

## The History of Jeju Jong Nang Binary Code

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### 요 약

제주정낭은 제주도에서 760년 전부터 사용되어온 인간의 이진수 부호통신으로 세계에서 처음으로 사용된 통신 방식이다.

정낭이 세개가 닫히면 주인이 장기 외출중이고 2개가 닫히면 2~3시간 외출, 한 개가 닫히면 잠시 외출중, 3개가 열려 있으면 주인이 집에 있는 통신 방식이다.

현재 교통신호등은 빨간 불이 켜지면 기다리고, 파란불이 켜지면 통행이 되는 게 정낭의 원리와 비슷하다는 것을 공학적으로 해석했다.

한편, 본 논문 관련 일부가 미국전기전자 학회(IEEE) VTS News Vol.50, No.1, Feb. 2003 에 실린바 있고, IEEE Vehicular Technology 세계학술 대회가 제주 convention center에서 2003년 4월 22일부터 25일 열렸었다.

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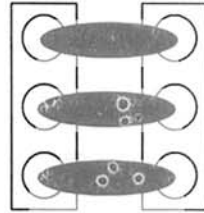
## Introduction

Thirty of years ago, in western society, F.G.Heath described the development of the binary code from Francis Bacon's "two-letter alphabet" which was conceived at the beginning of the seventeenth century, in "Origins of the Binary Code" [1]. Subsequently, Jacquardt's punch card operated loom (1805) and Boole's logical algebra (1854) led to the introduction of a binary telegraphic alphabet by Baudot (1875). Volker Aschoff, a Germany professor, reported the early history of the binary code in [2]. However, in oriental society, especially in Korea, concerned with 760 years old Jeju Island custom, Jeju *Jong Nang* Code is considered as one of the earliest Human Binary Coded Communication (HBCC) in the world with a definite "1" or "0" system.

*Jong Nang*, the wooden gate in Jeju Island dialect, had three wooden rafters placed on Jong-Ju-Mok (two large stones with three holes) to convey the family's whereabouts. A product of the wisdom of Jeju Island people in Korea, the *Jong Nang* was a unique custom of local culture. As there was no gate at the house in Jeju Island, timbers were used to prevent cattle or horses from entering and having the barley and millet that were spread out in the yard. Later, *Jong Nang* was developed into the means of informing visitors whether the residents were at home or not.

The *Jong Nang* used the binary system similar to digital communications and computers today. Three timbers were exactly like three binary digits. The *Jong Nang* system could convey eight different messages. One of three Jong-Nang placed between the Jong-Ju-Mok, or "100" indicated there was no one at home, but the

family would soon return from a neighboring area. Two *Jong Nangs*, or "101" meant the family was visiting a neighboring town and it would be a while before they returned. All these *Jong Nangs*, or "111" announced the family was out of town for a long time, as shown in Figure 1. When none of the *Jong Nang* was placed, or "000", this meant the family was at home, as shown in Figure 1. This system derived from the life of the Jeju Island people [3,6-8].

(a). House with *Jong Nang*(b). *Jong Nang* Code

**Figure 1** Jeju Island *Jong Nang*

Although it is not exactly known when the *Jong Nang* first appeared, is not clear, but it is considered to be about 760 years ago, during the Koryo dynasty. It seems to have started after the construction of stone fences. Stone fences were first erected to show the boundary of land ownership. During King Kojong's era, government officials and judges were sent to Jeju Island. In A.D.1234, Ku Kim was appointed as a judge and he ordered residents to build stone fences along their boundaries.

The dispute over boundaries and the damage of agricultural

products caused by grazing cattle and horses subsequently disappeared. The stone fences also acted as windbreaks. In addition, the collection of stones used to construct the fences contributed to easier cultivation and the quality of Island life. The Jong-Nang did not appear simultaneously with the erection of stone fences. To pasture cattle and horses in the Jung-sangan (=mountain) village on Jeju Island, the people built fence-like enclosures to prevent the animals from intruding onto farms. During the Chosun dynasty (A.D. 1392-1910), the practice became widely used across the Island.

Table 1 Jong Nang messages

Jong Nang Pattern	Jong Nang Communication	Jong Nang Digital code	Jong Nang Switching Channel/ Logic gate [8]	Traffic Signals & Code
	Staying at home	000		
	Visiting next door for a while	100		No signal
	Visiting a neighboring village	101		
	Out of town for a long time	111		

*Table 2 Relationships Between Traffic Light and Jong Nang Code*

Light \ Code	Traffic Signal Code	Jong Nang Code	Relationship
Red	111	000	1's complementary
Yellow	010	101	1's complementary
Green	000	111	1's complementary

The installation of 'Salchaegi' or 'Sombi' at the entrance became a starting point of the *Jong-Nang*. 'Salchaegi' or 'Sombi' originated as a field door set up vertically to pasture cattle and horses at the foot of Mt. Halla (1950m). It consisted of four to five thin logs or branches. At first, 'Sombi' was supposed to set up so that a horse could get in and eat crops located in the yard. When two *Jong Nangs* were used, large cattle or horses could not get in, but calves or ponies could. When one more *Jong Nang* was added, the calves and ponies could not get into the house at all.

A general communication system conveys information from its source to a destination some distance away using common symbols. The *Jong Nang* HBCC of Jeju Island, however, differs from preset wireless communication in that the people wanting to communicate had to visit to confirm the message.

The digital logic analysis of *Jong Nang* is presented as follows:

The mapping from Boolean algebra into digital switching was first noted in the paper "A symbolic analysis of relay and switching circuits". Computer logic and digital system have been developed from this circuit-switching concept. But the *Jong Nang* system based on NOR circuit has represented the output as "0" and "1" easily from about 760 years before. Table 1 which was proposed by author shows *Jong Nang* Switching Channel and Modern Traffic

Signals.

In Table 1, we present the relationship between the *Jong Nang* switching channel/logic gate and modern traffic light as follows. We can make sense that modern traffic signal codes are 1's complementary of *Jong Nang* codes in Table 2.

## The digital logic analysis of *Jong Nang*

**Definition 1:** *Jong Nang* system is composed of 3 bits as shown Table 1 and each bit conveys different meanings. MSB (Most Significant Bit) as an existing bit indicates whether people are at home or not. When the existing bit is "0", it means someone is at home. Second bit is a spatial bit, so if this bit marks "0", it carries the information that the landlord stays near outside from his house. LSB (Least Significant Bit) is a temporal bit. "0" represents that no one is in house but returns in a short time. For each bit, "1" means the opposite case, as shown in Figure 2. This custom is similar fashion as space-time coding scheme.

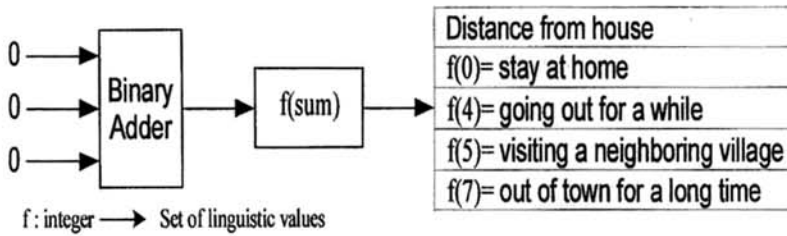
**Definition 2:** The information priority of 3 bit *Jong Nang* system is MSB, Medium bit, and LSB in a sequence order, i.e. MSB)Medium)LSB.

Counter case 1) "001": Existing MSB "0" shows someone is at home, spatial second bit "0" means nobody at home for visiting near village and temporal LSB "1" informs long time outgoing. Therefore, it is contrary to Definition 2, because the information priority does not follow the ordering.

Counter case 2) "110": Existing MSB "1" indicates house is empty,

spatial second bit "1" denotes long distance visiting and temporal LSB "0" shows short time outgoing. But long distance visiting generally requires long time to come back home. This case also is contrary to Definition 2 by the same reason of the counter case 1.

The above cases are not appropriate to the Definition 2, so they are not permitted in the Jong-Nang logic as shown in Table 3 (shaded entries).



*Figure 3 The Jong Nang Fuzzy Logic*

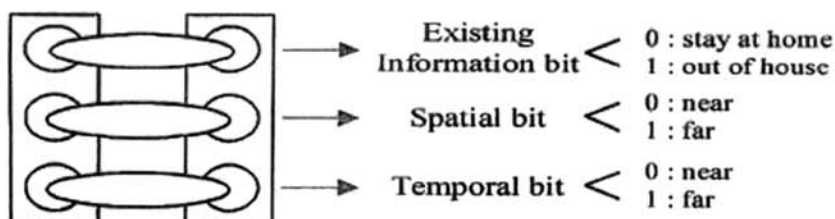
**Definition 3:** The larger Hamming weight of *Jong Nang* message, the longer the outgoing time. For example, "111" represents that it takes longer outgoing time than "100" or "101". Table 1 shows the different *Jong Nang* messages.

In view of *Jong Nang* HBCC development, it's evident that they used to place the upper *Jong Nang* first, then lower, and middle one last. The introduction and Table 1 also explain its history, which is based on the oriental philosophy. But, today it is often used "001" (place the lower *Jong Nang* only) and "011" (place the middle and lower *Jong Nang*) patterns respective form earlier *Jong Nang* Philosophy.

## The Fuzzy Concept Analysis of *Jong Nang*

The fuzzy concept was introduced by L. A. Zadeh for the first time in his "Fuzzy set" [5] paper in 1965. However, in Jeju Island, the fuzzy concept has been adopted to *Jong Nang* system about 760 years ago. They tried to represent the ambiguous concept(=(which usually contains various information hiding) through digital logic. We can perfectly certify this idea by NOR gate modeling.

In Table 1, *Jong Nang* of "100", "101" and "111" result in a NOR logic "0" output. However, the output "0" implies different intensity inputs such as *near*, *far* and *farther* distance.



*Figure 2 Jong Nang information codes*

(The temporal bit information should be corrected as 0: short time and 1: long time.)

**Table 3** The comparison of decimal and binary number in *Jong Nang*

Decimal	Binary	Comparison
0	000	<b>Staying at home</b>
1	001	Not permitted
2	010	Not permitted



Decimal	Binary	Comparison
3	011	Not permitted
4	100	<b>Visiting next door for a while</b>
5	101	<b>Visiting to neighboring village</b>
6	110	Not permitted
7	111	<b>Out of town</b>

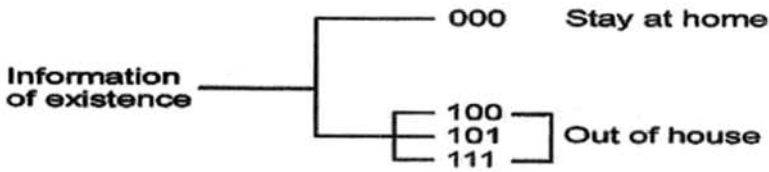


Figure 4 Jong Nang Tree

Figures 3 and 4 clearly show the mapping between spatio-temporal ambiguities and digital logic. Figure 5 is a life pattern transition diagram, which carries the information of family's existence.

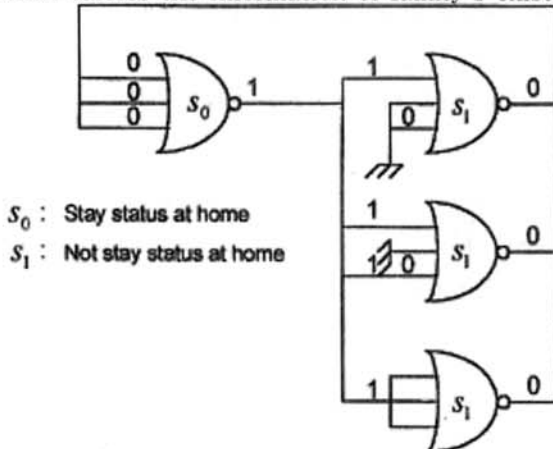


Figure 5 The Transition Diagram of Jong Nang

On the whole, the Jong Nang HBCC symbolizes the basic oriental philosophy of heaven, earth and human. The Chinese character "正"(Jong) decomposes of two characters: "一" meaning one or heaven, and "止" meaning that a man stands on the ground. "木"(Nang) which is a slang for tree in Jeju Island.

## Conclusion

The history of binary code technology can be written from many different points of view. It can limit itself to the simple description of the historical succession from the invention to the further development of particular instruments, machines, or apparatus as has occurred in western thought. On the contrary, in eastern civilisation, the description is based on the natural status.

With these considerations, the ancient Korean Jong Nang HBCC was introduced. Now we are using this custom in Jeju Island. The relationship between Korean ancient Jong Nang HBCC in view of digital logic and digital modern traffic signal was newly explained, also analysed that the Jong Nang HBCC has fuzzy concept to deliver the ambiguous information by using NOR gate modelling.

The *Jong Nang* HBCC was displayed at the Telecom. Pavilion of the Taejon Expo '93 (1993.8-1993.11) [3], where the history of world telecommunications were exhibited.

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*The island of Jeju, host to the VTC2003-Spring conference, has a long history in the communications field. Professor Moon Ho Lee of Chonbuk National University in Korea demonstrates the Jong Nang, an example of a binary code dating back over three quarters of a millennium.*