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A Study on the Sound That Occurs When Opening and Closing the JANGJIMUN of a HANOK (Traditional Korean House)

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Abstract **-** *The beauty and convenience of HANOK(Korean traditional style house), a traditional Korean house, is widely known. Representatively, HANOK's ONDOL culture for heating and ventilation facilities for cooling are scientific and original, and are admired by people around the world. HANOK is manufactured by elaborately assembling without using nails, and it is beautiful and practical rather than magnificent. There are many reactions that the sounds generated when using HANOK are not stimulating and feel emotional and comfortable. Based on such reaction, in this paper, among the sounds generated when using HANOK, the sound generated when opening and closing JANGJIMUN (a room door of traditional Korean house) was studied. For the study, the acoustic component of JANGJIMUN sound was analyzed and the hearing of people who listened to JANGJIMUN sound was tested. As a result of the study, HANOK's JANGJIMUN sound with CHANGHOJI (HANJI: Korea's representative paper) tautly affixed to the grid patterned door frame slidably opens and closes through the groove of MUNJIBANG (traditional Korean threshold), producing a very heavy, stable, refreshing and soft sound. I could see that it was being done. It was found that the sound component was composed of the frequencies of the middle and low tones and comfortably comforted the human hearing as if whispering. In the future, research on HANOK should continue in various ways.*

Keywords — *HANOK, JANGJIMUN, CHANGHOJI, HANJI, MUNJIBANG, sound*

I. INTRODUCTION

HANOK is a traditional house built to suit the environment of the Korean peninsula where Korea is located. HANOK has been developed based on the wisdom of our ancestors for a long time and is once again in the limelight as a well-being housing through health and healing in the modern society. The tree used to build HANOK is a tree called CHOONHYANGMOK, which is well known as red pine, and it is hard and has a good scent. HANOK is a practical housing with health and convenience by using ventilation and ondol. As these advantages were reviewed and recognized, HANOK's structure was preserved as it was, while the living facilities were renovated and reproduced to suit modern life. HANOK is not only aesthetically pleasing and practical for life, but also gives psychological comfort by generating a friendly and soft sound when used. In this paper, we studied the very soft, stable and comfortable sound that occurs when opening and closing JANGJIMUN, a room door installed in HANOK. As a research method, first of all, the sound characteristics of the JANGJIMUN opening and closing sound recorded while opening and closing HANOK's JANGJIMUN were scientifically analyzed were summarized. Next, the sound of HANOK's JANGJIMUN opening and closing was heard to the listener, and the level of the response was scored to check the sensitivity. The excellence of HANOK will serve as an opportunity to prove that we have tried to exert a good influence on the people who live in the sound that occurs when dealing with the JANGJIMUN installed inside, in addition to the beauty of the exterior and the convenience of internal life.

Fig. 1 HANOK(Traditional Korean Style House)

II. HANOK's JANGJIMUN

HANOK, a traditional Korean house, enriches life not only with the beauty of its appearance and ease of use, but also with the scent that naturally emanates from the CHOONHYANGMOK used to build HANOK, and the

sound of the trees when used. Among them, the sound generated when using JANGJIMUN, which can be called HANOK's room door, is clear and soft and beautiful, just like the sound that occurs when handling an instrument. JANGJIMUN is a wooden square frame with a thick paste of paper called HANJI.[1][2]

Due to HANOK's internal structure, it is a room door that blocks the space between the room and the room. JANGJIMUN is inserted into a door frame called MUNJIBANG and slides open and closes. As the glued HANJI, CHANGHOJI, dries, JANGJIMUN, which is tightly attached to the door, generates a clear ringing sound when opening and closing. JANGJIMUN also nicely decorates the lattice support for attaching HANJI to the wooden frame. JANGJIMUN, with paper applied to the wooden door, is placed on a grooved MUNJIBANG and slides open and closes through the groove.[3][4][5]

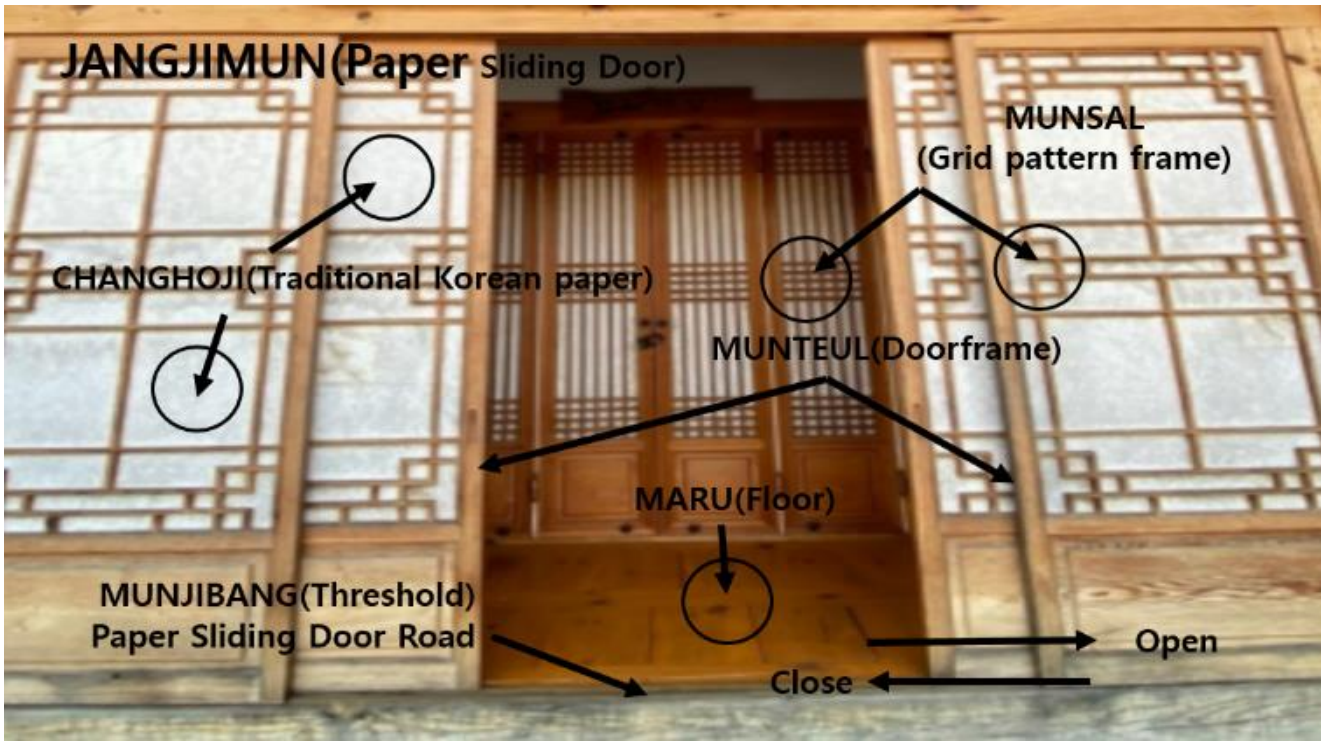

Fig. 2 JANGJIMUN(Room door of Traditional Korean House)

As shown in Figure 2, HANOK's JANGJIMUN consists of four square frames. The paper called CHANGHOJI is applied to JANGJIMUN, but the traditional Korean paper HANJI is used for CHANGHOJI. To attach HANJI to JANGJIMUN, a grid pattern or uniform wooden flesh is installed on the square frame. When HANJI is attached to the JANGJIMUN frame, a paste made of flour or rice is applied, but when the paste dries and the HANJI sticks tightly to the JANGJIMUN frame, the sound itself sounds like a musical instrument. The JANGJIMUN mold with HANJI is fitted on HANOK's MUNJIBANG and pushed left and right to open and close. When you open the wooden gate of HANOK and enter, the yard comes out, and when you walk across the yard to open JANGJIMUN and enter the building, you will find MAROO (traditional Korean wooden flooring) made of wooden floors. In the interior of HANOK, there are rooms on both sides centering on MAROO, and JANGJIMUN is also installed in each room.[6][7][8][9]

III. JANGJIMUN's sound analysis

The room door of HANOK, JANGJIMUN, is a door with HANJI applied by installing lattice or straight wood ribs in a square wooden frame. When the full-coated HANJI is attached to the door frame and the door of JANGJIMUN, it dries and is tightly fixed, it is inserted into the MUNJIBANG and used. MUNJIBANG is the lower part of a large wooden frame installed at the entrance that separates the entrance of the building from the room, and two rows of long grooves are drilled so that the JANGJIMUN can be inserted and closed. The two rows of long grooves dug in MUNJIBANG act like rails on a train track and move the JANGJIMUN to open and close it as if it slides left and right. The sound generated by JANGJIMUN being inserted into the groove of MUNJIBANG and moving left and right gives the people living in HANOK a natural response in their lives, just like the sound produced by an instrument. The harmonization of JANGJIMUN's frame and HANJI applied to JANGJIMUN functions like an instrument, and the sound generated when it

is inserted into the MUNJIBANG and moved sounds like the tune that occurs when playing the instrument. In order to scientifically analyze the beautiful sound made when JANGJIMUN opens and closes, the sound of opening and closing JANGJIMUN was recorded with a digital recorder by opening and closing HANOK in a room. The recorded sound source was analyzed in detail by three methods of sound component, energy, and pitch range using Adobe's Cool-Editor, an acoustic analysis tool, in time domain, spectrogram, and spectrum analysis.

A. Time domain analysis of JANGJIMUN's sound

The opening and closing sound of JANGJIMUN in HANOK is a unique sound that occurs when the door frame made of Choonhyangmok and the JANGJIMUN made of HANJI applied to the door are sliding from side to side as if sliding on the grooved MUNJIBANG like a rail. JANGJIMUN forms a frame with appropriate resonant sound as if the door itself had the basic structure of a musical instrument.

The instrument frame called JANGJIMUN produces a soft sound like a musical instrument playing as it slides through MUNJIBANG, and the sound is evaluated as giving people a sense of comfort and stability. JANGJIMUN For the analysis of the opening and closing sound, the intensity and roughness of the sound were compared and analyzed through the waveform of the time domain. Analyzing the graph of the time domain components, it can be seen that the concentrated waveform energy varies with time. In the time domain graph of the opening and closing sound of JANGJIMUN in Fig. 3, the concentrated waveform from the opening point where the JANGJIMUN opens through the sliding distance point to reach the closing point is uniquely expressed. At the opening point, JANGJIMUN's CHANGHOJI trembles while touching JANGJIMUN to open the door, and the JANGJIMUN frame fixed at MUNJIBANG moves and shows a unique waveform that begins to open. At the sliding distance point, the unique waveform that the JANGJIMUN frame slides through the groove of MUNJIBANG is calmly depicted. The closing point is the end of MUNJIBANG, where the JANGJIMUN frame reaches, and the JANGJIMUN frame hits the MUNJIBANG frame, showing a strong waveform. Since the waveform of the closing point moves in the opposite direction in time to the opening point, it is natural to have opposite shapes.[10][11]

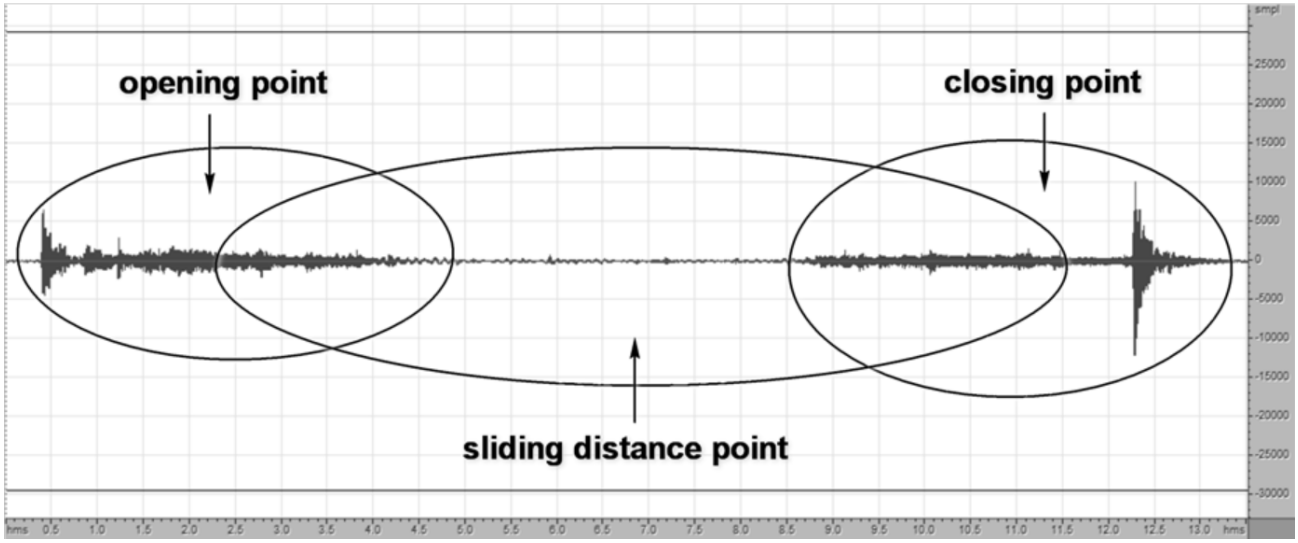

Fig. 3 Time domain graph of JANGJIMUN's sound

B. Spectrogram analysis of JANGJIMUN's sound

Through the analysis of the spectrogram of the opening and closing sound of JANGJIMUN, the components of the JANGJIMUN sound were analyzed more clearly. In the spectrogram graph, the part where the energy is concentrated is expressed in dark red color, and as the energy decreases, the red color is expressed as if it gradually spreads lighter. As shown in the spectrogram of Fig. 4 JANGJIMUN sound, the sound energy of the part that opens and closes the JANGJIMUN is strongly expressed. In addition, when the JANGJIMUN is opened, it can be seen that the sound of the sliding friction between JANGJIMUN and MUNJIBANG has strong low-frequency energy as a whole. JANGJIMUN The sound of opening and closing has a resonant sound with a strong low-frequency sound and resonant overall.[12][13]

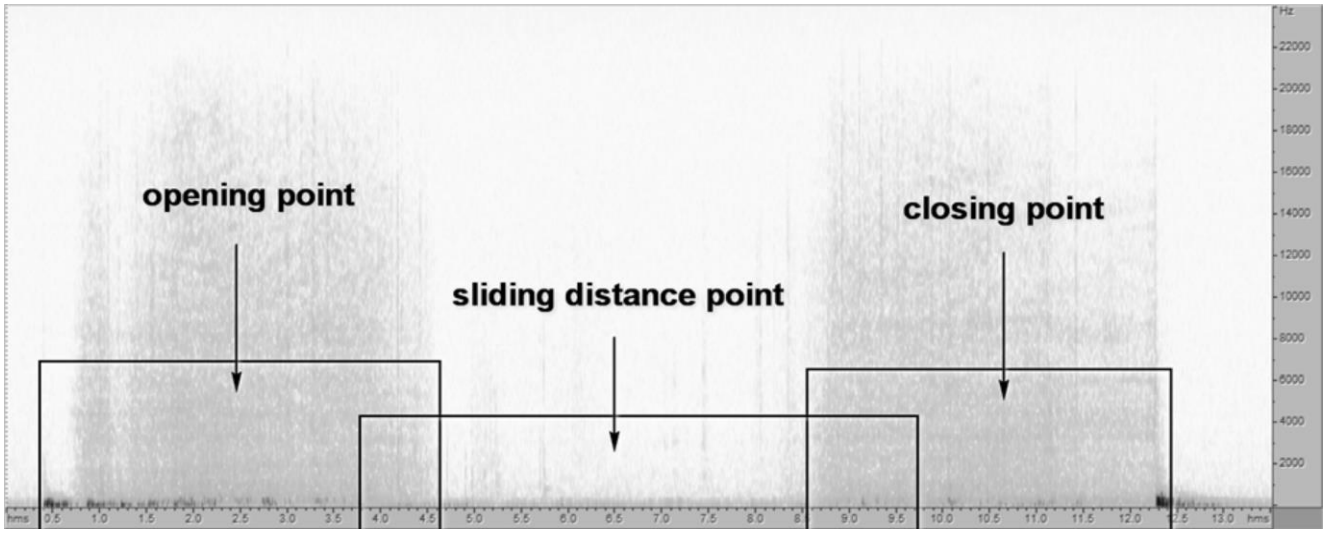

Fig. 4 Spectrogram graph of JANGJIMUN's sound

The reason why the JANGJIMUN sound creates a low-frequency resonance sound is that it plays an important role in generating low-frequency sound components due to the friction between the JANGJIMUN frame and MUNJIBANG, which are tautly attached to the HANJI CHANGHOJI using glue.

C. Spectrogram analysis of JANGJIMUN's sound

Through spectrum analysis, the characteristics of JANGJIMUN opening and closing sounds by frequency band were analyzed.

The frequency domain components were analyzed using the FFT concept and the result values were derived. The spectrum graph in Figure 5 is a graph that analyzes the overall average frequency of JANGJIMUN open and close sounds.

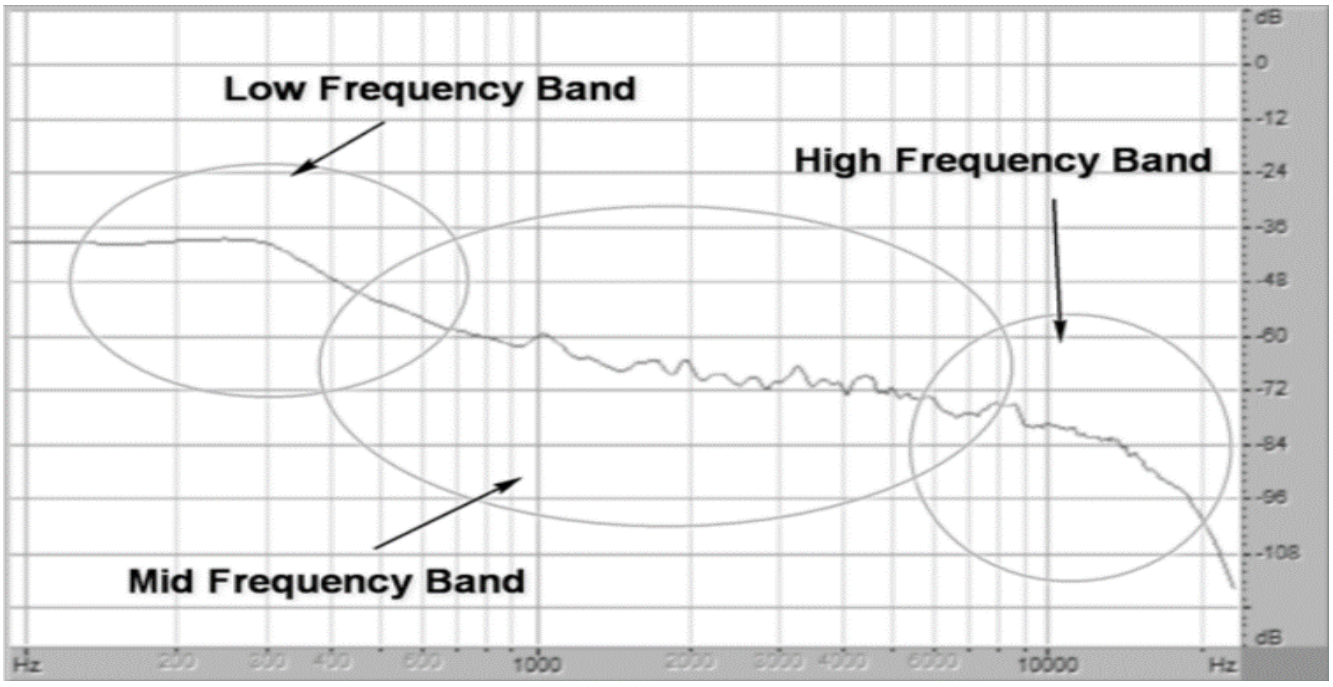

Fig. 5 Spectrum graph of JANGJIMUN's sound

The low frequency band of JANGJIMUN sound is strongly distributed up to the 300Hz point. The mid-frequency band of the JANGJIMUN sound gradually naturally decreases from 300Hz, and the high-frequency range rapidly decreases starting at 10,000Hz. From these characteristics, it can be seen that the sound frequency characteristics of the JANGJIMUN open and close sound are based on a strong low-frequency sound overall, and have a heavy and soft sound characteristic due to the natural harmony of the mid-frequency. In addition, the sound in the high-frequency range is almost inconspicuous, so it is a sound characteristic that is comfortable and unobtrusive to hear. JANGJIMUN opening and closing sound is based on stable and comfortable low-frequency sound, and it has been proven that the cool, soft mid-frequency fricative sound makes the listener feel good.[14][15][16]

IV. MOS Test of JANGJIMUN's sound

MOS Test was conducted to find out the affinity of the sound made when opening and closing JANGJIMUN. The MOS (mean opinion score) test was used as a means to verify how friendly the sound of opening and closing JANGJIMUN affects human psychology and body through the reaction of listeners. As a morse test method for the study of human friendliness of JANGJIMUN sound, the sound of opening and closing JANGJIMUN was heard to 15 listeners, and the degree to which each listener responds was investigated in 5 steps. The questions on the MOS Test are “very good to hear”, “good to hear”, “normal”, “I hate to hear”, and “very hate to hear”. The detailed feelings that each person can feel are summarized into simple questions. You hear the sound made when you open and close JANGJIMUN, and some say it's good to hear and some say they don't want to hear it. This is because each person can have different feelings even when they hear the same sound. Some say it's good to hear because it's a soft, whispering sound, while others say it's hate to hear because the fricative sound seems to scratch my body and mind. Likewise, among those who say they don't like to hear, the fricative sound that occurs when opening and closing JANGJIMUN causes a headache, and some say they do not like it. Since we cannot test all of these various reasons, we have simplified it into five questions.

Table 1. MOS test of JANGJIMUN opening and closing sound by listener

Response Category ₩ Listener	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Very good to hear.	●	●		●						●	●	●			●
Good to hear.					●		●	●	●					●	
Normal to hear			●			●									
Hate to hear.													●		
Very hate to hear.															

As a result of hearing the sound occur when opening and closing JANGJIMUN to 15 listeners, as shown in MOS Test table of table 1 above, 7 out of 15 recognized it as a very good sound, and 5 responded positively saying that it is generally good to hear. If you add up to 2 people who said it was just normal, 14 people answered positively. There was also a negative answer, but there was only one, and the answer was "hate to hear" rather than "very hate to hear". As indicated by these MOS test results, it can be seen that the sound generated when HANOK opens and closes the JANGJIMUN door is also designed to have a good effect on residents.[17][18][19]

V. CONCLUSIONS

Most of the sounds that occur when living in HANOK give to resident a feeling of emotional comfort. Among them, this paper studied the components of sound generated when opening and closing HANOK's JANGJIMUN and its effect on people. As a result of scientific and acoustic analysis of the sound generated when opening and closing JANGJIMUN, it generates a sense of stability by generating a heavy sound based on a strong low frequency sound of less than 300 Hz, and the mid-frequency sound that gradually weakens to 10,000 Hz gives a soft and comfortable feeling.Relatively, the high-frequency sound above 10,000Hz is rapidly reduced and does not give a stimulating feeling, so it is a sound without a sense of resistance. In addition, as a result of conducting a morse test to find out the effect of the JANGJIMUN sound on people, most of the listeners gave a positive evaluation that the JANGJIMUN sound is good to hear. JANGJIMUN is a room door of HANOK, and because it is the door that must be opened and closed most often in order to live in HANOK, you have to live while listening to the sounds that occur most often. As such, the sound that occurs when opening and closing JANGJIMUN can be said to be the sound that has the greatest impact on people who have to live in HANOK. In conclusion, the sound that occurs when opening and closing JANGJIMUN in HANOK is a study that has been judged as a sound that makes people feel secure and comfortable. In the future, we will study the sound generated by HANOK to spread the excellence of HANOK, a traditional house in Korea, to the world.

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