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"Instruction-Category" Approach of Test Suite Construction for Oven Embedded System

Mengqing Tanli[1], Jiyi Xiao[1], Ying Zhang[2]

[1]School of Software, University of South China, Hengyang, China
[2]School of Mechanical Engineering, University of South China, Hengyang, China
Email: TLMQ-TEAM@163.com

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Abstract

Being different from testing for popular GUI software, the "instruction-category" approach is proposed for testing embedded system. This approach is constructed by three steps including refining items, drawing instruction-brief and instruction-category, and constructing test suite. Consequently, this approach is adopted to test oven embedded system, and detail process is deeply discussed. As a result, the factual result indicates that the "instruction-category" approach can be effectively applied in embedded system testing as a black-box method for conformity testing.

Keywords

"Instruction-Category" Approach, Test Suite Construction, Embedded System

1. Introduction

As a developing industry country with complete industrial system, almost all kinds of industry product can be manufactured under own producing ability of China. However, without excessive taboo, it is only "Almost" in the informationalization age and global supply chains. On the other hand, in our assembly product, there are always some parts or components that were fabricated in other districts or countries via global economic cooperation. That is to say, in our own assembly products, some parts or components are produced in other places. Moreover, some high technology products including software system are imported from other countries.

Following the global supply chains, the quality assurance of part and component or product, demonstrated as above, has become an incompletely solved problem with lower cost and high effectiveness, especially for medium-small en-

terprises under e-commerce environment. For these parts and components or products, the quality state should be also supervised by our related government department, and the reasonable supervision structure should be adopted. However, it is noticed that the supervision point should be set in market monitoring rather production process monitoring of manufacturing factory. Consequently, the testing technology including software testing techniques [1] [2] is the basis of quality supervision.

Embedded system, generally as an application software, is widely used in industry area and routine life today. How to assure the effectiveness of quality supervision of embedded system and improve the accuracy and efficiency of embedded system testing are a very important issue [3]. Inventing and constructing effective testing approach especially for embedded system is an important technological task in software testing [1]-[3].

2. Related Literature and Work

Louse Tamres has proposed the "outline" approach in his book "Introducing Software Testing" [4], which the test categories are applied and test cases eventually created based on these test categories. However, the "outline" approach is based on requirements in software development.

Kim G. Larsen, *et al.* [5] discussed the testing problem of real-time embedded system with UPPAAL-TRON, and the concept of "conformance testing" was proposed. In their research, a practical example of electronic thermostat regulator was deeply analyzed, and IUT (Implementation under Test) is EKC201 manufactured by Danfoss. However, the conformance testing in their study focused on input and output, and the safety testing of IUT system/device was not strengthened.

In the study of Rodrigo P. Pontes, *et al.* [6], the practical experience of verifying an on-board data handling software was demonstrated, but its test object is not an industrial scene with real-time processing.

As a creative approach for embedded system testing, by summarizing from home and abroad [3]-[6], we proposed the "instruction-category" approach based on "product instruction" to deal with the testing problem of factual embedded system, in which the scene our faced is product quality monitoring for market rather the product quality control for development, and the safety testing, as one critical item of system testing [7] [8], is strengthened.

Recent study [7] has deeply investigated the strategy and methodology of integration testing for GUI software, which focus on the test suite construction of integration testing. Similarly, our work [9] has discussed the test suite construction of unit testing for new testing organization—"pair-wise" mode, and a previous work [10] has proposed the method of test suite construction for smoke test which tackled a typical quality control scene of shop-floor in manufacturing factory. Additionally, some recent research works [11] [12] focus on "grey-box" approach for GUI-oriented software testing, which test suite construction based on the "Grey-box" approach is deeply discussed. Consequently, this study will

discuss test suite construction of conformity testing for embedded system including information collection of product instruction, refining of instruction content, drawing of test category and final test suite construction based on "instruction-category". As a key point, the test suite construction of oven embedded system will be depicted for factual scene.

Our team has investigated the strategy and methodology of GUI-oriented software testing with a lot volume of discussion. But these work mainly tackled with the software testing for software producer from internal view [13]. Now, it is necessary to do a little discussion from external view and top view of product quality supervision of government.

This study will answer following questions. 1) What to do in conformity testing for embedded system. 2) How to perform the conformity testing for embedded system and how to perform the "instruction-category" approach. 3) Detail construction of test suite for oven embedded system.

3. Embedded System and Its Conformity Testing

3.1. Embedded System

The embedded system usually includes three parts: 1) sensor section, 2) computation and information processing section—generally micro-controller, and 3) actuator section. As following **Figure 1** shows, the sensor section serves to information gathering, and it will use various sensors to get required physical quantities, e.g. temperature (t), pressure (p), position (x, y, and z), velocity ($v_x/v_y/v_z$, or $\omega_x/\omega_y/\omega_z$), etc. As a consequence, the computation and information processing section is the brain of embedded system, acquisition information from sensors are input into this brain and output control instruct to actuator in terms of specification. At the same time, all required computing, analysis and tackling are done in this brain. Conversely, the actuator section serves to operate actuating, and it will output all kinds of instructions to execute the corresponding operation.

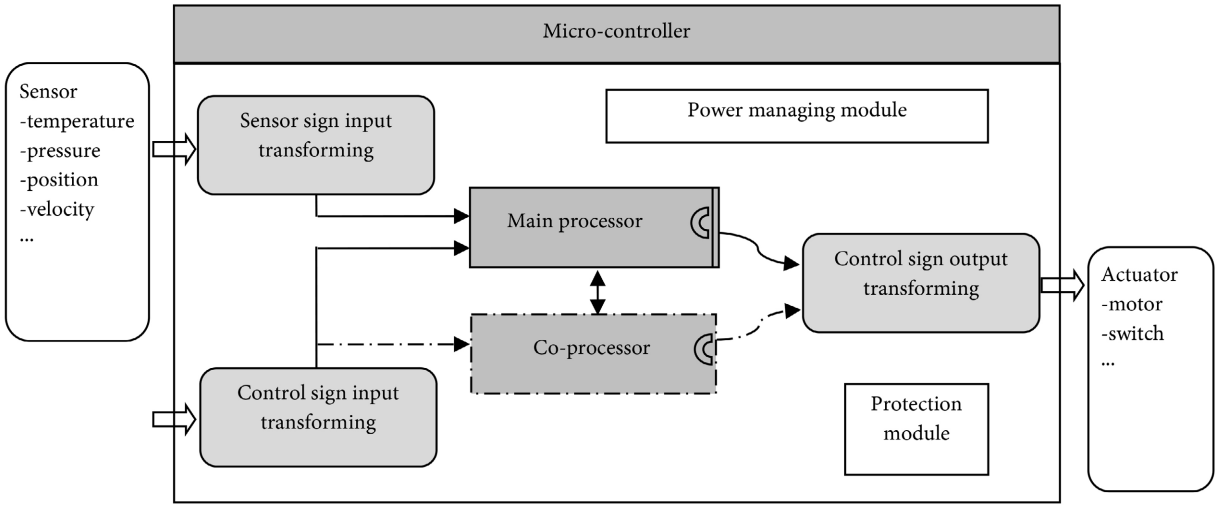

Figure 1. The general frame of embedded system.

3.2. Conformity Testing of Embedded System

The digital and intelligent product with embedded system have been widely applied and used in industrial production and popular life, however, their testing is a difficult issue [3], especially for heterogeneous platform system. In China, at the level of import supervision and control of abroad product, it is a dilemma and an essential trade-off for software testing of embedded system for abroad product with blind internal structure and detail logic [14], because of the technological protection of abroad product, e.g. intellectual property protection.

The conformity testing of embedded system should include following contents: 1) Function testing—For the majority of embedded system, the action loop "start-run-alarm-record-stop" should be mainly considered. 2) Safety testing [8]—Obliging to "up and below limitation" is basic safety consideration, at the same time, you must take care of some unusual state. 3) Verification and acceptance testing [1] [2]—Testing task should be noted upon end-user and factual operator. 4) Accessibility testing—Some usability testing including easy-to-use of key.

4. "Instruction-Category" Approach for Embedded System

4.1. The Profile of Tackling Program

The "instruction-category" approach is a black-box method [14] at some extent, and its basic principle is the taxonomy for testing contents. In the book of Louise Tamres [4], for the construction of test cases for developing procedure, the outline approach along requirement analysis should be divided into four steps, including: 1) extracting the requirement, 2) creating test outline, 3) producing and applying test categories to create detail outline, 4) creating test cases. Because the embedded system testing here is a task based on market monitoring, rather than test design for software development, the process organizing must be rearranged in terms of product monitoring for market. At first, the step of "Extracting the requirement" should be replaced by "classifying and refining software instruction". At the same time, considering the features of the embedded system especially with micro-controller, the process of creating detail outline should be altered to conducting of "instruction-brief" and "instruction-category". As a consequence, many times, the tackling program of "instruction-category" approach should include four steps, *i.e.*: 1) Classify and refine the software instruction from the specification of producer; 2) Refine "instruction-brief"; 3) Draw "instruction-category"; 4) Construct test suite and test cases. In brief, the profile of "instruction-category" approach can be concluded as shown in **Figure 2**.

4.2. General Process of "Instruction-Category" Approach

When the producer requires the test department to test and verify an embedded system, there generally are three situations. 1) Determining whether or not a system meets the specified requirement in function and performance; 2) Testing whether or not the performance of the system has reached the index; 3) Verifying

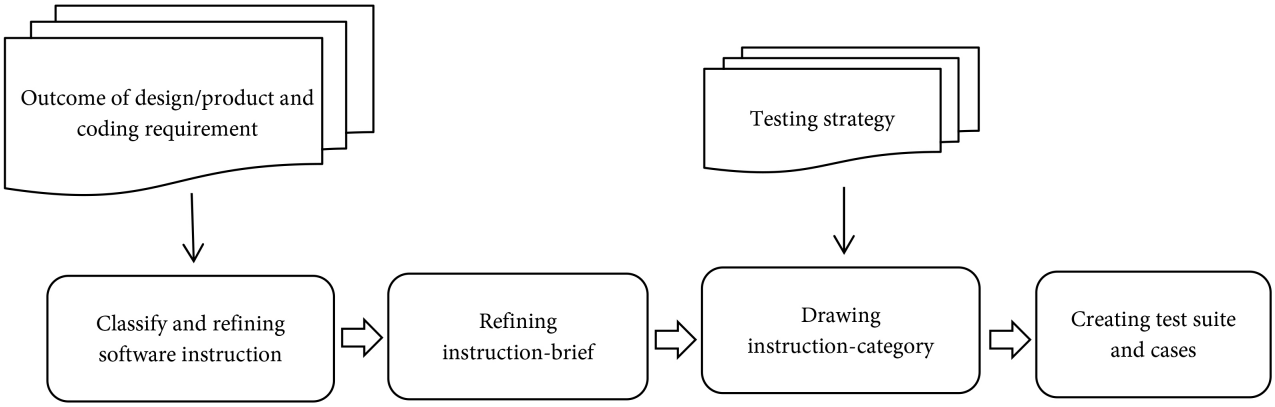

Figure 2. The profile of "instruction-category" approach.

whether or not the function and performance have been better than old one/the previous version. Usually, the first one is more popular. For the tester or test designer, there are two materials to tackle for test department, *i.e.* 1) The design document is given; 2) The product instruction is supplied. For the market monitoring, the second one is a usual status. Anyway, all content of the material must be arranged and sorted, then assign the context into consistent code item-to-item with [I-##] that matters most.

1) Instruction-brief.

If the product instruction is "richer", the tester can start refining "instruction-brief" at once. If the content of product instruction is more "poor", the tester should expand your testing materials including the operation of product system. Generally, the general format of "instruction-brief" can refer to **Figure 3**, and it is noticed that [I-##] refers to the code of context item of product instruction, which will be accounted for later.

```
1 Key parameter to consider - may be several parameters
    1.1 [I-##] Boundary
    1.2 [I-##] Interval
    1.3 [I-##] Default
2 Control mode I - usually "Manual mode"
    2.1 [I-##] Key parameter A
    2.2 [I-##] Start
    2.3 [I-##] Stop
3 Control mode II - usually "Automatic mode"
    3.1 [I-##] Key parameter A
    3.2 [I-##] Key parameter B
    3.3 [I-##] Start
    3.4 Stop
        3.4.1 [I-##] Stop parameter a
        3.4.2 [I-##] Stop command
```

Figure 3. The list of the general format of instruction-brief.

2) Instruction-category

The "instruction-category" is a dedicated technological classification with more

details. At some extent, it should be more synthetic than "instruction-brief". In "instruction-category", all control parameters can be inserted into "control mode" categories. As a result, the general format of "instruction-category" is shown in Figure 4.

1 Control mode I - usually "Manual mode"
- 1.1 Key parameter A
  - 1.1.1 [I-##] Boundaries
  - 1.1.2 [I-##] Intervals
  - 1.1.3 [I-##] Default
- 1.2 [I-##] Start
- 1.3 [I-##] Stop

2 Control mode II - usually "Automatic mode"
- 2.1 Key parameter A
  - 2.1.1 [I-##] Boundaries
  - 2.1.2 [I-##] Intervals
  - 2.1.3 [I-##] Default
- 2.2 Key parameter B
  - 2.2.1 [I-##] Boundaries
  - 2.2.2 [I-##] Intervals
  - 2.2.3 [I-##] Default
- 2.3 [I-##] Start
- 2.4 Stop
  - 2.4.1 [I-##] Stop parameter a
  - 2.4.2 [I-##] Stop command

Figure 4. The list of the general format of instruction-category.

3) Construction of test suite

In terms of "instruction-category", the tester or test designer can construct the test suite of the embedded system. This process is not very difficult for a tester with a bit of experience [15]. However, there are some differences from past content of test construction for GUI-oriented software [12]. In brief, the tester must notice that: a) The prior state should be given for every test case; b) The repeated test case must be deleted; c) If necessary, display output can be written in "expected results" column.

5. Application of "Instruction-Category" to Oven Embedded System

5.1. Product Analysis

The digital oven, in our study, is a house-ware made in Germany. In this product, there is a simply user-interface without redundant operation. Specially, it is characterized with convenient setting and good usability. Additionally, the whole figure shape is stable and coordinated without less beauty. In a word, it embraces the dedicated feature of German products.

The main function of this oven is to cook food in terms of setup temperature and time, or user customization in which ten user modes are given. Based on general requirement of software testing, we get following features from product instruction of this oven [4].

1) The control panel adopts digital display, and it is shown with clearness and

convenient to operate.

2) The displaying interface is fitly layout and easy to use.

3) Button "open" and "shut off" applies the same key and operates with simplicity.

4) The adjustment of cooking temperature adopts fine-tuning key rather "Edit-box" pattern, which avoid the mistake of user operation, and specified data is set with interval of 5˚C.

5) The adjustment of cooking time also adopts fine-tuning key rather "Edit-box" pattern, which avoids mistake occurring, and specified data is set with interval of 1 min.

6) In the cooking process, re-setting is considered for parameters setting.

7) The limitation of cooking temperature is 80˚C - 200˚C and cooking time is 1 min - 90 min.

8) In order to keep safety, reasonable tackling is set-up as follows.

a) The default setting for starting to get convenience and avoid the careless operation.

b) The operation of over-limitation is not able to be accessed.

c) When the door is opened, the oven will shut off until it is closed.

d) After the oven shuts off, the cooling fan will run for 20 seconds.

5.2. Testing Requirement

This conformity testing should test following contents.

1) All kinds of function of the oven, including:

a) The specified cooking function.

b) User customized function.

2) Safety assurance, including reasonable dealing with:

a) Over-ranging of cooking temperature and time.

b) Misoperation.

c) The state of damaging device.

d) The state of injuring people.

5.3. Test Suite Construction Based on "Instruction-Category" Approach

5.3.1. Refining Instruction and Drawing Improved STD

1) Refining item from product instruction

If you have got product instruction, instruction items can be refined from the product instruction. In this instruction itemization process, you must pay attention to accuracy, completeness and briefness. Additionally, the continuous code should be given, such as "I11" or "IN11". The result of instruction itemizing for the digital oven is listed as follows.

I1—In order to decrease the oven temperature and keep oven out of destroy, the cooling fan must run continuously for 20 seconds.

I2—If the temperature is beyond the up limit, the oven must stop work.

I3—The user interface has the alphanumeric display.

I4—The temperature and output message are posted to an alphanumeric display.

I5—Oven counts the elapsed time with an alphanumeric display.

I6—The default temperature is 185˚C.

I7—Oven temperature is controlled between 80˚C and 200˚C in multiplier 5

I8—User can specify a temperature with step 5˚C.

I9—Adjusting the temperature, the button "+" and "−" at the left can be used with step 5˚C.

I10—For automatic mode, user should specify cooking time.

I11—The limitation of cooking time setting is between 1 min and 90 min.

I12—Adjusting the cooking time, the button "+" and "−" at night can be used with step 1 min.

I13—After setting of temperature or time for 4 seconds, oven will start automatically.

I14—After setting of temperature or time, user can push the power button to start at once.

I15—In manual mode, user can stop cooking by pushing the power button.

I16—In automatic mode, oven will stop cooking when setting time is elapsed or the user push the power button for stop.

I17—After the front door is closed, oven starts work.

I18—When the power button is pushed for stop or the power loss occurred for cause-of-accident, oven can restart.

2) Conducting the improved STD [7] [12]

Though instruction items have been got from product instruction, it is necessary to grasp the operation procedure. Consequently, the improved STD is an effective measure and tool, and **Figure 5** is the improved STD of digital oven summarized from the product instruction and factual operation. In the process of test suite construction, you can contrast the improved STD with the content of test case. Additionally, you can find flaws of test case design to avoid unnecessary mistakes by this contrasting.

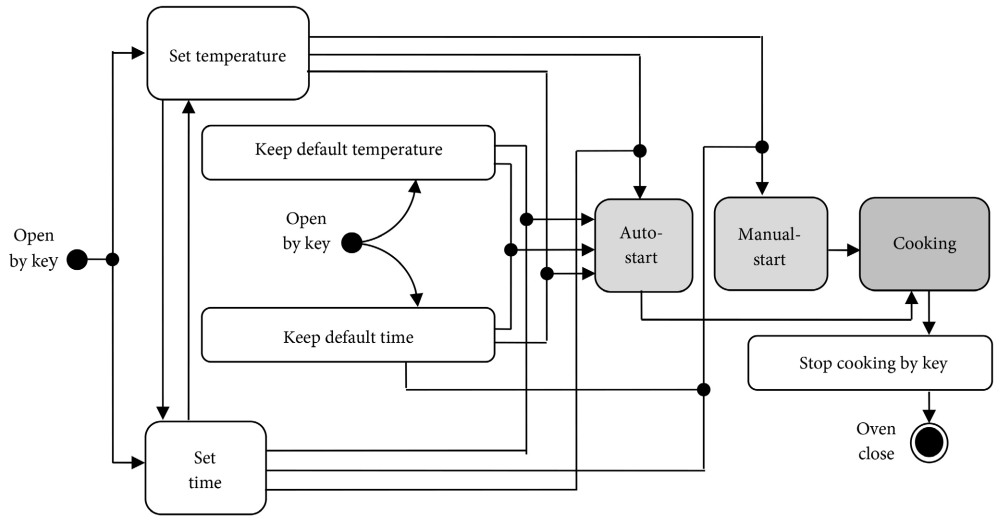

Figure 5. The improved STD of digital oven.

5.3.2. Drawing "Instruction-Brief" and "Instruction-Category" [4]

1) Instruction-brief

After finishing the instruction-items and the improved STD, can start to draw "instruction-brief" for digital oven. Generally, drawing "instruction-brief" can be divided into two steps, including: a) initializing key control parameters, and b) inserting operation category. For digital oven, the key parameter is the cooking temperature, so you can get the "instruction-brief" I as Figure 6 shown.

1 Oven temperature
- 1.1 [I-7] Boundaries 80˚C - 200˚C
- 1.2 [I-7, 8, 9, 12] Multiple of 5˚C
- 1.3 [I-6] Default to 185˚C

2 Manual mode
- 2.1 [I-8] Cooking temperature
- 2.2 [I-14] Start command
- 2.3 [I-15] Stop command

3 Automatic mode
- 3.1 [I-8] Cooking temperature
- 3.2 [I-10] Cooking time
- 3.3 [I-13] Start command
- 3.4 [I-16] Stop cooking
  - 3.4.1 [I-16] Elapsed time
  - 3.4.2 [I-16] Stop command

Figure 6. The "instruction-brief" I of digital oven.

It is obvious that the "instruction-brief" I has some repeated contexts, such as the repeating among "1", "2.1", and "3.1". In order to achieve the briefness of "instruction-brief", the context of key parameters should be inserted into fitted sub-item of item 2 and item 3, e.g. "1.1", "1.2" and "1.3" are respectively taken as the sub-item of "2.1" and "3.1" and individually re-code them. Thus, we can get "instruction-brief" II as shown in Figure 7.

1 Manual mode
- 1.1 [I-8] Cooking temperature
  - 1.1.1 [I-7] Boundaries 80˚C - 200˚C
  - 1.1.2 [I-7, 8, 9, 12] Multiple of 5˚C
  - 1.1.3 [I-6] Default to 185˚C
- 1.2 [I-14] Start command
- 1.3 [I-15] Stop command

2 Automatic mode
- 2.1 [I-8] Cooking temperature
  - 2.1.1 [I-7] Boundaries 80˚C - 200˚C
  - 2.1.2 [I-7, 8, 9, 12] Multiple of 5˚C
  - 2.1.3 [I-6] Default to 185˚C
- 2.2 [I-10] Cooking time
- 2.3 [I-13] Start command
- 2.4 [I-16] Stop cooking
  - 2.4.1 [I-16] Elapsed time
  - 2.4.2 [I-16] Stop command

Figure 7. The "Instruction-brief" II of digital oven.

2) Instruction-category

For next step of drawing "instruction-category", in fact, it is a process of extending and subdivision. Comparing general construction method, the "instruction-category" uses the "Parameter-Operation" category to organize the test suite/cases construction for all control mode, and data input testing is inserted into "Parameter" part, as a consequence, operation/state testing is inserted into "Operation/Behavior" part. As a result, data input testing includes testing of limit values, valid data testing, invalid data testing, empty data testing, etc. Conse-

quently, operation/state testing includes legal operation testing and illegal operation testing. As an improvement, we add some safety testing items, e.g. testing for usual and unusual conditions—"open the door", "power loss", etc. For digital oven, it is necessary that enough cooling time must be consider for out-of-dangerous to user and equipment. With application of the improvement, the detail content of "instruction-category" of digital oven is drawn out as shown in Figures 8-11.

1 Manual mode
- 1.1 [I-8] Cooking temperature
  - 1.1.1 [I-7, 8, 9, 12] Boundaries 80˚C - 200˚C/Multiple of 5˚C
    - 1.1.1.1 80˚C
    - 1.1.1.2 85˚C
    - 1.1.1.3 199˚C/200˚C/201˚C
    - 1.1.1.4 195˚C/200˚C/205˚C
    - 1.1.2 [I-6] Default to 185˚C
  - 1.1.2 [I-6] Default to 185˚C
  - 1.1.3 Valid data
    - 1.1.3.1 155˚C
  - 1.1.4 Invalid data
    - 1.1.4.1 21˚C (Note: cannot enter a value less than low limitation and with increment of 1˚C)
    - 1.1.4.2 87˚C (Note: cannot enter a value with increment of 2˚C)
    - 1.1.4.3 103˚C (Note: cannot enter a value with increment of 3˚C)
    - 1.1.4.4 204˚C (Note: cannot enter a value more than up limitation and with increment of 4˚C)
- 1.2 [I-14] Start command
  - 1.2.1 No data/default
    - 1.2.1.1 Oven is idle
- 1.3 [I-15] Stop command
  - 1.3.1 No data/default
    - 1.3.1.1 Oven is heating
      - 1.3.1.1.1 Oven stops with reached time
      - 1.3.1.1.2 Oven stops without reached set time
- 1.4 [I-17] Open the door
  - 1.4.1 Oven is idle
  - 1.4.2 Oven is heating
- 1.5 [I-18] Abort command
  - 1.5.1 Oven is heating
- 1.6 [I-18] Power loss
  - 1.6.1 Oven is idle
  - 1.6.2 Oven is heating
- 1.7 [I-1] Other safety
  - 1.7.1 The temperature must be less than up limitation
  - 1.7.2 The cooking time must be less than up limitation
  - 1.7.3 After stopping cooking, the fan must run continuously for more than 20 seconds, and restarting is forbidden during this period of time.

Figure 8. The "instruction-category" of digital oven.

2 Automatic mode – delay 4 seconds to start
2.1 [I-8] Cooking temperature
2.1.1 Boundaries 80˚C - 200˚C/Multiple of 5˚C
2.1.1.1 80˚C
2.1.1.2 85˚C
2.1.1.3 199˚C/200˚C/201˚C
2.1.1.4 195˚C/200˚C/205˚C
2.1.2 Default to 185˚C
2.1.3 Valid data
2.1.3.1 155˚C
2.1.4 Invalid data
2.1.4.1 21˚C (Note: cannot enter a value less than low limitation and with increment of 1˚C)
2.1.4.2 87˚C (Note: cannot enter a value with increment of 2˚C)
2.1.4.3 103˚C (Note: cannot enter a value with increment of 3˚C)
2.1.4.4 204˚C (Note: cannot enter a value more than up limitation and with increment of 4˚C)
2.2 [I-10] Cooking time
2.2.1 Boundaries 1 min~90 min/Multiple of 1 min
2.2.1.1 1 min
2.2.1.2 2 min
2.2.1.3 89 min/90 min/91 mn
2.2.2 No data/default
2.2.2.1 15 min
2.2.3 Valid data
2.2.3.1 45 min
2.2.4 Invalid data

Figure 9. The "instruction-category" of digital oven (continued).

2.2.4.1 0 min (Note: cannot enter a value less than low limitation)
2.2.4.2 91 min (Note: cannot enter a value more than up limitation)
2.2.4.3 100 min (Note: cannot enter a value more than up limitation)
2.3 [I-13] Start command
2.3.1 No data/default
2.3.1.1 Oven is idle
2.3.1.2 Oven is heating
2.4 [I-16] Stop cooking
2.4.1 Elapsed time
2.4.1.1 Cooking time is specified by user
2.4.1.2 Cooking time is not specified by user
2.4.2 Stop command
2.4.2.1 No data/default
2.4.2.1.1 Oven is idle
2.4.2.1.2 Oven is heating
2.5 [I-17] Open the door
2.5.1 Oven is idle
2.5.2 Oven is heating
2.6 [I-18] Abort command
2.6.1 Oven is heating
2.7 [I-18] Power loss
2.7.1 Oven is idle
2.7.2 Oven is heating
2.8 [I-1] Other safety
2.8.1 The temperature must be less than up limitation
2.8.2 The cooking time must be less than up limitation
2.8.3 After stopping cooking, the fan must run continuously for more than 20 seconds, and restarting is forbidden during this period of time

Figure 10. The "instruction-category" of digital oven (continued).

3 User customization mode
- 3.1 [I-8] Cooking temperature
  - 2.1.1 Default
- 3.2 [I-10] Cooking time
  - 2.2.1 Default
- 3.3 [I-13, 14] Start command
  - 2.3.1 Default
- 3.4 [I-15, 16] Stop cooking
  - 2.4.1 Elapsed time
    - 2.4.1.1 Default
  - 2.4.2 Stop command
    - 2.4.2.1 Default
- 3.5 [I-17] Open the door
  - 2.5.1 Oven is idle
  - 2.5.2 Oven is heating
- 3.6 [I-18] Abort command
  - 2.6.1 Oven is heating
- 3.7 [I-18] Power loss
  - 2.7.1 Oven is idle
  - 2.7.2 Oven is heating
- 3.8 [I-1] Other safety
  - 3.8.1 The temperature must be less than up limitation
  - 3.8.2 The cooking time must be less than up limitation
  - 3.8.3 After stopping cooking, the fan must run continuously for more than 20 seconds, and restarting is forbidden during this period of time

Figure 11. The "instruction-category" of digital oven (continued).

Because data input pattern adopts incremental fine-tuning keys, some input types are naturally impossible statuses, the design for these situation are ignored in data input testing, *i.e.* "Parameter" part. These ignored input types include: a) Negative value; b) Real value; c) Alphabetic character; d) Other symbol.

Additionally, for the control mode—"automatic mode", the operation "stop cooking" must add the control parameter "elapsed time" to execute "stop command" operation, and details are listed in item "2.4" of **Figure 10**.

For the digital oven, there is a special control mode for dealing with the special cooking, and we may call it "User customization mode"—it is a special food cooking mode for user. In order to give necessary convenience for user, the digital oven in our study has ten cases of this mode. Hence, the drawing of "instruction-category" should consider this "user customization mode", and details are shown in **Figure 11**.

5.3.3. Construction of Test Suite

It is a key step to construct test suite in "instruction-category" approach. The constructing method may refer to [7] [12], which the mainly constructing content should include "data testing", "function testing" and "state testing". Here, "data testing" is mainly tackling data input testing.

In general, for transforming instruction category to test suite/test cases, every leaf-item in instruction category can be transformed into a test case. However,

there will be many repeated cases [16]. In this situation, you must merge them in terms of testing purpose and content. The constructing specification of test suite is similar with the construction method for GUI-oriented software, details refer to related guideline of our team [12]. However, it is noticed that "instruction-category" column is added especially, and it indexes the "instruction-category" context with the code/serial number. The "prior state" column is conducted for general state testing consideration. As a consequence, the detail context of test suite construction for digital oven is given in **Table A1** of Appendix.

6. Summary and Conclusion

In general, the testing of embedded system is different from GUI-oriented software because of different user-interface and real-time processing. However, the testing content has some common features including data testing, function testing and state testing. In our study, referring to market supervising, the "instruction-category" approach is used to test the embedded system, mainly including three steps, *i.e.* 1) Refining items from product instruction; 2) Drawing "instruction-brief" and "instruction-category"; 3) Constructing test suite/test cases. This approach can be applied in the construction of test suite for similar digital device or system [17], including embedded system based on micro-controller.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Table A1. Test cases of the oven embedded system.

ID	Instruction-category	Prior state	Input	Expected results
OVEN-ENT-IVS-TC001	1.1.1.1	idle	Hit power key, keep default time 15min and set temperature 80˚C.	Oven turns on and heats to 80˚C. Temperature in range 78˚C - 82˚C. Display: 80˚C/15min.
OVEN-ENT-IVS-TC002	1.1.1.2 1.7.2	idle	Hit power key, set temperature 85˚C and time 90 min.	Oven turns on and heats to 85˚C. Temperature in range 83˚C - 87˚C. Display: 85˚C/90min.
OVEN-ENT-IVS-TC003	1.1.1.3 1.7.1	idle	Hit power key, keep default time 15min and set temperature 200˚C.	Oven turns on and heats to 200˚C. Temperature in range 198˚C - 202˚C. Display: 200˚C/15min.
OVEN-ENT-IVS-TC004	1.1.1.4	idle	Hit power key, keep default time 15min and set temperature 195˚C.	Oven turns on and heats to 195˚C. Temperature in range 193˚C - 197˚C. Display: 195˚C/15min.
OVEN-ENT-IVS-TC005	1.1.2 1.2.1.1	idle	Hit power key, keep default setting.	Oven turns on and heats to 185˚C. Temperature in range 183˚C - 187˚C. Display: 185˚C/15min.
OVEN-ENT-IVS-TC006	1.1.3.1	run TC001	2minus after heating in TC001, then set to 155˚C.	Oven heats to 155˚C. Temperature in range 153˚C - 157˚C. Display: 155˚C/15min.
OVEN-ENT-IVS-TC007	1.1.4.1	idle	Hit power key, keep default time 15min, then set temperature to 140˚C, and then hit power key to start heating.	Oven turns on and heats to 140˚C. Temperature in range 138˚C - 142˚C. Display: 140˚C/15min.
OVEN-ENT-IVS-TC008	1.3.1.1.1	idle	Heating with default for 1 minutes, then alter to 190˚C, and then hit power key.	Oven turns on and heats to 190˚C. Temperature in range 188˚C - 192˚C. Display: 190˚C/15min.
OVEN-ENT-IVS-TC009	1.3.1.1.2 1.7.3	idle	1 minutes after heating starts in TC001, then hit power key to shut off.	Oven stop heating and shuts off, then sounds buzzer, and the fan run continuously for 20 seconds. Display: OFF.
OVEN-ENT-IVS-TC100-AD	1.4.1	idle	Hit power key, and keep heating for 1 minutes with default of temperature 185˚C and cooking time 15 min, then open the door.	Oven shuts off and keep idle. Display: <empty>.
OVEN-ENT-IVS-TC101-AD	1.4.2	run TC007	1 minutes after heating starts in TC007, open the door.	Oven stop heating and shuts off. Display: <empty>.
OVEN-ENT-IVS-TC102-AD	1.5.1	run TC007	5 minutes after heating starts in TC007, then hit power key to shut off.	Oven stop heating and shuts off, then sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC103-AD	1.6.1	idle	Keep power-on without heating, 2 minutes later, the power loss occurred.	Oven stop heating and shuts off. Display: <empty>.

Continued

OVEN-ENT-IVS-TC104-AD	1.6.2	run TC005	1 minutes after heating starts in TC005, the power loss occurred.	Oven stop heating and shuts off. Display: <empty>.
OVEN-ENT-IVS-TC010	2.1.1.1 2.2.2.1	idle	Hit power key, and keep default of cooking time 15 min, and set temperature 80˚C, then wait for 4 seconds and automatically starts cooking.	When cooking time is reached 15 min, oven shuts off. Temperature in range 78˚C - 82˚C. Display: 80˚C/15min.
OVEN-ENT-IVS-TC011	2.1.1.2	idle	Hit power key, and keep default of cooking time 15 min, and set temperature 85˚C, then automatically starts cooking.	When cooking time is reached 15 min, oven shuts off. Temperature in range 83˚C - 87˚C. Display: 85˚C/15min.
OVEN-ENT-IVS-TC012	2.1.1.3 2.1.1.4 2.8.1	idle	Hit power key, and keep default of cooking time15 min, and set temperature 200˚C-up limitation, then automatically starts cooking.	When cooking time is reached 15 min, oven shuts off. Temperature in range 198˚C - 202˚C. Display: 200˚C/15min.
OVEN-ENT-IVS-TC013	2.1.1.4	idle	Hit power key, and keep default of cooking time 15 min, and set temperature 195˚C, then automatically starts cooking.	When cooking time is reached 15 min, oven shuts off. Temperature in range 193˚C - 197˚C. Display: 195˚C/15min.
OVEN-ENT-IVS-TC014	2.1.2 2.2.1.1 2.3.1.1	idle	Hit power key, and keep default of 15 min and 185˚C, then automatically starts cooking.	When cooking time is reached 15 min, oven shuts off. Temperature in range 183˚C - 187˚C. Display: 185˚C/15min.
OVEN-ENT-IVS-TC015	2.1.3.1	idle	Hit power key, and keep default of cooking time 15 min, and set temperature 155˚C, then automatically starts cooking.	Oven turns on and heats to 155˚C. Temperature in range 153˚C - 157˚C. Display: 155˚C/15min.
OVEN-ENT-IVS-TC105-AD	2.2.1.1 2.8.3	idle	Hit power key, and keep default of temperature 185˚C, and set cooking time 1 min, then automatically starts cooking.	Oven turns on and heats. Temperature in range 183˚C - 187˚C. Display: 185˚C/1min. Oven shuts off after 1 min and sounds buzzer, then the fan run continuously for 20 seconds. Display: OFF.
OVEN-ENT-IVS-TC016	2.2.1.2	idle	Hit power key, and keep default of temperature 185˚C, and set cooking time 2 min, then automatically starts cooking.	Oven turns on and heats. Temperature in range 183˚C - 187˚C. Display: 185˚C/2min. Oven shuts off after 2 min and sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC106-AD	2.2.1.3 2.8.2	idle	Hit power key, and keep default of temperature 185˚C, and set cooking time 90 min, then automatically starts cooking.	Oven turns on and heats. Temperature in range 183˚C - 187˚C. Display: 185˚C/90min. Oven shuts off after 90 min and sounds buzzer. Display: OFF.

Continued

OVEN-ENT-IVS-TC107-AD	2.2.1.3	idle	Hit power key, and keep default of temperature 185˚C, and set cooking time 89 min, then automatically starts cooking.	Oven turns on and heats. Temperature in range 183˚C - 187˚C. Display: 185˚C/89min. Oven shuts off after 89 min and sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC108-AD	2.3.1.2	run TC 016	After heating for 1 minute starts in TC016 with default of temperature 185˚C, then set cooking time 5 min, and then automatically starts cooking.	Temperature in range 183˚C - 187˚C. Display: 185˚C/5min.
OVEN-ENT-IVS-TC017	2.4.1.1 2.2.3.1	idle	Hit power key, and set temperature 115˚C, and set cooking time 45 min, then automatically starts cooking.	Oven turns on and heats. Temperature in range 113˚C - 117˚C. Display: 115˚C/45min. Oven shuts off after 45 min and sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC018	2.4.1.2	idle	Hit power key, and keep default of cooking time 15 min, and set temperature 115˚C, then automatically starts cooking.	Oven turns on and heats. Temperature in range 113˚C - 117˚C. Display: 115˚C/15min. Oven shuts off after 15 min and sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC019	2.4.2.1.1	idle	Hit power key, and keep default 15 minute with temperature 185˚C, then after 1 min hit power key to shut off.	Oven turns on and heats to 185˚C. Temperature in range 183˚C - 187˚C. Display: 185˚C/15min. Oven shuts off after 1 min and sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC020	2.4.2.1.2.	run TC 016	After heating for 1 minute starts in TC016, then set cooking time 15 min. when 15 min is reached, power automatically shut off.	Oven turns on and heats to 185˚C. Temperature in range 183˚C - 187˚C. Display: 185˚C/15min. Oven shuts off after 15 min and sounds buzzer. Display: OFF.
OVEN-ENT-IVS-TC109-AD	2.5.1.	idle	Hit power key, and keep default of temperature 185˚C and set cooking time 5 min, then automatically starts cooking. After 1 minute, open the door.	Oven shuts off and keep idle. Display: <empty>.
OVEN-ENT-IVS-TC110-AD	2.5.2.	run TC 016	After heating for 1 minute starts in TC016, open the door. Waiting for 1 minute, then close the door.	Oven shuts off and keep idle. Display: <empty>. Then, oven starts heating again. Temperature in range 183˚C - 187˚C. Display: 185˚C/1min.
OVEN-ENT-IVS-TC111-AD	2.6.1.	run TC 016	After heating for 1 minute starts in TC016, hit power key to shut off.	Oven shuts off and stop heating. Display: OFF.
OVEN-ENT-IVS-TC112-AD	2.7.1	idle	Hit power key, set temperature to 100˚C, and keep automatically heating for 1 minute, then power loss occurred.	Oven shuts off and stop heating. Display: OFF.

Continued

OVEN-ENT-IVS-TC113-AD	2.7.2.	run TC 016	After heating for 1 minute starts in TC016, then power loss occurred.	Oven shuts off and stop heating. Display: OFF.
OVEN-ENT-IVS-TC114-AD -TC123-AD	3.1.1.	idle	Hit power key, and choose a user mode to start cooking manually. Waiting specified time.	Oven shuts off and the food has been achieved. Display: OFF.
OVEN-ENT-IVS-TC124-AD -TC133-AD	3.2.1.	idle	Hit power key, and choose a user mode to start cooking automatically. Waiting specified time.	Oven shuts off and the food has been achieved. Display: OFF.