Development of the BioAPI v2.0 Conformance Test Suite and Testing according to ISO24709

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Abstract

In the information age of today, in which security is important, the use of biometric technologies such as fingerprint recognition and face recognition has been growing continuously. As many biometric products have been released to the market, it is necessary to evaluate whether these products are implemented in conformance with the international standard BioAPI. This paper presents a concrete case that develops and applies the BioAPI v2.0 CTS (Conformance Test Suite), which can evaluate the BioAPI standard conformance of the BSP object implemented according to the method described in the ISO/IEC 24709. To verify the effectiveness of the CTS evaluation method and evaluation tool proposed by this paper, BSP products from three security product vendors were received, and a standard conformance test was performed on those products. This paper also describes the test details.

Keywords: *BioAPI, ISO/IEC 24709, Testing, CTS, BSP*

1. Introduction

In the information age of today, in which security is important, the use of biometric technologies such as fingerprint recognition and face recognition has been growing continuously. Various products based on biometric technology have been released, including a door lock using iris recognition technology, laptops/smartphones secured with fingerprint recognition technology, and the face recognition systems introduced by many countries at facilities related to immigration control, such as airports and ports.

BioAPI, the international standard for the API used for the development of the biometric recognition system, was first developed by the US as ANSI/INCITS 358-2002 (also known as BioAPI v1.1), and BioAPI v2.0 ISO/IEC 19784-1 was enacted in 2006 [1][3]. As many biometric technology products are being released in the market and used widely, it has become important to check whether these products are implemented in conformance with the international standard BioAPI. The BioAPI standard conformance test provides the following benefits.

- Standard conformance testing improves the security of the developer or product user in the reliability of the product.

- Standard conformance testing guarantees compatibility between standards-based products and systems.

- Standard conformance testing encourages the biometric technology product developer to comply with relevant standards.

Due to these needs, the international standard, ISO/IEC 24709-1, was enacted in 2007 as the method of testing standard conformance with the BioAPI. In addition, another international standard, ISO/IEC 24709-2, was published, which enables the standard conformance test to be run on the BioAPI BSP (Biometric Service Provider) product using concrete test cases, so that the test can be performed clearly [4, 5].

ISO/IEC 24709-1, the international standard for BioAPI standard conformance testing, stipulates that test assertion definition, data type, grammar, and construction specified in ISO/IEC 24709 should be used for evaluation. That is, the CTS creates a testing result by accepting the BSP implementation object, which will be a testing target, as well as the test assertion that describes the testing procedure and content. The test assertion for BSP testing is described in ISO/IEC 24709-2.

This paper is designed to develop the BioAPI v2.0 CTS (Conformance Test Suite), which can evaluate BIOAPI standard conformance of the BSP implementation object according to the method described in ISO/IEC 24709, and presents the detailed application case. Chapter 2 explains the test assertion that is described in the procedural method form, in order to evaluate conformance of the test target. Chapter 3 explains the BioAPI standard conformance methodology described in ISO/IEC 24709. Chapter 4 explains the CTS tool and test based on ISO/IEC 24709. Chapter 5 introduces studies related to this paper. Finally, a conclusion is drawn and future study tasks are reviewed.

2. Test Assertion

A test assertion is the specification that describes the software procedure used to evaluate conformance of the test target. The ISO/IEC 24709 standard series uses XML to evaluate BioAPI standard conformance. ISO/IEC 24709-2 presents 75 test assertions in total for 24 major functions for BSP standard conformance testing. That is, 24 major BioAPI functions are the target of BSP standard conformance testing. The ID of the test assertion is expressed with numbers and letters, such as 1a, 1b, 2a, and 2b. The number at the beginning refers to the type of the target BioAPI, while the letter at the end refers to the test type. Table 1 shows the list of test assertions proposed by ISO/IEC 24709-2.

Table 1. Test Assertions

Name of the BSP function to test	ID of the test assertion	Name of the BSP function to test	ID of the test assertion
BioSPI_BSPLoad	1a, 1b	BioSPI_Enroll	13a- 13d
BioSPI_BSPUnload	2a, 2b, 2c, 2d	BioSPI_Verify	14a, 14b, 14c
BioSPI_BSPAttach	3a, 3b, 3c, 3d	BioSPI_DbOpen	15a, 15b
BioSPI_BSPDetach	4a, 4b, 4c	BioSPI_DbClose	16a, 16b
BioSPI_FreeBIRHandle	5a, 5b, 5c	BioSPI_DbCreate	17a, 17b, 17c
BioSPI_GetBIRFromHandle	6a, 6b, 6c	BioSPI_DbDelete	18a, 18b, 18c
BioSPI_GetHeaderFromHandle	7a, 7b, 7c, 7d	BioSPI_DbSetMarker	19a, 19b, 19c
BioSPI_EnableEvents	8a, 8b	BioSPI_DbFreeMarker	20a, 20b, 20c
BioSPI_Capture	9a, 9b, 9c, 9d	BioSPI_DbStoreBIR	21a, 21b
BioSPI_CreateTemplate	10a – 10f	BioSPI_DbGetBIR	22a, 22b, 22c
BioSPI_Process	11a – 11e	BioSPI_DbGetNextBIR	23a, 23b
BioSPI_VerifyMatch	12a, 12b, 12c	BioSPI_DbDeleteBIR	24a, 24b

A test assertion is a type of test running script composed of XML. The CTS evaluation tool contains the test assertion analysis and execution function, and proceeds with standard conformance testing of the BSP product by executing the test assertion. Figure 1 shows an example of the test assertion.

```
<?xml version="1.0"?>
<package name="01f6c6f0-0c19-1085-97fe-0002a5d5fd2e">
    <assertion name="BioSPI_BSPLoad_ValidParam" model="BSPTesting">
       <input name="_BspUuid"/>
       <input name="_BioAPINotifyCallback"/>
       <input name="_BFPEnumerationHandler"/>
       <input name="_MemoryFreeHandler"/>
       <invoke activity="BioSPI_BspLoad">
          <input name="BspUuid" var="_BspUuid"/>
          <input name="BioAPIdNotifyCallback" var="_BioAPINotifyCallback"/>
          <input name="BFPEnumerationHandler" var="_BFPEnumerationHandler"/>
          <input name="MemoryFreeHandler" var="_MemoryFreeHandler"/>
       </invoke>
    </assertion>
    <activity name="BioSPI_BspLoad">
       <input name="BspUuid"/>
       <input name="BioAPIdNotifyCallback"/>
       <input name="BFPEnumerationHandler"/>
       <input name="MemoryFreeHandler"/>
       <invoke function="BioSPI_BSPLoad">
          <input name="BSPUuid" var="BspUuid"/>
          <input name="BioAPINotifyCallback" var="BioAPIdNotifyCallback"/>
           <input name="BFPEnumerationHandler" var="BFPEnumerationHandler"/>
          <input name="MemoryFreeHandler" var="MemoryFreeHandler"/>
          <return setvar="return"/>
       </invoke>
       <assert_condition>
          <equal_to var1="return" var2="__BioAPI_OK"/>
       </assert_condition>
       <invoke function="BioSPI_BSPUnload">
          <input name="BSPUuid" var="BspUuid"/>
          <return setvar="return"/> </invoke>
       <assert_condition response_if_false="undecided">
          <equal_to var1="return" var2="__BioAPI_OK"/>
       </assert_condition>
    </activity>
</package>
```

Figure 1. Test Assertion Example - T.A. 1b

Each of the test assertions tests whether the BioAPI function under a given environment could work according to the BioAPI v2.0 ISO/IEC 19784-1 or not. For example, we want to test whether the *BioSPI_BSPLoad()* function works when a valid input parameters was given to the test assertion 1b - *BioSPI_BSPLoad_ValidParam* shown in Figure 1.

In XML, the test assertion is expressed as <assertion> tag. In the assertion Element, it assigns inserted values using <input> tag and usually, it brings out separately defined activity element using <invoke activity="…">. The invocation of the function of BSP implementation under test is specified using <invoke function="…"> tag. To run a test assertion, the input parameter value should be specified. In Figure 1, four input parameters are required - <input name = "_BspUuid"/>, <input name = "_BioAPINotifyCallback" />, <input name = "_BFPEnumerationHandler"/>, and <input name = "_MemoryFreeHandler"/>.

Selecting the input parameter is important, because the test assertion execution result can vary depending on this input value. ISO/IEC 24709-2:2007 doesn't explain the input parameter in detail, and this is not included in the BCS (BioAPI Conformance Statement) information submitted by the applicant for evaluation.

This study analyzed the input parameter of the test assertions described in ISO/IEC 24709-2 while developing the standard conformance evaluation method and tool, and determined the input parameters that should be submitted together with the BCS by the BSP module development company. Most input parameters of the test assertions described in ISO/IEC 24709-2 are duplicated or can be processed by the system internally. However, information such as the "UUID" of the BSP product or "payload support status" is based on the characteristics of the BSP product. Therefore, these input parameters should be submitted together with the BCS by the BSP vendor. Table 2 shows the parameters of test assertions

Table 2. Parameters of Test Assertions

Parameter name	Description
_inserttimeout	Timeout for the BioAPI_NOTIFY_INSERT event (msec)
_sourcepresenttimeout	Timeout for the BioAPI_NOTIFY_SOURCE_PRESENT event (msec)
_capturetimeout	Timeout for BioSPI_Capture (msec)
_verifytimeout	Timeout for BioSPI_Verify (msec)
_maxFMRRequested	MaxFMRRequested for BioSPI_Verify(msec)
_payloadPolicy	Payload policy
_supportPayload (or _payloadSupported)	Indicates whether the BSP of the test claims support for payload
_supportAuditData	Indicates whether the BSP of the test claims support for audit data
_intermediateQualitySupported	Indicates whether the BSP of the test claims support for quality in an intermediate BIR
_processedQualitySupported	Indicates whether the BSP of the test claims support for quality in a processed BIR
_noSourcePresentSupported	Indicates whether the BSP of the test does not claim support for the BioAPI_NOTIFY_SOURCE_PRESENT event notification
_dbUuid (for DB)	Database UUID to be opened
_nbrRecords (for DB)	Number of Records used in BioSPI_DbCreate()
_readAccessRequest (for DB)	Read Access Request to the database
_writeAccessRequest (for DB)	Write Access Request to the database

3. Conformance Test Methodology

Standard conformance testing of the BSP module is started when the BSP module vendor submits the BSP module, parameters, and BCS (BioAPI Conformity Statement) to the evaluation agency. The evaluation agency inputs the received data into the CTS evaluation tool and performs evaluation based on the data. The person in charge at the evaluation agency checks the evaluation result and reports it to the vendor. If necessary, the test report can be sent to the vendor, so that the vendor can understand the reason and timing of the problem's occurrence. Evaluation is performed through the following steps.

Step 1. The vendor of the BSP product for testing submits the following to the evaluation agency.

- BSP product to test
- Biometric terminal (fingerprint recognition device, iris recognition device, etc.)
- Terminal driver (for Windows OS)
- BCS and test assertion parameter values

Step 2. The evaluator connects the received biometric terminal and installs the driver, and then checks whether the terminal operates normally.

Step 3. The evaluator inputs the BCS detail and test assertion parameters into the CTS evaluation tool, and saves them in the database.

Step 4. The list of test assertions to run the CTS evaluation tool will be calculated, depending on the entered BCS detail.

Step 5. Perform a standard conformance evaluation by using the CTS evaluation tool.

Step 6. The evaluator checks the evaluation process and result.

Step 7. The evaluation result and test report are reported to the vendor.

Step 8. If the evaluation result is not "pass" the vendor analyzes the reason by referring to the test report, and then modifies the BSP module and requests a re-evaluation.

Step 9. If the evaluation result is "pass", the evaluation agency issues a certificate for the product in question.

The BCS information to be submitted by the vendor is described in detail in ISO/IEC 24709-2. Major components of the BCS are as follows.

- Vendor information
- Product information
- BioAPI conformance class for testing
- BioAPI conformance subclass for testing
- Additional BSP functions provided by the BSP product for testing
- Additional functions provided by the BSP product for testing
- Additional information related to BSP product

The list of test assertions for standard conformance testing is determined by the submitted BCS detail. The CTS evaluation tool can be considered as a kind of interpreter that reads and executes each test assertion in the list.

The execution result of each test assertion can be classified as PASS/ FAIL/ UNDECIDED. PASS means that the BSP product runs normally for each test item, whereas FAIL means that the BSP product doesn't run properly, or the expected response is not received. UNDECIDED means that the test was not carried out properly because a problem occurred with an item other than the testing function. For the tested BSP product to pass the standard conformance test, the execution result of all test assertions included in the list should be PASS. If any item is evaluated as FAIL or UNDECIDED, the product cannot pass the standard conformance test.

4. CTS Implementation and Test

For this study, an engine was developed that can read and execute the test assertion in real time that is described in ISO/IEC 24709-1 and ISO/IEC 24709-2. In addition, a CTS evaluation tool was developed that supports the entire process of BioAPI standard conformance testing, based on the test assertion execution engine. Figure 2 shows the CTS evaluation tool screen that is used to input the vendor information and BCS information.

Evaluation begins with the entered BCS information. The information related to test assertion operation is displayed at the bottom window and saved in the database, simultaneously to the evaluation. Figure 3 shows the screen in which the test assertion list is calculated that will be executed by the CTS evaluation tool according to the entered BCS detail, and standard conformance is performed according to the calculated test assertions.

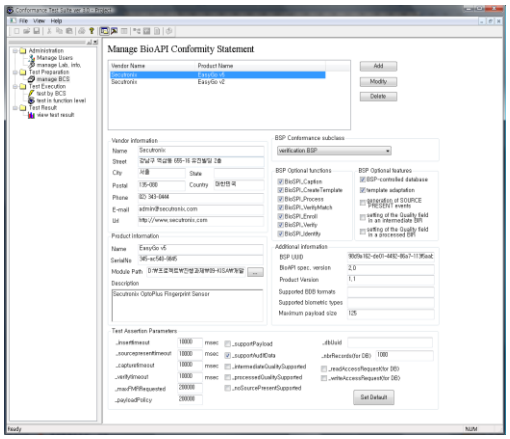

Figure 2. CTS tool – Vendor Information and BCS Information Input Screen

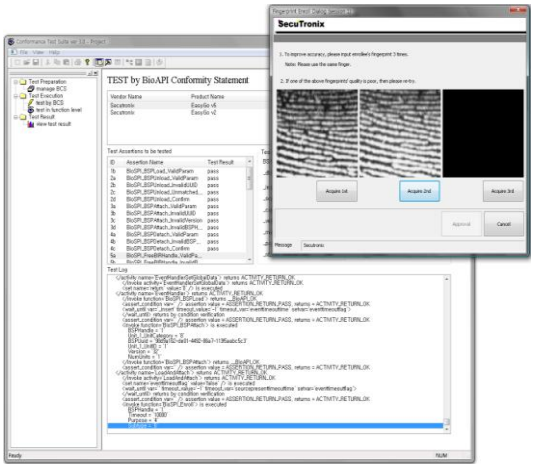

Figure 3. CTS Evaluation Tool – Evaluation Processing Screen

The test assertion execution result will be created according to the XML schema rules defined in ISO/IEC 24709-1, together with the overall evaluation progress process information, and saved in the database. The evaluation method and tool proposed by this paper is used by the Korea Internet & Security Agency for the BioAPI standard conformance certification test. To verify the effectiveness of the CTS evaluation method and tool, BSP products are received from 3 security product vendors, and the standard conformance authentication test was performed.

Table 3. Parameters of Test Assertions

Test target	Product A		Product B		Product C	
Number of evaluations	1st Test	2nd Test	1st Test	2nd Test	1st Test	2nd Test
1*BioSPI_BSPLoad	Pass	Pass	Pass	Pass	Pass	Pass
2*BioSPI_BSPUnload	Pass	Pass	Pass	Pass	Pass	Pass
3*BioSPI_BSPAttach	Pass	Pass	Pass	Pass	Pass	Pass
4*BioSPI_BSPDetach	Pass	Pass	Pass	Pass	Pass	Pass
5*BioSPI_FreeBIRHandle	Pass	Pass	Pass	Pass	Pass	Pass
6*BioSPI_GetBIRFromHandle	Pass	Pass	Pass	Pass	Pass	Pass
7*BioSPI_GetHeaderFromHandle	Pass	Pass	Pass	Pass	Pass	Pass
8*BioSPI_EnableEvents	**Fail**	**Fail**	Pass	Pass	Pass	Pass
9*BioSPI_Capture	Pass	Pass	Pass	Pass	Pass	Pass
10*BioSPI_CreateTemplate	Pass	Pass	**Fail**	Pass	**Fail**	Pass
11*BioSPI_Process	Pass	Pass	Pass	Pass	Pass	Pass
12*BioSPI_VerifyMatch	**Fail**	Pass	**Fail**	Pass	**Fail**	Pass
13*BioSPI_Enroll	Pass	Pass	**Fail**	Pass	**Fail**	Pass
14*BioSPI_Verify	**Fail**	Pass	Pass	Pass	Pass	Pass
15* ~ 24* *DB related functions*	N/A	N/A	N/A	N/A	N/A	N/A
Overall Result	**Fail**	**Fail**	**Fail**	Pass	**Fail**	Pass

Table 3 shows the result of the test on three received BSP products. When the first standard conformance test was performed on each product, the final result of all products was "FAIL," which means that those products failed to pass the BioAPI standard conformance test in accordance with ISO/IEC 24709. The test result was reported to each vendor, together with the information on the failed test item. Vendors modify the BSP product based on that information. Two vendors passed the second test, whereas one vendor failed the test because the No. 8 test item (*BioSPI_EnableEvents* function) was not implemented at all.

5. Related Works

NIST/ITL's BioAPI CTS implementation [6] and DoD BMO BioAPI CTS study [7] are the representative BioAPI standard conformity studies. NIST/ITL's BioAPI CTS implementation is based on the INCITS Project 1703-D – "Information Technology Conformance Testing Methodology for ANSI INCITS 358-2002". The CTS evaluation tool is implemented with C++ and Java, and contains the execution engine that performs evaluation by reading the XML-type test assertion code. DoD BMO BioAPI CTS also performs standard conformance testing of the BSP product according to the INCITS Project 1703-D – "Information Technology Conformance Testing Methodology for ANSI INCITS 358-2002". It also contains some of the standard conformance testing function for BioAPI applications.

These studies are based on BioAPI version 1.1, and don't support the BioAPI version 2.0 on which recent products are based. The conformance testing methodology for BioAPI version 2.0 was not included in these studies either, because ISO/IEC 24709 was selected as an international standard in 2007.

[8] designs a Conformance Test Suite for BSP based upon the BioAPI v2.0. But, it does not implement the abstract test engine that has to reflect the semantics of the assertion language shown in the ISO/IEC 247091. [9] suggests new conformance test methodologies that couples CTS with Framework.

6. Conclusion

This study developed the BioAPI v2.0 CTS (Conformance Test Suite), which can evaluate the BioAPI conformance of BSP implementation products according to the method described in ISO/IEC 24709, presented concrete cases. To verify the effectiveness of the CTS evaluation method and evaluation tool proposed by this paper, BSP products from three security product vendors were received, and standard conformance test was performed on those products. This paper also describes the test details.

The standard conformance test method using XML-type test assertion is flexible and scalable, and can eliminate misunderstandings in evaluation because the result is expressed clearly. Therefore, the method could conveniently be applied to other test areas.

Acknowledgements

This work was supported by the Industrial Strategic Technology Development Program, 10039149, Development of Basic Technology of Human Identification and Retrieval at a Distance for Active Video Surveillance Service with Real-time Awareness of Safety Threats funded by the Ministry of Knowledge Economy (MKE, Korea).

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