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Ideology of AoD: Analog On Digital

Operating Digitized Objects and Experiences with Analog-like Approach

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***Abstract*—Recently, content and services that merge the digital and the analog together have gathered people's attention. While every kind of tool and service has been digitized, people are rediscovering functionality provided by analog-like methods or user experiences. In this paper, we demonstrate the design concept and method for producing digital content, which we named "Analog on Digital (AoD). AoD is the idea of controlling digital content on devices through analog-like methods, and it is different from the idea of "Internet of Things (IoT)" to control physical tools or machines digitally. We also introduce the development examples based on the AoD concept that our research team is engaged in.**

Keywords—Analog on Digital; AoD; Internet of Thing; IoT; Interface Design; Media Design; Interaction; User Experience

I. INTRODUCTION

In the field of computerized expression technology such as computer graphics, movies, and application development, it is often the case that the creator or the content user misunderstands whether he or she improved his or her own producing technique or expression ability according to the computer's better functionality and software's high-quality. Ultimately the creator's original expression ability has nothing to do with the rich expression skills brought by the computers' processing speed or the highly functional design software. Empowered skills or techniques by development of devices, software or digital environments are quite a one-sided perspective. They cannot replace human creativity.

Of course, with the advancement and diversification of the tools and environments, the users' expression ability and creativity can burst into bloom. For example, the idea of the pencil was invented in around 1565 and its widespread utilization has brought us a more diverse ability of creative expression and improved paperwork capability. The advent of the pencil was indispensable to development of our expression ability. However, a case with this historic impact rarely happens in our daily lives. It seems impossible that this kind of breakthrough happens just because of the speed-up of the computer processing or the diversification of the software functions.

If someone knows which is which regarding the buttons of CG software with high functionality, he or she can easily manipulate photos or images like a professional's works. However, it does not mean that the software user's ability is at a professional level. It just means that the software can produce the output that deserves the professional level. Anyone who knows which is which and each function can produce the professional-level work equally regardless of his or her own ability or experiences. It is certain that it is very convenient, however, it leads to many people's misunderstanding that the output is a result of their own technique or ability.

Whereas development and advancement of the computer environments makes our lives convenient, there are also demerits and disadvantages to them. The remarkable examples are illegal copies (reproduction) of data or software, outbreaks of malicious software such as computer viruses, and compromised accounts. With the increase of the number of useful computers and digital environments, the problems caused by them increase and generate more inconvenience or difficulties than the originally targeted usefulness. There are many more examples of digitalization for the sake of convenience leading to inconvenience as a result.

Today, every kind of production activity consists of digitized steps and we cannot sustain our lives without using the Internet or digital devices. However, the environments in which everything is digitized and connected to the Internet quite often bring considerable disadvantages to our lives or production activities. We suppose that it is because digitalization of tools and environments has reduced the human being's feeling of "using tools" that we originally have, and this phenomenon makes "creating something" difficult. For humans who acquired the skills of using tools, sensory reality caused by physical contact has always accompanied the use of tools for over two million years. Digitalization of the tools and the environments that decreases sensory reality seems to damage human work efficiency.

For human beings, the difficulties of "using tools" or "creating something" can mean that their intellectual evolution will be stuck and the methods to enrich our lives will only be narrowed by the improved performance of the computers or the diversification of software functions.

The authors focus on this issue and propose "Analog on Digital (AoD)": the representation method that enables human beings to feel the sensory reality of "using tools" or "creating something" while using the Internet environments or the digital devices. AoD is applied to digital devices, however, it aims to improve the user-friendliness by a different approach from the

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convenience pursued by the digital methods. AoD provides sensory reality of "using tools" utilizing the analog-like methods in respect of operability and presentation. In this paper, we present the concept and summary of AoD and also introduce the more easy-to-understand examples of AoD tools, which we are developing.

II. AoD Concept and the Difference from IoT

A. What is IoT?

Nowadays, the merging of analog and digital tools is gathering attention widely as so-called "Internet of Things (IoT)". IoT means that all devices (things) are connected to each other by Internet communication. IoT is the system or the approach to realize more comfortable and secure everyday lives, for example, by attaching sensors to physical devices (things), monitoring the acquired information through the Internet, collecting the information, and controlling the devices remotely.

At a glance, "Analog on Digital (AoD)"proposed in this paper seems to be similar to the concept of IoT. However, the design concept of AoD is fundamentally different from that of IoT and the qualities of the targeted convenience and approaches are distinct. IoT is the idea of attaching the sensors to the physical objects (fridges, air conditioners, doors or lights), and collecting the acquired information or controlling the objects remotely through the Internet. The remarkable characteristic is the remote control of the physical living wares by embedding the sensors or the digital equipment into them.

B. What is AoD?

As well as IoT, AoD also aims to merge analog and digital. However, it is much different from IoT, upon which the physical devices are monitored or controlled in the digital environments with the attached sensors. AoD is the idea of using or controlling the various digitized tools through analog-like methods. In respect of that, AoD is precisely the opposite idea of IoT.

For example, the ultimate form of AoD that the authors suppose is the "Flashlight" function equipped on smartphones as standard. Probably, many people often use this function. It is the function that enables the user to use the smartphone as a temporary flashlight utilizing the camera lights that are embedded in most smartphones. The flashlight function of the smartphone is the use of the smartphones, the up-to-date digital devices, as the quite simple and rudimentary home electronic device, and this function is one of the most frequently used functions of the smartphone.

Another remarkable example is "Nintendo Labo", the new platform that enables the user to enjoy the analog-like operations with the combination of Nintendo's video game console, "Switch" and crafts made of cardboard parts. This can be also regarded as an example of AoD. Thus, the idea and the concept of AoD proposed in this paper are gathering people's attention radically and it can be said that AoD is a field that will be more and more commercialized from now on.

C. Analog-like "Sensory reality" and AoD

When working, the sensory reality of "using tools" is extremely important. For example, recently the performance of the voice input system by speech recognition has been improved and it progresses in stages of the practical use. There are also very-thin keyboards and non-physical infrared keyboards. It is convenient to input characters without any object (character input device such as a keyboard). Moreover, the user can reduce the number of the things to carry and save space in the office. The new systems seem to be all good, however, it is sometimes inconvenient or has a negative side for us.

For example, it is difficult for us to actually feel "I have pressed the keys just now" because those input systems are totally different from what we have been familiar with so far: the rhythmic input with sounds by typing the characters one by one on physical keyboards. As a result, sensory reality of the work, "typing keys" becomes more transparent, and it leads to the reduced interest or feelings of attachment toward the work. In other words, the user's work efficiency may drop or their motivation to do the work could be decreased.

Needless to say, it is easy to imagine that the voice input and non-physical character input/control such as software will be deployed more in the future. However, people's need for "sensory reality" acquired by the physical operations will remain steadily. Because the interest in the sensory reality of "using tools" is a human's built-in instinct. We suppose that the interest in sensory reality can be an important factor to increase work efficiency in this digital age, in which everybody is exposed to using digital tools.

III. AoD Development Examples

In this chapter, we introduce the actual examples of AoD development that our research team is engaged in.

A. Analock: Schedule Management Utilizing Analog Clock as Motif

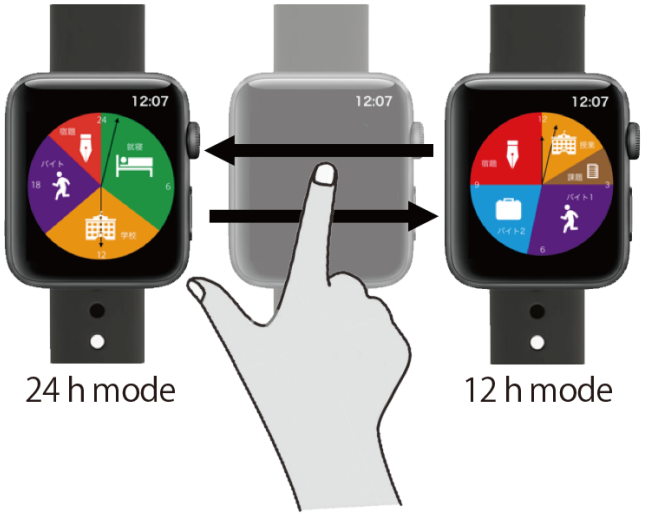


Fig.1 Control image of "Analock"

The "Circular Schedule" is one of the most popular schedule representation methods, and people can record their daily schedule or events on circles assuming that one circuit means 24 hours. As a matter of course, this method is a metaphor of the "analog clock" that indicates 12 hours (AM/PM) by one circuit.

We can perceive time better by checking the analog clocks that express the passage of time by movements of hour and minute hands on the circle with 12 main equal divisions. The spatial hand movements are supposed to suit the human time recognition mechanism. Although they have lower accuracy than the digital clocks that just switch the numbers, they allow us to perceive time as a whole. For this reason, even today when people quite often use digital clocks or smartphone watch functions, many people who focus on the qualities of time management still dare to use analog clocks.

"Analock" is an application that merges "circular schedule" and sensory reality of hand movements of analog clocks through digital technology. The application is realized by fusing the designs of "circular schedule" and the analog clock. Specifically, the progress of the day's events on the circular schedule can be perceived with time indicated by hand movements of the clock. On the dial, the schedule for the day is displayed and the "current" activity changes according to the hand movements. The application represents the circular schedule by hand movements that provide reality which fits our time perception best, and enables the users to manage the schedule in better ways.

We implemented this application for Apple Watches by Apple Inc. and the schedules are paired with the ones stored in iPhones. By sliding the dial screen, the user can check the events at that same time on one day or more prior, or on the following days. Also, 12h (12 divisions to indicate one day) or 24h (24 divisions) interfaces can be selected to make the schedule application more convenient.

B. *Qwerkey: Two-handed QWERTY Style Input System for Smartphones*

Fig.2 Prototype image of "Qwerkey"

Today, most smartphones can provide performance equal to typical laptop computers. With the rapid popularization of smartphones, the number of people who do not use computers is increasing rapidly. As computers are being replaced with smartphones, the interfaces for text input on smartphones are being optimized. Commonly, the text input methods on smartphones are based on smaller-size software keyboards placed on small smartphone screens. Of course, placing not only the QWERTY style software keyboard but also various kinds of software interfaces for better work efficiency has been developed.

However, the previous style of placing a small software keyboard on the display is difficult to use and so is voice input, because people cannot sufficiently feel the sensory reality of inputting the text. To solve this problem, our research team is developing "Qwerkey", the two-handed input system for smartphones with which the user can input the text quickly using both of his or her thumbs on a QWERTY-like layout.

Qwerkey has a software keyboard that is spread along the far right and far left of the display keeping QWERTY's basic arrangement and its simple usage. The size of the buttons is the same as those on keyboards on small laptop computers. The reaction sounds are set for the keyboard on the display and the user can feel the sensory reality of pushing the buttons.

To use Qwerkey, just tap the keys on the display while holding the smartphone in a vertical position with both hands (this is the most common way of holding when people play games) and using both right and left thumbs. Since Qwerkey adopts the layout in a longitudinal direction based on the common QWERTY layout for two-handed inputs, the user can feel the sensory reality of typing on the usual full keyboard and he or she can touch type once the user gets used to the method. The input text is displayed in the center of the display as a form of "display in display" and it is used by being transferred to other applications such as email applications and text editors with copy and paste functions.

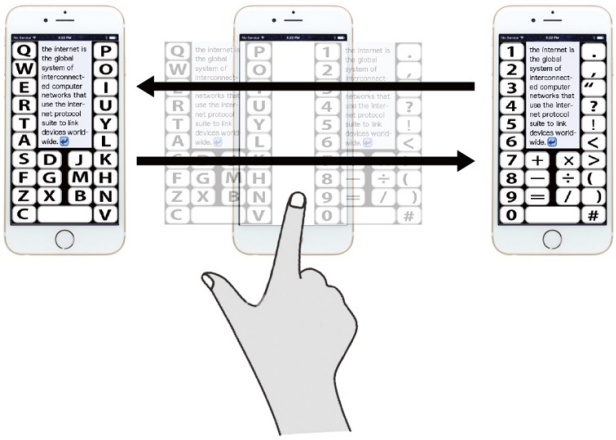


Fig.3 Control image of "Qwerkey"

Also, this system solves the sizing problem by switching between two modes: the alphabet key mode or the number/special character mode. The two modes can be

switched intuitively by sliding the top of the screen horizontally.

C. sMouse: Turning a Smartphone into a Computer Mouse

With recent downsizing of computers and their improved performance, there are a large number of people who use a small laptop computer as their main computer. In many cases, the equipped track pads are used as computer mice. Track pads save space in mobile offices and have high functionality. However, a considerable number of people prefer and carry computer mice for external connection as input devices.

The principal reason is that the operation of track pads and touch displays lack physical operations like holding and moving the tangible devices called "computer mice" and the users cannot feel the sensory reality of actually using tools. No matter how high-performance a device is, it is difficult to have feelings of attachment to the system or the device that does not provide sensory reality of the use. Lack of sensory reality of using a tool can also decrease the product's convenience and the user's motivation to use it. For example, the biggest problem to be solved regarding the virtual systems such as VR and AR is how they can make the user feel the reality of the experience. Just advanced graphics and simulations are not enough to make the users become emotionally involved in them.

A lot of people carry laptop computers and external mice with them, however it is an example of getting one's priorities wrong because they have to carry something extra in spite of downsizing the computers. To solve this problem, our research team is developing "sMouse", an application that enables the user to use their smartphone, which is now the most frequently carried device, as a computer mouse with the same kind of sensory reality as the physical computer mouse.

Some applications that turn smartphones into computer mice have already been proposed. However, to the best of our knowledge, they are all reproductions of the trackpad functions or something used like operating pointers for presentations. They can work like mice, however the users cannot feel the sensory reality of using so-called "mice". Regarding our application, the users can use smartphones connected via Bluetooth as mice with the same kind of sensory reality as using physical mice.

The user can control the mouse pointer on the display by moving the smartphone back and forth and around on a desk. For right and left clicks, "the clicking sound" is set up and when the user rolls the scroll wheel, "the rolling sound" is heard. By these detailed gimmicks, the user can feel the sensory reality of using a mouse.

D. 3D-Reflector: Materialization of 3D representation Utilizing Smartphones

With the high functionality of smartphones, the qualities of 3D representations have been dramatically improved and their expression ability is as rich as that of normal computers. However, they have coverage, which is limited within small displays, and it is a matter of course to express 3D representations beyond the coverage of the display.

To clear these limitations, we are developing "3D-Reflector", a method to enable the user to experience a 3D hologram, which is based on 3DCG projected by smartphones. In this method, the reflector is a square pyramid that people can easily create with reflective plastic sheets. By placing this square pyramid on the smartphone display, it can work as the projector and 3DCG can be represented outside of the display. Inside of the square pyramid, the extremely digital representation of 3DCG can be transformed into a brand-new expression that provides analog-like sensory reality, utilizing the application developed to generate 3DCGs and the DIY craft.

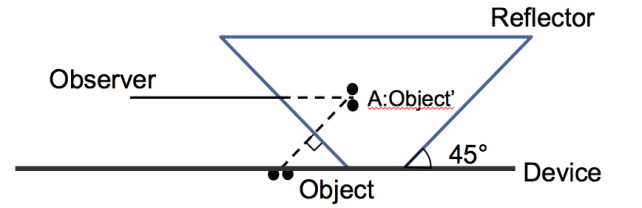


Fig. 4 The system of the 3D hologram

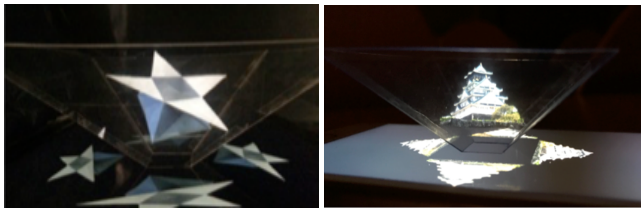


Fig.5 3D image by a tetrahedral reflector and a smartphone

The mechanism of 3D-Reflector is quite simple. The 3DCG movies or images that the user wants to represent sterically by the square pyramid display, just need to be reproduced at 90 degree angles to the center and placed in four directions equally. By putting the square pyramid upside down in the center of the four movies or images, inside of the pyramid the movies or the images reflected from four directions are represented in 3D.

The square pyramid display and the application are quite simple technologically, and everyone can easily create and operate them. Needless to say, there is a wide variety of more sophisticated 3D CGs for smartphones using more advanced technologies.

There are plenty of them applying the technologies such as VR and AR. However, there are few successful examples to materialize 3DCG representation based on digital technology with a method that provides analog-like sensory reality.

E. Infinite Scale: Smartphone Ruler that Provides Sensory Reality of Using Tools

There are a lot of applications with which smartphones can be used as rulers. They are classified according to the following two types.

One is the type that shows a ruler with real size divisions on a smartphone display, to be used as a ruler to measure up to the length of the screen size. The other is the type that estimates the length based on a calculation of the distance between the target object and the smartphone by image recognition technology.

The common point of the many different applications is that they are designed to complete the measurement process only inside of the smartphones. Because both types are used as virtual rulers, they have merits that they can measure the length of a shape that is difficult to measure with physical rulers, or the length at a distance. However, these merits also have the negative effect of decreasing the sensory reality that the tool called a "ruler" originally has. The sensory reality of the ruler means the ordinary reality perceived by holding the tool, placing it on the object and moving it for the measurement as necessary.

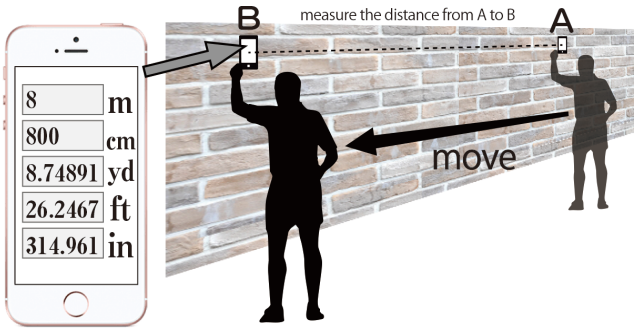


Fig.6 Control image of "Infinite Scale"

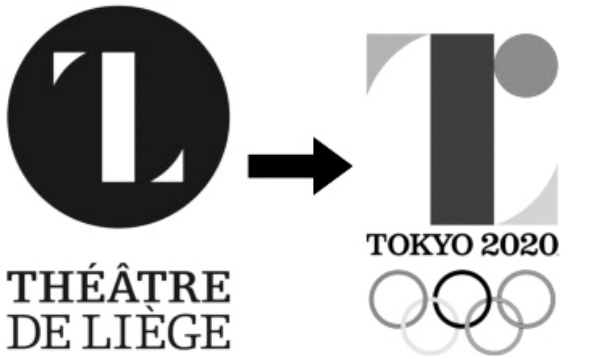
Thereupon, we propose "Infinite Scale", with which the user can feel the sensory reality of actually using the tool called a ruler. Regarding "Infinite Scale", first, the users place down their smartphones on the object that they want to measure the size of or distance from, and they measure the length by drawing a straight line as needed. It has quite a simple mechanism to display the distance the smartphone ruler was moved. The biggest difference from the previous ruler applications is that our application requires the user's physical actions to move the smartphone ruler for the measurement of the distance or size. They can fully appreciate the actual feeling of using the ruler for measuring the size.

IV. DESIGN TO PREVENT BEING COPIED

The development or design based on the AoD concept aims to make the users interested in the tools or the works and improve their work efficiency by providing the users with the "sensory reality of using tools" on the digital tools or software. In addition, it has another purpose. With digitalization always comes the risk of unfair use such as illegally copying.

No matter how precise a mechanism someone invents, it can be imitated immediately, and the copies will spread or will be distributed while reducing the rarity value. For example, although the present form of SNS originates from "SixDegrees.com", which was started by a business entrepreneur, Andrew Weinreich in 1997, his idea was imitated at once and generated Facebook and Instagram. SixDegrees.com, which was their originator, was sold in 2001 after increasing the number of users up to one million, and it is already closed and has almost faded into obscurity.

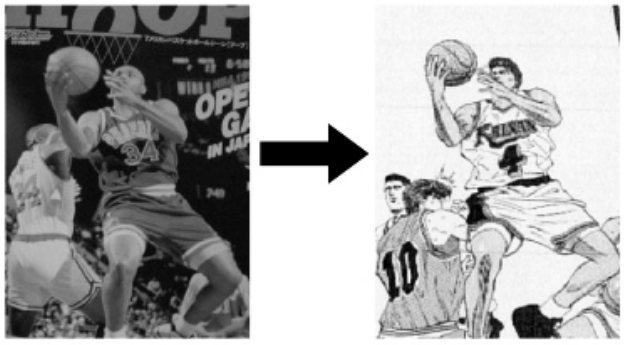
Our age is the Internet era and we cannot avoid encountering this kind of imitating regardless of legality. The situation of this kind of imitating is expressed with the word "pakuri" in Japanese and it is widely used as the prominent key word to represent today's design society in Japan. "pakuri" is a unique, frequently-used Japanese word, which means, in a wide sense, "imitating, stealing or being similar to" content regardless of the existence of vicious will or criminality, or despite being ethically right or wrong. The crime of reproducing the third party's content without permission is "pakuri", and as is lightheartedly retelling over drinks the funny secondhand story originally heard from someone else. "pakuri" covers an extremely wide range of "imitaing" and is used conveniently for various occasions of our lives. Since the 1990s, when society transformed to the Internet society, it became one of the most-frequently used words in generations.



(Original image: Logo of "Théâtre de Liège")

(PAKURI image?: Logo of "Tokyo Olympic2020")

Fig.7 pakuri suspicion case1



(Original image: "HOOP", Vol.13)

(PAKURI image?: "Slam Dank",Vol.13)

Fig8. pakuri suspicion case2

If we consider the definition of the word, "pakuri", we can say that the word is applied to most of the services or content

that are on a global-scale today, notably Facebook or Instagram. The Apple vs. Microsoft debate regarding 'copying' is also famous. However, none of these have reached conclusive settlements. Because it is ultimately difficult to prove the applied "pakuri" to be illegal "stealing" or "content theft". Therefore, unless the applied "pakuri" is coping of the source code, the mascot, or the logo design, it is difficult to accuse someone of illegal copying or stealing.

The biggest reason is that the mechanism or the system (content) of software is difficult to be pointed out as an obvious copy or similarity by comparing the superficial designs. A number of similar ideas, services, or mechanisms are invented day by day and it is impossible to deny the possibility of coincidental similarity. As long as people use the common critical technologies, resemblance is a matter of course. Specifically, the more prevailing the system or the service is, the more simple and sophisticated its mechanism is and imitating the idea is not difficult. Even though someone does not steal the source code, it is easy to imitate the innovative part or the idea on the level of a more meta-system. In other words, this kind of copying is difficult to prove as stealing or copyright infringement. "Pakuri-problems" are inevitable in the digital age.

For these problems, we suppose that the idea of AoD can provide the solutions to some extent. AoD is applied to the software or the digital devices, however, it provides "sensory reality" like "using physical tools". Features of the "sensory reality" are as clear or more so than the appearance.

Therefore, even without superficial similarities or imitated features, if someone copies any aspects of an AoD tool, in the end, resemblance is easily discovered in many cases. For example, if someone invents new form of play combining Nintendo Switch with some external cardboard crafts, that would be understood as "pakuri of Nintendo Labo", even if Nintendo Labo does not have a certain product that looks quite similar to that invention in its product lineup.

The designs based on the idea of AoD would be difficult to copy. Strictly speaking, AoD designs should have features that will be easily discovered when someone steals them. Today, the interest in intellectual properties and their importance are increased and the risks in case of the disclosure of copying or stealing are quite huge.

Not many people would dare to copy something with a risk that the applied "pakuri" is easily discovered. We suppose that ultimately, the digital content based on the idea of AoD would be difficult to copy. It is the design to prevent being copied that AoD aims at as another goal.

V. CONCLUSION

In this paper, we demonstrated the concept and summary of AoD, the design method proposed by the authors, and we also introduced specific examples of AoD tools development. Providing "sensory reality" like using physical tools is more meaningful than the novelty or the attraction for usability of digital content or software.

For example, it can work as a measure to some extent for the "copying" problems that we cannot avoid regarding digital content. It goes without saying that all digital content or software cannot necessarily be designed with the method or concept of AoD.

However, in the present age in which everything is digitized, we suppose that the idea of AoD can open huge potential for further development.

ACKNOWLEDGMENT

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[15] Fig.8(Takehiko Inoue), "Slam Dank", Vol.13, p.120, Shueisha, 1996 (English version: VIZ Media LLC, 2008