PDR

February 10

2016

Making Facility Management more intelligent and efficient.

Preliminary Design Review

Revision record			
Version	Date	Authors	Comment
1.0	29.04.16	Zhili Shao	
1.1	04.05.16	Zhili Shao	Add function block diagram and IDEF0

Contents

1. System Requirements Analysis

Based on the stakeholders' requirements, existing solutions for HVAC control, SFM team identified system requirements for the HVAC control system, Table 1.1 green part lists the requirements of a smart HVAC control system may have, the first column shows the corresponding stakeholder requirements they satisfy. COTS column shows the modules will be used to implement system requirements. The classification has three level: "Must to have" means the functions can be found in normally used thermostat, which is the existing HVAC control panel we want to change. "Nice to have" means the functions that are preferred to add to existing HVAC control panel according to SFM team's survey to users. "Desirable" means functions also are preferred, but SFM team don't have enough time and capability to implement. The HVAC control panel will be improved with "desirable" function when the SFM team get enough resource.

Stakeholder Requirement	**System Requirement**	**COTS**	**Classification**
Monitor and adjust temperature	Collect temperature data for display and computation	Temperature Sensor	Must to have
Monitor humidity	Collect humidity data for display and computation	Humidity Sensor	Must to have
Monitor and adjust CO2-level	Collect CO2-level data for display and computation	CO2 Sensor	Must to have
Ease of use, Accessibility	Provide UI to interact with user	Touchscreen	Must to have
Ease of use	UI reaction logic, Communication with sensors, Data calculation, HVAC control signal output.	Microcontroller	Must to have
Adjust indoor environment, Compatibility with existing HVAC system, Ease of deployment	Connect to HVAC controller	4-Channel Relay Module	Must to have
Adjust humidity	Increase air humidity	Humidifier	Nice to have
Ease of use	Change the configuration of indoor temperature according to time.	Microcontroller	Nice to have
Energy saving, Ease of use	Automatically switch to economy mode	Motion Sensor	Nice to have
Ease of use	Collect weather information	WIFI module,	Desirable

	from internet	weather forecast website	
Accessibility, Ease of use	To tell information and setting about HVAC system using voice for blind people or people in dark room.	WIFI module, Voice interaction server	Desirable
Cost of implementation	Give user access to get information and setting HVAC system by website.	WIFI module, Website	Desirable
Ease of use	Give user access to get information and setting HVAC system by mobile phone.	WIFI module, Apps	Desirable

Table 1.1 System Requirement Analysis

2. Function Analysis

Figure 2.1 shows overview of the Function Analysis Block Diagram, more detail can be found form ANNEX 7.1. First level shows the system requirements. Left three with red boundary are the system requirements "Nice to have", and they are designed as the new functions will make the thermostat smarter. The right part illustrates function analysis of existing thermostat, they are very commonly used in our daily lift for home and office buildings.

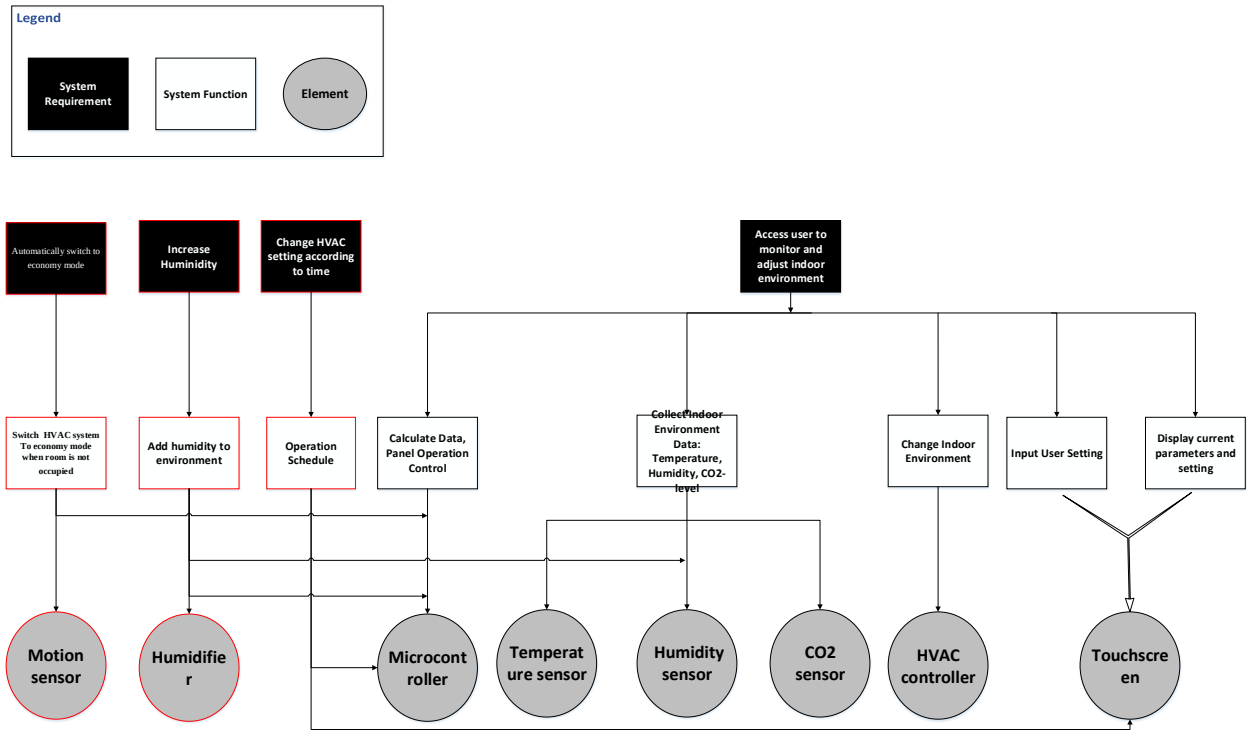


Figure 2.1 Functions Analysis Block Diagram

3. Function Block Diagram

Figure 3.1 show the function block diagram of HVAC control panel, and it mainly focus on the new requirements that will make HVAC control smart for user to use. The three new function are the "Nice to have" functions mentioned in table 1.1.

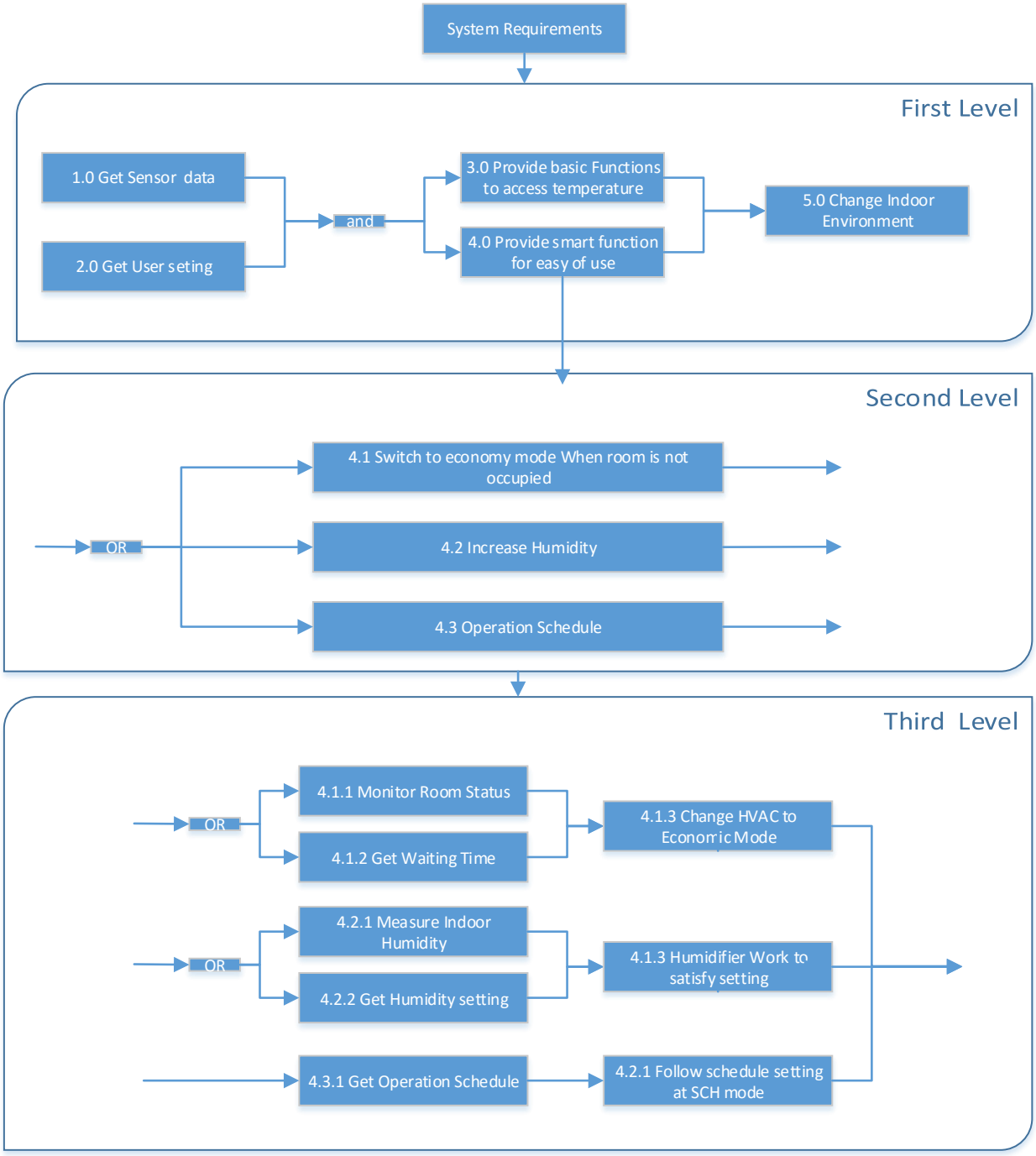


Figure3.1 Function Block Diagram

4. IDEF0 Diagram

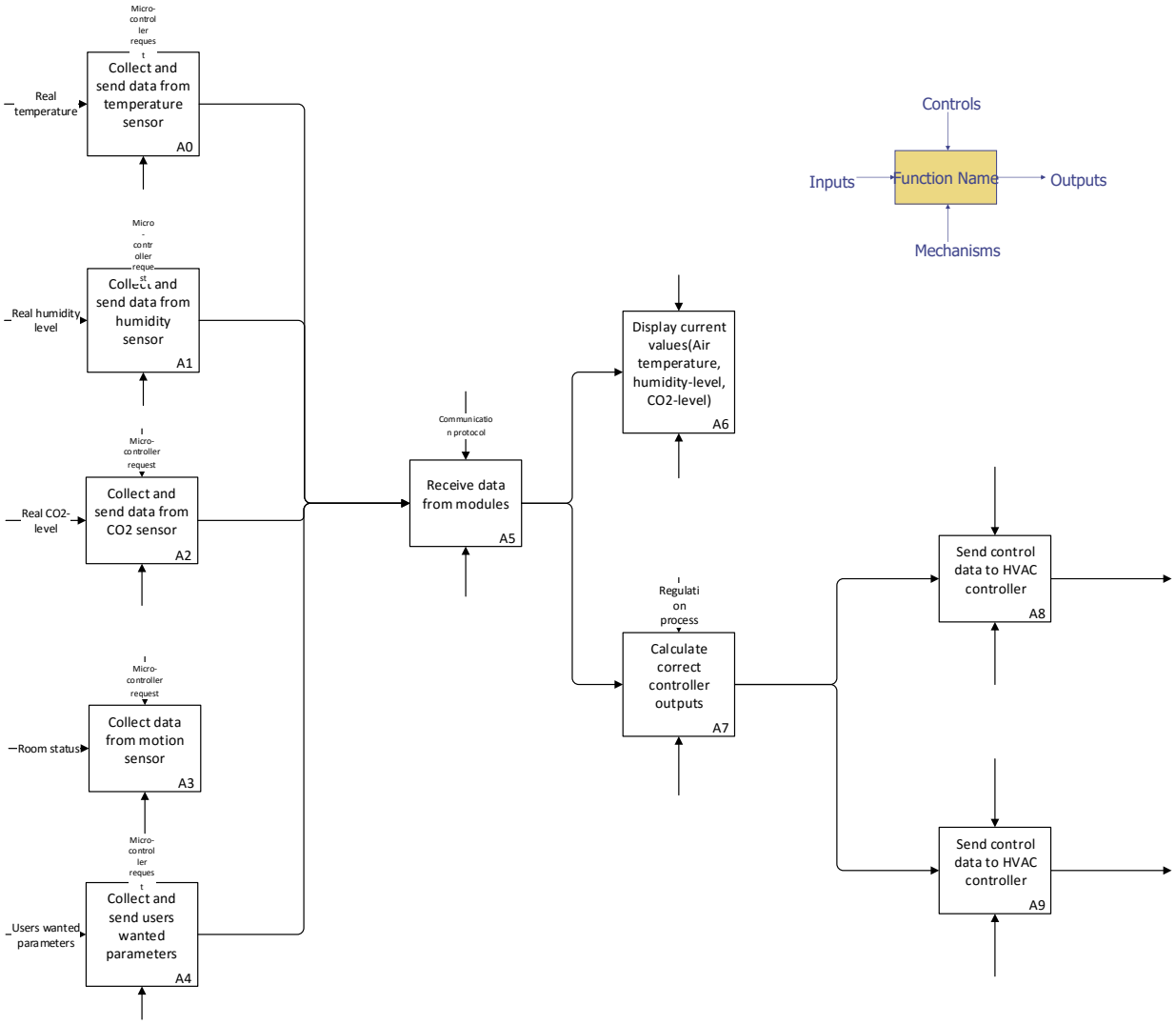


Figure 4.1 IDF0 Diagram

5. Human-machine interfaces

SFM team designed the human-machine interfaces for the HVAC control system. Figure 4.1 shows the default page which are mostly used by users. Firstly, user can easily get access to time, weekday, date from the left part of screen, touch their position to change their value. In the middle area of the screen, it provides the information of temperature, humidity and CO2-level. Through the buttons "+" and "-", users can easily set the values of temperature and humidity they want, the CO2 threshold stands for when indoor CO2 reach to this level, Fan start to work to decrease CO2 level. When users push the button, the parameters will increase or decrease one

unite every time. If user hold the buttons for a period of time, the values can increase or decrease quickly. Motion sensor waiting time can be increased or decreased half one-hour every time. When the room is not occupied for this period of time, the HVAC system will switch to economy mode automatically. For the Fan control, users can turn on it or set to Auto. When the cooler or heater start to work, the fan will turn on. Also it will start to work when the CO2-level higher than set threshold. There are three modes for the HVAC control, cool mode will active the air conditioner to work, its boundary will become green when it is active, heat mode will active the heater to work. On SCH mode, thermostat will operate according to schedule. Pushing "OFF" button, HVAC system will stop to work, but the time and indoor environment area still shows the real-time parameters. Users can also configure the parameters, then the setting will be available when the HVAC system starts to work. Pushing "SET SCHEDULE" will enter the user interface for schedule setting, Figure 4.2 shows the user interface of "SET SCHEDULE".

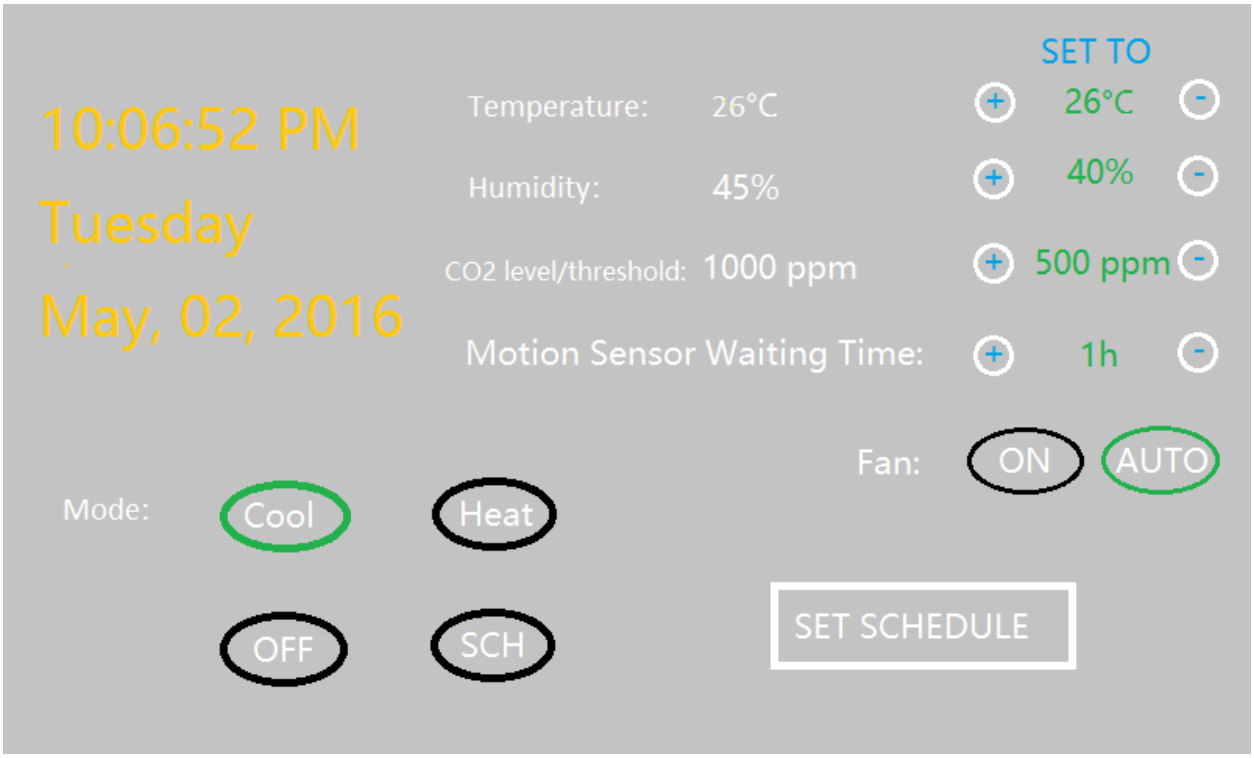


Figure 5.1 Default Page

Users can set the temperature schedule for one week. For certain day, users can choose one time through the black stick, and a dialog block will appear like the green-boundary block. Users can set the temperature they want at this time point, choosing "Save" button to save or "Delete" button to delete setting. Here only temperature will be set, because it's the most sensitive

parameter which people concerns about. For humidity and CO2-level, it will be stable once users set them to a proper value.

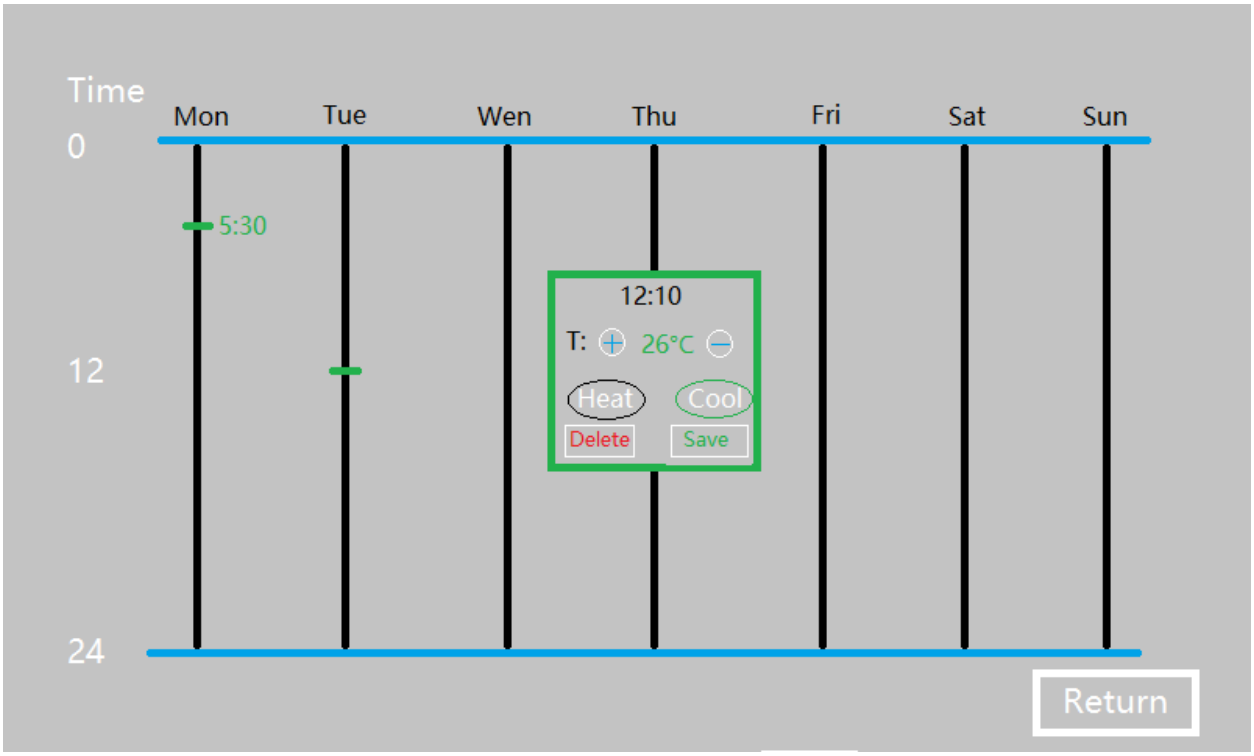


Figure 5.2 SET SCHEDULE

6. Parameter Scope

Power Supply: 24V 15W (from HVAC controller)

Temperature Regulation Range: 10℃ to 30℃ (change 1℃ every time)

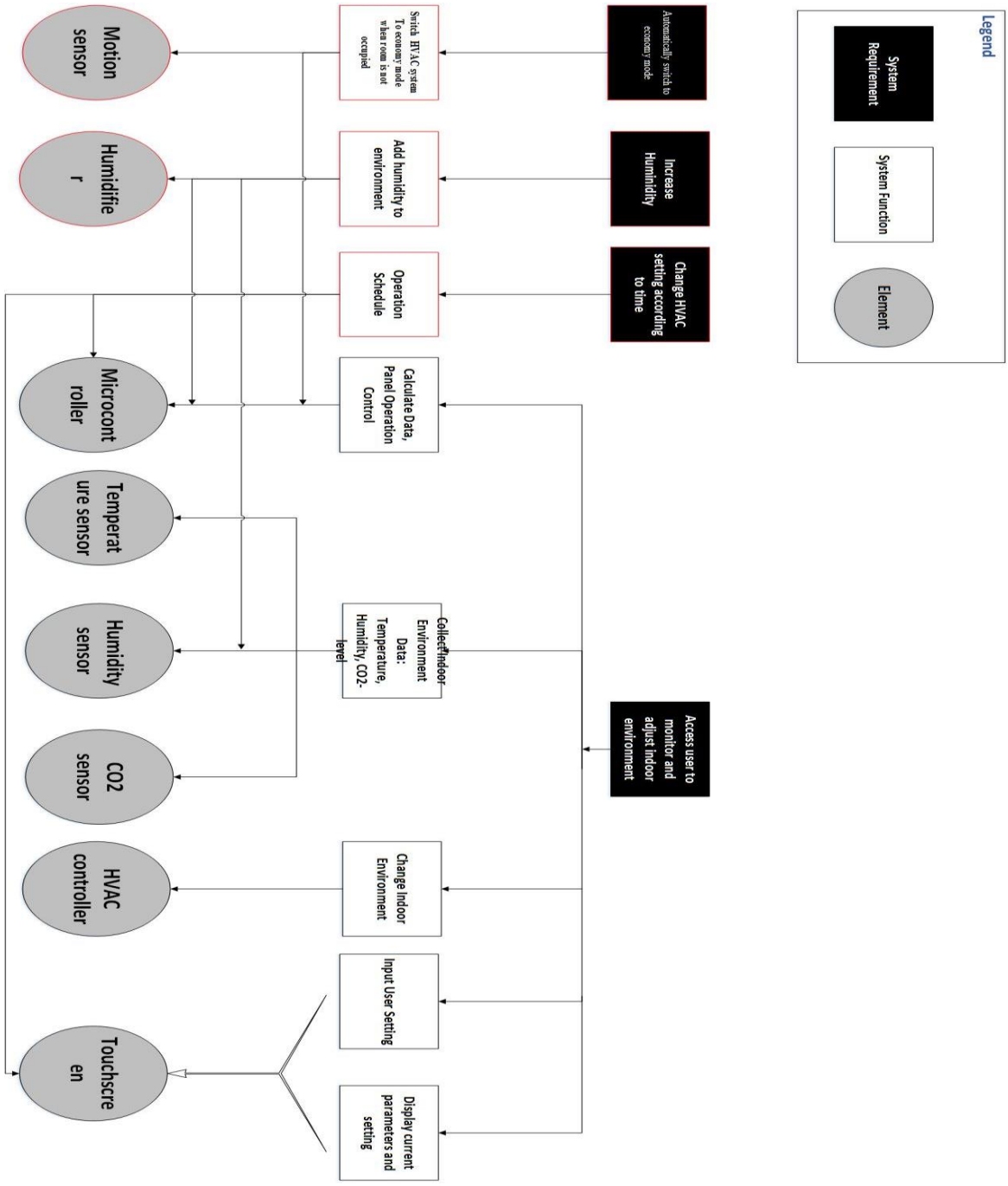
Relative Humidity Regulation Range: 25% to 60% (change 1% every time)

CO2-level Regulation Range: 500ppm to 2000ppm (change 50ppm every time)

Motion Sensor Waiting Time: 0.5h to 5h (change 0.5h every time)

7. ANNE

7.1 Function Analysis Block Diagram



8. References

[1] Blanchard, Benjamin S. c2008. *System engineering management*. Hoboken, NJ .

[2] ES-4000 Systems Engineering slides

[3] http://www.idef.com/