Paper:

Optimal Location of Wireless LAN Access Points Using Fuzzy ID3

Isao Hayashi*, **Takashi Kobayashi***, **Yoshinori Arai****, **Toshiyuki Maeda*****, **and Atsushi Inoue******

*Faculty of Informatics, Kansai University, 2-1-1, Ryozenji, Takatsuki, Osaka 569-1095, Japan
**Faculty of Engineering, Tokyo Polytechnic University, 1583, Iiyama, Atsugi, Kanagawa 243-0297, Japan
*** Faculty of Management Information, Hannan University, 5-4-33, Amami-higashi, Matsubara, Osaka 580-8502, Japan
**** Department of Computer Science, Eastern Washington University, CEB319F EWU, Cheney, WA 99004-2493, USA
[Received February 16, 2008; accepted November 25, 2008]

Although wireless LAN is useful in its small size and mobility, the connection region of transmitted radio wave is strongly affected by other electric devices, consumer products, and differences in size and type of the room. Besides, wireless LAN points (APs) must exclude a personal computers without permitting to connect to the Internet. Therefore, how optimally APs are located is important. In this paper, we propose the APs' optimal location method. The proposed algorithm integrates fuzzy rules acquired by fuzzy ID3 with knowledge of security experts, and estimates the connection region for AP. We discuss how to formulate the method for setting AP optimal location and show the effectiveness of this method by illustrating the examples of AP optimal locations.

Keywords: wireless LAN, security, fuzzy ID3, fuzzy rules

1. Introduction

Recently, development of the Internet [1, 2] and lowered cost of personal computers (PCs) enable us to embrace the environment where we can access various piece of information and use them through the Internet. In particular, as the performance of wireless LAN [3] has improved, wired LAN system has rapidly been replaced by wireless LAN system. Although wireless LAN is useful in its small size and mobility, the connection region of transmitted radio wave is strongly affected by other electric devices, consumer products, and differences in size and type of the room. Besides, wireless LAN points (APs) must exclude a personal computers without permitting to connect to the Internet. Therefore, how optimally APs are located is important. This is called AP optimal location problem. For example, if some PCs and APs are located within a room, the number of PC, which can connect to an AP, needs to be limited. Moreover, these PCs must be located within the connection region of AP, and wherever a PC is situated, it must be connected to the AP all the time. Also, APs must be safely located within a room excluding a PC without permission from connecting the Internet. Under these subjects, it is necessary to ensure that PCs are located within important connection region in order to minimize the number of AP by locating them at the optimal region. To solve this problem, it is possible to utilize the mathematical programming. However, we only find the information of whether PC can be connected or not. Moreover, the connection region of AP is uncertain, and the knowledge of security experts cannot be utilized. To overcome these situations, in this paper, we propose the AP's optimal location method applying the knowledge of security experts.

Quinlan [4] has proposed ID3 (Interactive Dichotomizer 3) algorithm, which acquires the production rules from given data. When input and output data are given to ID3, an attribute is selected where average mutual information is maximized, data sets are divided by the attribute, and finally if-then rule of tree structure is organized. Fuzzy ID3 [5–9] is a powerful method to acquire the structures of fuzzy decision trees from given data using formulates average mutual information and membership functions. On the other hand, Hayashi et al. [10] has formulated fuzzy AND operator by t-norm operator [11] with parameters, and proposed learning-type fuzzy ID3 that can determine attributes by tuning AND operator [12]. The AND operator is adjusted to the extent that the average mutual information is maximized. Fuzzy ID3 yields equivalent results as conventional ID3, when all membership functions are crisp, since this is a fuzzification of the conventional algorithm with respect to its partitioning. There are many practical applications reported using fuzzy ID3, including for oil refining plants [13] and electric plants [14].

In this paper, the algorithm for AP optimal location is proposed. First, each connection region of AP is estimated by using fuzzy ID3, and the overall connection regions are fixed by utilizing knowledge of security experts among the acquired fuzzy rules. Next, whether several AP connection regions occupy the room is judged, either access or unaccess. Moreover, whether there are any AP connection regions which cover the frequently-PC-situated region ($FPSR$) is judged. Finally, AP is shifted to the improved evaluation index, where AP connection region which cover the $FPSR$ is most widened and the number of AP is minimized. As a result, optimal locations of APs are determined. We formulate the algorithm for determining AP optimal locations, and show the usefulness of the AP optimal location method through introducing an example.

2. Algorithm of Fuzzy ID3 with Learning

Let f_i, $i = 1,2,\cdots,M$ be attributes and C_k, $k = 1,2,\cdots,U$ be classes, $F_{ti}, t = 1,2,\cdots,Q$ be fuzzy sets and o_{tk} be a real degree in the [0,1] for each class. Fuzzy rules are described as follows:

$$\text{If } f_1 \text{ is } F_{t1} \text{ and } \cdots \text{ and } f_M \text{ is } F_{tM}, \text{ then } C_1 = o_{t1}, \cdots, C_U = o_{tU}. \quad (1)$$

Fuzzy ID3 is a powerful method for acquiring fuzzy rules. Let s, $s = 1,2,\cdots,W$ be an index of data and j, $j = 1,2,\cdots,N$ be an index of membership functions. When the data set D in which we have the data, f_{si}, $i = 1,2,\cdots,M$ with the class k, its grade for the class, γ_s and the membership functions are obtained, the fuzzy rules are obtained using the following steps.

[Step 1] Calculate the entropy $H(D)$ of all data D.

$$H(D) = -\sum_{k=1}^{U} G^k \log_2 G^k \quad (2)$$

$$= -\sum_{k=1}^{U} \left(\frac{\sum_{s\in\psi_k}\gamma_s}{\sum_{s=1}^{W}\gamma_s} \log_2 \frac{\sum_{s\in\psi_k}\gamma_s}{\sum_{s=1}^{W}\gamma_s}\right). \quad (3)$$

where ψ_k is a set of the data with the class k.

[Step 2] Select a attribute, i, temporarily and calculate the conditional entropy $H(D|i)$.

$$H(D|i) = -\sum_{j=1}^{N} g_j \sum_{k=1}^{U} G_{jk} \log_2 G_{jk} \quad (4)$$

where

$$g_j = \frac{\sum_{s=1}^{W} \mu_{F_{ij}}(f_{is})}{\sum_{j=1}^{N}\sum_{s=1}^{W} \mu_{F_{ij}}(f_{is})} \quad (5)$$

$$G_{jk} = \frac{\sum_{s\in\psi_k} \gamma_{js}^{new}}{\sum_{s=1}^{W} \gamma_{js}^{new}} \quad (6)$$

$$\gamma_{js}^{new} = \gamma_{js}^{old} \otimes \mu_{F_{ij}}(f_{is}) \quad (7)$$

and the initial value of $\gamma_{js}^{old} = 1$.

The operator $\otimes$ is the t-norm connective [11] with parameter $p > 0$ as follows:

$$x \otimes y = 1 - ((1-x)^p + (1-y)^p - (1-x)^p(1-y)^p)^{1/p}. \quad (8)$$

By changing the parameter p, t-norm connective expresses the various AND operators, e.g., drastic product describing the minimal AND operator at $p \to 0$, algebraic product of $x \times y$ at $p = 1$, and logical product describing the maximal AND operator at $p \to \infty$.

[Step 3] Calculate the average mutual information.

$$H(i,p) = H(D) - H(D|i,p). \quad (9)$$

[Step 4] Select the optimal attribute i^* and the optimal parameter p^* using a learning algorithm, e.g., the golden section method [10], the descent method and so on.

$$(i^*, p^*) = \{(i,p) | \max_{i,p} H(i)\}. \quad (10)$$

[Step 5] If the following condition is satisfied, then the process for adding some sub-trees under the membership function j is stopped.

$$G_{jk} > \delta \quad or \quad \sum_{s=1}^{W} \gamma_{js} < \zeta, \quad for\ \forall j. \quad (11)$$

where δ and ζ are thresholds.

If all of the processes for adding sub-trees are stopped, the algorithm is terminated.

[Step 6] If the condition is not satisfied, repeat it from step 2 to step 5.

After the algorithm is terminated, the fuzzy rules in Eq. (1) is obtained and class degree o_{tk} is calculated as follows:

$$o_{tk} = \frac{\sum_{s\in\psi_k} \gamma_{ts}}{\sum_{s=1}^{R} \gamma_{ts}}. \quad (12)$$

3. A Method of Wireless AP Optimal Location

The devices for Wireless LAN access point easily and continuously enable lap top computers to connect to the Internet wherever the PC is placed. There are three standards for wireless LAN:

a) IEEE802.11a
This is the standard for maximum 54 Mbps using 5 GHz band. The connection region is narrow compared to 11b and 11g, and the connection is sometimes influenced by the object reflection.

b) IEEE802.11b
This is the standard for maximum 11 Mbps, using 24 GHz band. The connection region is wide compared with others.

c) IEEE802.11g
This is the standard for maximum 54 Mbps using 2.4 GHz band. The performance is similar to 11b; however, it is yet still widely used.

Among above three standards, IEEE802.11b is popularized in terms of its performance, cost, and safety. However, in general, there are the following prerequisite conditions to connect with PC.

1) All PCs must be connected to AP.

2) All APs must be safely located excluding a PC without permitting to connect to the Internet.
3) The number of PC which can be connected to AP is limited.
4) The connection region for PC to connect with AP is limited, but the connection region becomes uncertain because of transmitted radio wave interfered by object reflection and size of the room, and security.
5) Since PC is available for various purposes, the PC is not fixed in one area, and their locations are not evenly distributed.

AP optimal location problem is to maximize the following purposes of locating AP considering above five subjects;

1) To minimize the number of AP.
2) To maximize the PC's multiple connection rates where PC is located in $FPSR$, which means the frequently-PC-situated region.

Let the location of AP be $ap_i = (x_i, y_i),\ i = 1, 2, \cdots, m$, the location of PC be $pc_j = (x_j, y_j),\ j = 1, 2, \cdots, n$, and the distance between ap_i and pc_j be $f(ap_i, pc_j)$. Also, let the connection distance of AP be a radius R, the connection region of ap_i be $F(ap_i)$, upper limit of the number of connected PC be T, and $FPSR$ be I. The subjects and purposes can be formulated as follows:

$$\sum_i ap_i \rightarrow min\ \ and\ \ \{\cup_i F(ap_i) \subset I\} \rightarrow max \quad . \quad (13)$$

subject to

$$\begin{cases} pc_j \sim Prob(x, y) \\ \min_{i,j} f(ap_i, pc_j) \leq R, \quad for\ \forall i, j \\ \sum_{j \in F(ap_i)} pc_j \leq T, \quad for\ \forall i. \end{cases} \quad . \ . \ . \ (14)$$

To solve above subjects and purposes, it is possible to apply mathematical programming, however, generally, the connection distance of AP, R, cannot be fixed due to the PC's operating environment and security problems. Moreover, we only find the information of whether PC can be connected or not. Therefore in this paper, we propose the AP's optimal location method applying the knowledge of security experts.

Now, we assume that there is a room as shown **Fig. 1**. We here treat this problem of AP location as two dimensional, not three dimensional. Our purpose is to find out the AP optimal location in this room. Let $FPSR$ be a rectangle in the middle, and the location probability of PC in $FPSR$ be $Prob_L(x, y) = 1/3$. Also, locate AP which is $m = 3$ at random on the wall, defining the connection region from each AP as $R = 6.5$. Moreover, locate PC at random, which is $n = 15$, and let the connected number of PC in each AP be $T = 10$. Each location of AP is expressed as follows;

$$ap_1 = (0.0, 3.0) \quad ap_2 = (9.0, 10.0) \quad ap_3 = (15.0, 0.0).$$

In this location, one PC cannot connect from all APs.

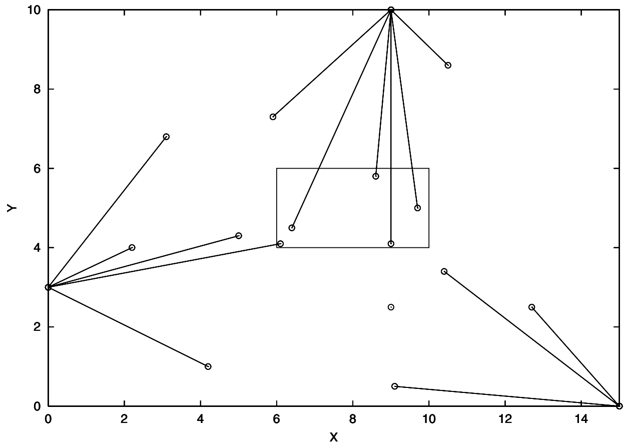


Fig. 1. Location of wireless LAN access point.

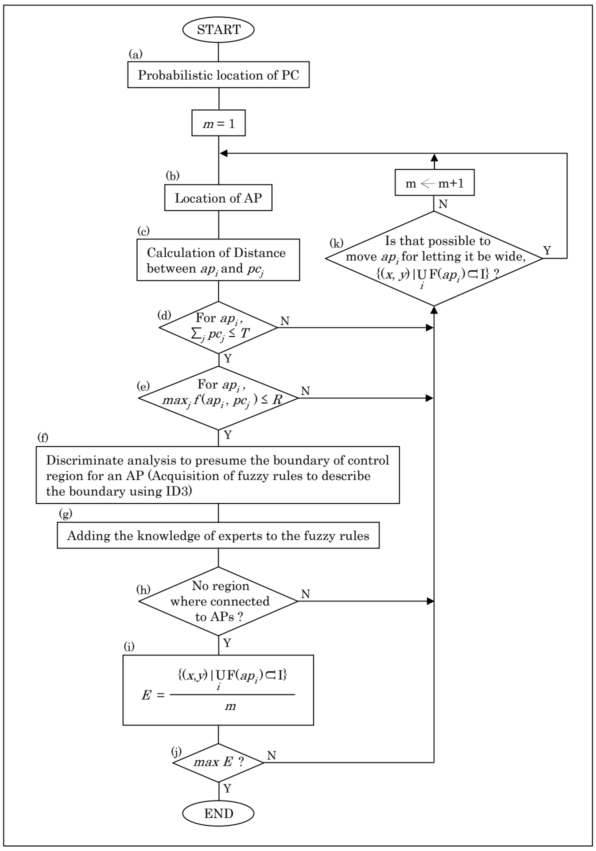


Fig. 2. Flowchart for location of wireless LAN access point.

Figure 2 shows the diagram of AP optimal location algorithm. First, the location of PC and $FPSR$, which is L, are determined at (a). In (b), the initial location of AP is determined, and the location of AP shifted to the next step is also determined. The distance between AP and PC is calculated at (c). In (d), whether the number of connected PC at each AP exceeds the upper limit T is judged. In (e), it is judged whether PC is located out of the connection region R for each AP. After these conditions are judged, each connection region of AP is estimated at (f) by using fuzzy ID3. In fuzzy ID3, the coordinate $pc_j = (x_j, y_j)$ for PC is an attribute variable, and when the PC is connected, the value of output class is categorized as 'access.' If the PC is not connected, the value of output class is catego-

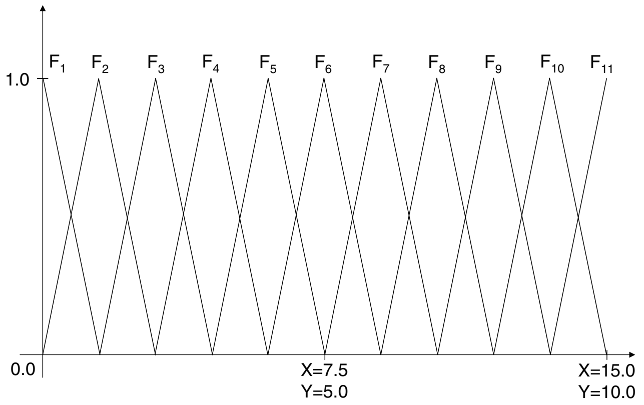


Fig. 3. Fuzzy sets.

rized as 'unaccess.' Besides, the golden section method is applied for determining of the optimal attribute i^* and the optimal t-norm parameter p^*. Applying the fuzzy ID3 to the input/output data, fuzzy rules which describe the connection region of AP are obtained. In (g), the knowledge of security experts is used to adjust the fuzzy rules, and more optimized fuzzy rules are determined. In the next (h), the connection region of AP is estimated by using above obtained fuzzy rules. Also, whether there are any regions that cannot be connected overall is judged. If such region exists, the following multiple connection region K within $FPSR$, which is identical with I, is first calculated.

$$K = \{(x,\ y) | \cup_i F(ap_i) \subset I\}. \quad (15)$$

In the next (k), whether each AP can be shifted to the direction where region K is increased is judged. If it is possible for AP to be shifted, APs are shifted by the following equations:

$$x^{new} = S_x(x^{old}) \quad (16)$$

$$y^{new} = S_y(y^{old}) \quad (17)$$

where, $S_x(\ )$ and $S_y(\ )$ are the shifted function for removing APs to new positions. We have proposed four methods, i.e., step method, dichotomy method, golden section method, and steepest descent method. For example, for the step method, the shifted function is defined as

$$S_x(x) = x + \triangle x \quad (18)$$

$$S_y(y) = y + \triangle y. \quad (19)$$

If it is impossible for APs to be shifted, m, which is the number of AP is incremented. On the other hand, if no connection region exists, calculate the following density, which is the multiple connection regions per one PC, and shift the location of AP to the direction where the index E is increased.

$$E = \frac{K}{m}. \quad (20)$$

Finally the optimal location is determined.

Now, let's determine the optimal location of AP by using the algorithm for optimal location. The algorithm starts from the initial location of AP as described in **Fig. 1**. Fuzzy sets F_{ti} in Eq. (1) are described as **Fig. 3**, and let m be 3, $n = 15$, $R = 6.5$, and T be 10. The probability of PC

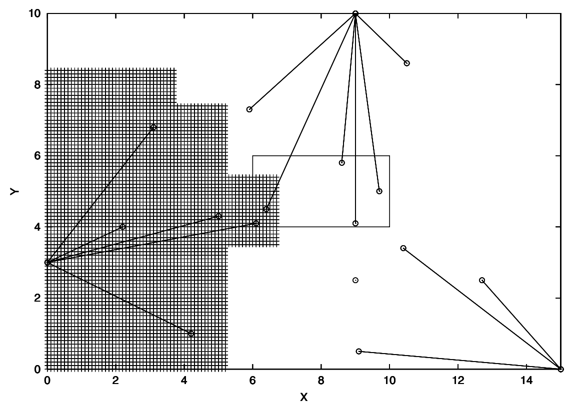


Fig. 4. Area of the first wireless LAN access point.

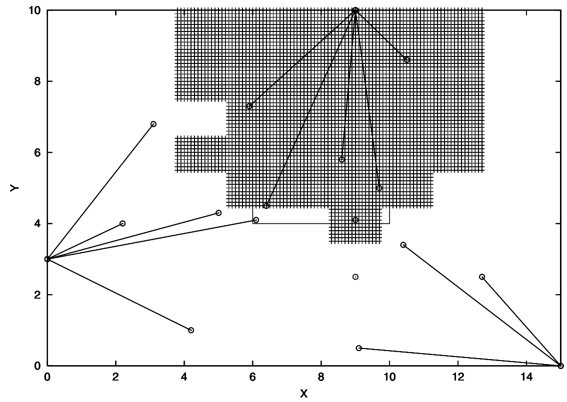


Fig. 5. Area of the second wireless LAN access point.

location is 1/3 in $FPSR$, which is L. The location of PC is determined at (a), and the initial location of AP is determined at (b). The conditions for the connection region R and T, the number of connected PC, are judged in accordance with the steps from (c) to (e). **Fig. 1** shows that one PC is unable to access from every AP. However, since the minimum distance to AP is 6.5, and the connection region is $R = 6.5$, the connection region becomes uncertain. Therefore, we decide that this PC is out of recognition, and we should proceed to the next step. In (f), assuming $\delta = 0.8$, $\zeta = 0.1$, the fuzzy ID3 is used. Then, the first connection region of AP is estimated. The following fuzzy rules are obtained by adding the knowledge of security experts at (g).

If X are F_1 to F_3 $\text{and}_{p^* \to 0}$ Y are F_1 to F_9,
then $Access(1.0),\ Unaccess(0.0)$.

If X is F_4 $\text{and}_{p^* \to 0}$ Y are F_1 to F_8,
then $Access(0.96),\ Unaccess(0.04)$.

If X is F_5 $\text{and}_{p^*=0.13}$ Y is F_5,
then $Access(0.84),\ Unaccess(0.16)$.

If X is F_5 $\text{and}_{p^*=0.13}$ Y is F_6,
then $Access(0.33),\ Unaccess(0.67)$.

If X is F_6,
then $Access(0.11),\ Unaccess(0.89)$.

Else $Access(0.0),\ Unaccess(1.0)$.

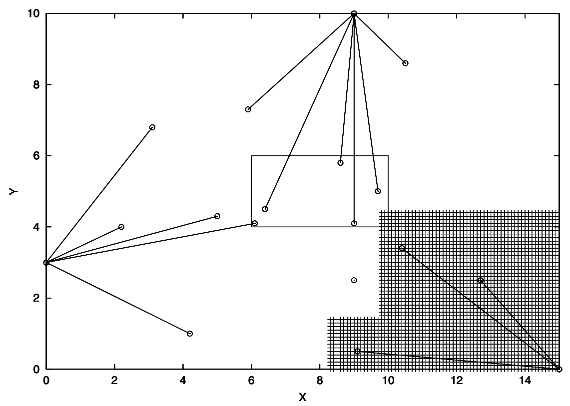


Fig. 6. Area of the third wireless LAN access point.

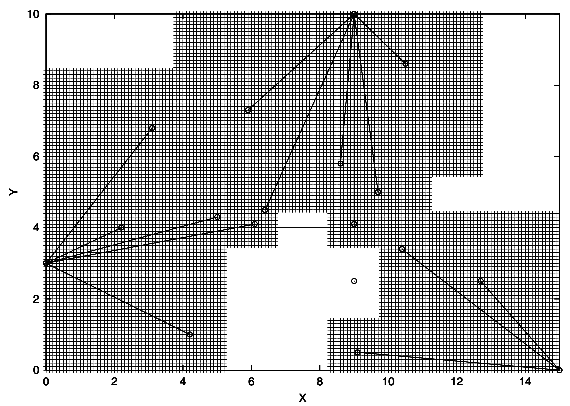


Fig. 7. Area of all wireless LAN access point at the first step.

We got six rules and the AND operators are learned by t-norm connective. Since the parameter values p^* of the first rule and the second rule are converged to zero, the connection strength of locations, X and Y, is very strong because of t-norm definition. On the other hand, the parameter values p^* of the third and the forth rules are 0.13, and the connection region of locations, X and Y, combine weakly.

Figure 4 shows the estimated connection region. The dot meshing area shows the connection region. From the fuzzy rules, the connection regions estimated by the third and the forth rules are obviously weak for connecting with PCs. In a similar way, **Fig. 5** shows the connection region of second AP, and the third AP is shown in **Fig. 6**. It is obvious that each estimated region covers the PC, which is connected with the AP. **Fig. 7** shows the whole area combining three figures, **Fig. 4, 5**, and **6**. We find that there are three blank non-connection regions in which PC is not connected with any APs. To show the usefulness of our method using fuzzy ID3, we compared it with J48 which is a kind of conventional ID3 method with numerical variables. **Fig. 8** shows the whole connection region of APs using J48. It is obvious that the non-accessible three regions is larger than fuzzy ID3, and the PC which was out of recognition in **Fig. 1** is mistaken as connected to the third AP.

At (h) of **Fig. 2**, whether there are any non-connection regions is judged, so x, y for AP is shifted to the direction

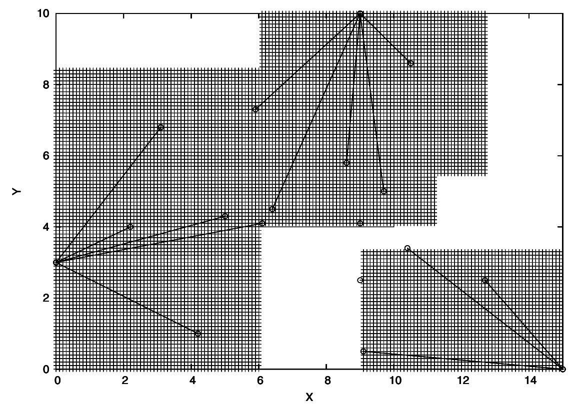


Fig. 8. Area of all wireless LAN access point at the first step using J48.

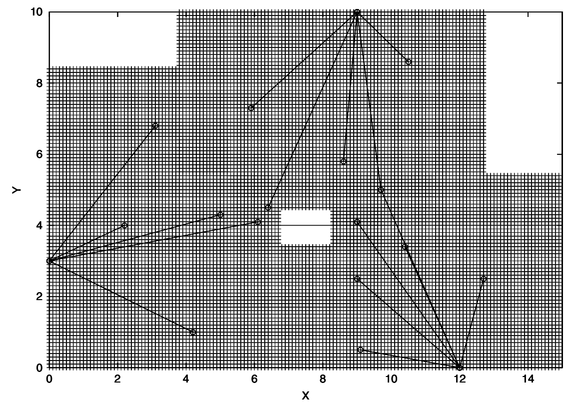


Fig. 9. Area of all wireless LAN access point at the 31th step.

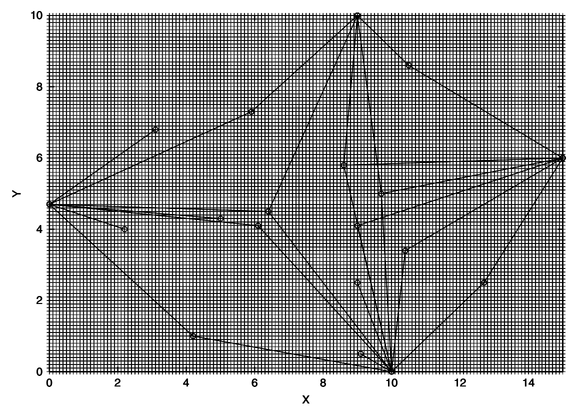


Fig. 10. Area of all wireless LAN access point at the last step.

where K calculated by Eq. (15) improves as $\triangle x = 0.1$, $\triangle y = 0.1$ in the case of the step method, Eqs. (18) and (19). Afterward, the algorithm is repeated. The connection region is shown in **Fig. 9**, where three sets of APs are integrated after shifting those sets of APs for 31st times.

$$ap_1 = (0.0, 3.0) \quad ap_2 = (9.0, 10.0) \quad ap_3 = (12.0, 0.0).$$

Comparing **Fig. 7** with **Fig. 9**, we find out that the non-accessible three regions become smaller, and PC, which is not connected in **Fig. 7** can now connect to AP because ap_3 is shifted. In addition to this, while the index E of Eq. (20) for **Fig. 7** is calculated to $E = 4.0$, the index E for **Fig. 9** is calculated to $E = 5.5$. Therefore, the value of

Table 1. Step times and index of E for four methods.

	Times of Steps	Index of E	E/times
Step Method	129.4	7.63	0.059
Dichotomy Method	14.6	3.25	0.22
Golden Section Method	19.6	6.25	0.32
Steepest Descent Method	23.6	7.13	0.30

$FPSR$ is improved.

Figure 10 shows all connection regions of 87th times. At 87th times, all connection areas are accessible, and the value of $FPSR$ is obtained as $E = 7.875$, which was the maximum among the values of E. As the value of E becomes maximum, the algorithm is terminated at (j) of **Fig. 2**. In total, four sets of APs are located by adding one more new AP. The following locations of AP are expressed. As a result, All PCs connect with AP, and all connection areas are accessible, satisfying the condition of $R = 6.5$ and $T = 10$. Therefore, these AP locations are optimized for PCs.

$$ap_1 = (0.0, 4.7) \quad ap_2 = (9.0, 10.0)$$
$$ap_3 = (10.0, 0.0) \quad ap_4 = (15.0, 6.0).$$

The average times of steps, and the index of E after conducted totally 30 trials of experiments are showed in **Table 1**. The minimal times of steps is the dichotomy method with 14.6 times for getting all connection areas be accessible, but the index of E is the worst value as $E = 3.25$. The best index of E is obtained as $E = 7.63$ for the step method, but the connection area was accessible at totally 129.4th times for times of steps. As a result, the most balanced method is the golden section method by the value of 0.32 divided the index of E by times of steps.

4. Conclusions

We proposed the method of locating optimal Wireless LAN access points using fuzzy ID3. This method enables us to estimate the connection region for PCs and the location for APs by adding the knowledge of security experts to the if-then rule.

Acknowledgements

This is a product of research which was financially supported in part by the Kansai University Research Grants: Grant-in-Aid for Joint Research, 2006. "Building and Application of Construction Product Model in Road Maintenance Field." In addition, this research is partially supported by the Ministry of Education, Culture, Sports, Science, and Technology of Japan under Grant-in-Aid for Scientific Research number 18500181.

References:

[1] S.Bradner, The Internet Standards Process, http://www.ietf.org/rfc/rfc2026.txt?number=2026, 1996.

[2] T. Tone, "How Networks Work," Nikkei BP, 2002.

[3] B. O'Hara and A. Petrick, "The IEEE 802.11 Handbook," A Designer's Companion, IEEE, 1999.

[4] J. R. Quinlan, "Discovering Rules by Induction from Large Collections of Examples, in Expert Systems in the Micro Electronics Age," Edinburgh University Press, 1979.

[5] R. Weber, "Fuzzy ID3: A Class of Methods for Automatic Knowledge Acquisition," Proc. of the 2nd Int. Conf. on Fuzzy Logic and Neural Networks, pp. 265-268, 1992.

[6] C. Z. Janikow, "Fuzzy Processing in Decision Trees," Proc. of the Int. Sympo. on Artificial Intelligence, pp. 360-367, 1993.

[7] M. Umano, H. Okamoto, I. Hatono, H. Tamura, F. Kawachi, S. Umezu, and J. Kinoshita, "Fuzzy Decision Trees by Fuzzy ID3 Algorithm and Its Applications to Diagnosis System," Proc. of Third IEEE Int. Conf. on Fuzzy Systems, Vol.3, pp. 2113-2118, 1994.

[8] H. Ichihashi, T. Shirai, K. Nagasaka, and T. Miyoshi, "Neuro-fuzzy ID3: A Method of Inducing Fuzzy Decision Trees with Linear Programming for Maximizing Entropy and an Algebraic Method for Incremental Learning," Fuzzy Sets and Systems, Vol.81, No.1, pp. 157-167, 1996.

[9] C. Olaru and L. Wehenkel, "A Complete Fuzzy Decision Tree Technique," Fuzzy Sets and Systems, Vol.138, No.2, pp. 221-254, 2003.

[10] I. Hayashi, "Acquisition of Fuzzy Rules Using Fuzzy ID3 with Ability of Learning for AND/OR Operators," 1996 Australian New Zealand Conf. on Intelligent Inform. Systems, pp. 187-190, 1996.

[11] B. Schweizer and A. Sklar, "Associative Functions and Abstract Semigroup," Publ. Math. Debreccen, Vol.10, pp. 69-81, 1963.

[12] D. Dubois and H. Prade, "Fuzzy Sets and Systems," Academic Press, 1980.

[13] T. Tani, M. Sakoda, and K. Tanaka, "Fuzzy Modeling by ID3 Algorithm and Its Application to Prediction of Heater Outlet Temperature," Proc. of the First IEEE Conf. on Fuzzy Systems, pp. 923-930, 1992.

[14] X. Boyen and L. Wehenkel, "Automatic Induction of Fuzzy Decision Trees and Its Application to Power System Security Assessment," Fuzzy Sets and Systems, Vol.102, No.1, pp. 3-19, 1999.

Name:
Isao Hayashi

Affiliation:
Professor, Faculty of Informatics, Kansai University

Address:
2-1-1, Ryozenji, Takatsuki, Osaka 569-1095, Japan

Brief Biographical History:
1981-1983 Sharp Corporation
1987-1993 Panasonic Corporation
1993-2004 Hannan University
2004- Kansai University

Main Works:
• "A Proposal of TAM Network with Gabor Type Receptive Field," Journal of Japan Society for Fuzzy Theory and Intelligent Informatics, Vol.18, No.3, pp. 434-442, 2006.

Membership in Academic Societies:
• International Fuzzy Systems Association (IFSA)
• The Institute of Electrical and Electronics Engineers, INC. (IEEE)
• Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT)
• Japanese Neural Network Society (JNNS)

Name:
Takashi Kobayashi

Affiliation:
Associate Professor, Faculty of Informatics, Kansai University

Address:
2-1-1 Ryozenji, Takatsuki, Osaka 569-1095, Japan

Brief Biographical History:
1994- Joined Faculty of Informatics, Kansai University
1997- Assistant Professor, Kansai University
2004- Associate Professor, Kansai University

Main Works:
• "The Implementation of Intrusion Detection System Focused on Port Violation," Proc. of The Third Int. Symposium on Communications and Information Technologies, Vol.1, pp. 79-83, 2003.

Membership in Academic Societies:
• The Institute of Electronics, Information and Communication Engineers (IEICE)
• The Japanese Society for Artificial Intelligence (JSAI)
• The Japan Society for Computational Engineering and Science (JSCES)

Name:
Toshiyuki Maeda

Affiliation:
Professor, Faculty of Management Information, Hannan University

Address:
5-4-33, Amami-higashi, Matsubara, Osaka 580-8502, Japan

Brief Biographical History:
1986- Matsushita Electric Industrial Co. ,Ltd.
1999- Fukuyama Heisei University
2003- Hannan University

Main Works:
• "Reconfigurable Interactivity for Net-Accessible Pet-Type Rehabilitation Robot System," Int. Journal of Robotics and Automation, Vol.22, No.1, pp. 44-48, 2007.

Membership in Academic Societies:
• Information Processing Society of Japan (IPSJ)
• The Institute of Electrical Engineers of Japan (IEEJ)
• IEEE (originally an acronym for the Institute of Electrical and Electronics Engineers, Inc)

Name:
Yoshinori Arai

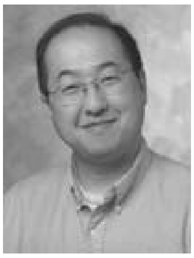
Affiliation:
Associate Professor, Department of Applied Computer Science, Tokyo Polytechnic University

Address:
1583, Iiyama, Atsugi, Kanagawa 243-0297, Japan

Brief Biographical History:
1986- CSK Research Institute Co. Ltd.
1987- RICOH Co. Ltd.
1992- LIFE (Laboratory for International Fuzzy Engineering Research)
1994- Tokyo Polytechnic University

Main Works:
• "Car Type/Name Recognition System Based on the Concept of Fixation," Journal of Advanced Computational Intelligence, Vol.3 No.4, pp. 274-281, 1999.
• "Fuzzy controlled robot arm playing two-dimensional ping-pong game," Int. Journal of Fuzzy Sets and Systems, Vol.32, No.2, pp. 149-159, 1989.

Membership in Academic Societies:
• Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT)
• International Fuzzy Systems Association (IFSA)
• The Japanese Society for Artificial Intelligence (JSAI)



Name:
Atsushi Inoue

Affiliation:
Associate Professor, School of Computing and Engineering Science, Eastern Washington University

Address:
CEB319F EWU, Cheney, WA 99004-2493, USA

Brief Biographical History:
2000 BISC, University of California at Berkeley, USA
2002- Eastern Washington University
2006-2007, Professor, Carnegie Mellon CyLab Japan

Main Works:
• A. Inoue, T. Wong, J. Zhan, et. al., "Application of Machine Learning to Information Security and Privacy," SOFT Journal, Vol.19, No.3, pp. 222-232, 2007.
• A. Inoue, A. L. Ralescu, "Computational Model of Perceptual Information Processing," FUZZ-IEEE99, Seoul, S. Korea, pp. 824-829, 1999.

Membership in Academic Societies:
• Japan Society for Fuzzy Theory and Intelligent Informatics (SOFT)
• North American Fuzzy Information Processing Society (NAFIPS)