV devices e.g. AHU (air handling unit), FCU (fan cool unit) to adhere to the submission deadline and timeframes. However, it is envisaged that the system is expandable to accommodate other facility equipment not yet included.

## 3.2 Functions

All the functions of the chatbot as listed in Table 1 were implemented.

All the listed intents and entities were configured in the DialogFlow platform with fulfilment implemented via a NodeJS webhook hosted on the Heroku platform.

### 3.3 improvements / Additional features

In addition to the scope and features mentioned in the original proposal, the following additional features were added:

a) Integration with Telegram social platform in addition to Slack messaging platform.
b) Mobile App Integration using Ionic/ Cordova.
c) Implementation of webhook function using NodeJS and web front-end using jade templating engine and hosting on Heroku platform (https://fms-ws.herokuapp.com)
d) Implementation of backend cloud database using Mongo DB Atlas

### 3.4 Problems Encountered/ Challenges

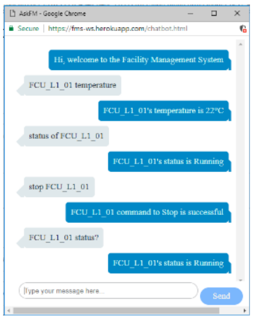
- All the intents accept either an equipment name or location as an input parameter for the webhook fulfilment to work. However, individual training phrases including each of name and location needed to be configured separately e.g. “FCU_L1_01 status”, “StarBucks status”. If only one is configured e.g. “FCU_L1_01 status”, the user phrase “StarBucks status” will not work.
- For training phrases that include more than one parameter, individual training phrases need to be configured to cater for the different appearance order of the parameter e.g. “status of FCU_L1_01” and “FCU_L1_01 status” (where *FCU_L1_01* and *status* refers to the “EqptName” and “EqptName” parameters respectively).

## 4. References

- [1] Rohan Kar, Rishin Haldar (2016). Applying Chatbots to the Internet of Things: Opportunities and Architectural Elements. International Journal of Advanced Computer Science and Applications(ijacsa), Volume 7 Issue 11, 2016.
- [2] Creating a NodeJS based Webhook for Intelligent Bots. https://chatbotslife.com/creating-a-nodejs-based-webhook-for-intelligent-bots-a91ecbe33402

## 5. Appendix

**Figure 3 – Chatbot Client Interfaces**


AskFM - Google Chrome
Secure | https://fms-ws.herokuapp.com/chatbot.html

Hi, welcome to the Facility Management System

FCU_L1_01 temperature

FCU_L1_01's temperature is 22°C

status of FCU_L1_01

FCU_L1_01's status is Running

stop FCU_L1_01

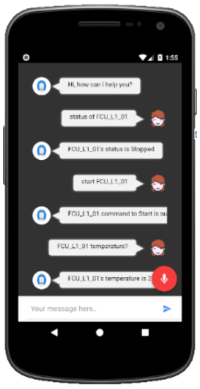
FCU_L1_01 command to Stop is successful

FCU_L1_01 status?

FCU_L1_01's status is Running

Type your message here...
Send

Web Chatbot Interface



Hi, how can I help you?

status of FCU_L1_01

FCU_L1_01's status is Stopped

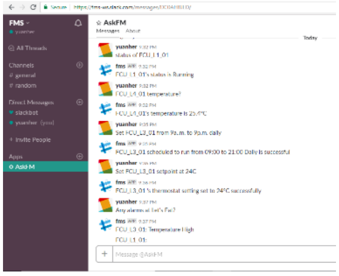
start FCU_L1_01

FCU_L1_01 command to Start is su

FCU_L1_01 temperature?

FCU_L1_01's temperature is 2

Mobile App Interface



yuanher 9:32 PM
status of FCU_L1_01

fms APP 9:32 PM
FCU_L1_01's status is Running

yuanher 9:32 PM
FCU_L4_01 temperature?

fms APP 9:32 PM
FCU_L4_01's temperature is 25.4°C

yuanher 9:35 PM
Set FCU_L3_01 from 9a.m. to 9p.m. daily

fms APP 9:35 PM
FCU_L3_01 scheduled to run from 09:00 to 21:00 Daily is successful

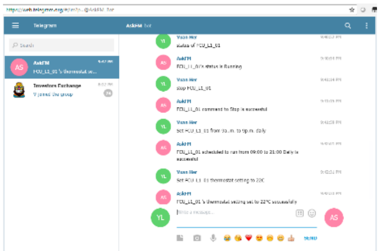
yuanher 9:36 PM
Set FCU_L3_01 setpoint at 24C

fms APP 9:36 PM
FCU_L3_01 's thermostat setting set to 24°C successfully

yuanher 9:37 PM
Any alarms at Let's Eat?

fms APP 9:37 PM
FCU_L3_01: Temperature High
FCU_L1_01:

Slack Messenger Interface


https://web.telegram.org/#/im?p=@AskFM_Bot
Telegram
AskFM bot
Search
AskFM
FCU_L1_01 's thermostat se...
Investors Exchange
V joined the group

Yuan Her
status of FCU_L1_01

AskFM
FCU_L1_01's status is Running

Yuan Her
stop FCU_L1_01

AskFM
FCU_L1_01 command to Stop is successful

Yuan Her
Set FCU_L1_01 from 9a.m. to 9p.m. daily

AskFM
FCU_L1_01 scheduled to run from 09:00 to 21:00 Daily is successful

Yuan Her
Set FCU_L1_01 thermostat setting to 22C

AskFM
FCU_L1_01 's thermostat setting set to 22°C successfully

Telegram Messenger Interface