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A Comparative Study Based on SVR for the Change of Strawberry Productions by the Variation of Nutrient Water Flow

A.B.M.Salman Rahman, Myeongbae Lee, Vasanth Ragu, Yongyun Cho, Jangwoo Park, Changsun Shin*

Department of Information and Communication Engineering, Suncheon National University

A B S T R A C T

Strawberry is one of the most well-liked fruits all over the world, and strawberry productions is rapidly rising as one of the most healthy economies all over the world. Due to the high demand for strawberries, greenhouse strawberry cultivation is increasing rapidly and farmers are using different types of methods for greenhouse cultivation to get high productions. The aims of this study are to find out the high production rate of the strawberry based on nutrient solutions with water flow rate. Farmers use a different amount of water nutrient solutions for strawberry production but mostly they don't know how much nutrient solutions with water flow is good for getting high production because of giving the high amount or less amount of nutrient solutions with water flow are always not good or bad for productions. Farmers have to know about the amount of nutrient solutions with water flow for getting good productions and now this is the high time to support farmers for increasing their strawberry productions by giving technological support. Therefore, in this study, we analyze the production rate of strawberries based on the nutrient solutions with water flow rate of strawberries in every bed. Finally, through the results and discussion by using the support vector regression model we find out that how much nutrient solutions with water flow should be needed to obtain high yielding of strawberries.

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KEYWORDS: Green house, Support vector regression, Nutrient water, Strawberry production, Cell growth, Photosynthesis.

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*Corresponding author is with the Department of Information & Communication Engineering, Suncheon

National University, Suncheon-si, Republic of Korea, 57922. E-Mail address: csshin@suncheon.ac.kr

1. Introduction

Nowadays strawberry is one of the most popular fruits all over the world. Strawberry is so much nutrient fruits also. Strawberry fruits consist of several nutrients such as Potassium, Carbohydrate, Protein, Calcium, Magnesium, Iron and high content of Vitamin C, etc. [1]. For this reason, peoples are showing so much interest to take strawberry fruits in their routine life and the demand for strawberries is increasing day by day. In the year 2006, the total world strawberry production was 58, 41,237 tons but in the year 2014, it was hugely increased 81, 14,373 tons [1]. So, farmers are also thinking to increase the production of strawberries.

Due to the high demand for strawberries, greenhouse strawberry cultivation is growing up rapidly. For greenhouse cultivation, nowadays farmers are using different types of method. Some method is used for growing plants with soil by using mineral nutrient solutions in a water solvent. Nitrogen, Potassium, and Phosphorus (NPK) are essential for basic plant survival. Nitrogen is for cell growth, phosphorus for the roots, flowers, and buds, and potassium is for photosynthesis [2]. The basic nutrient solutions of water are considering in its composition only nitrogen, phosphorus, potassium, calcium, magnesium and sulfur, and they are supplemented with micronutrients. Greenhouse strawberry cultivation is rapidly recognizing as the most productive and efficient form of food production. In the greenhouse, farmers are using different types of nutrient solutions with water flow for

strawberry productions. In our study, we try to find out the good nutrient solutions with water flow rate for getting high productions by using the support vector regression algorithm.

These study deals to analysis the nutrient solutions with water flow rate and the productions rate of strawberries. We used support vector regression algorithm to predict the average nutrient solutions with water flow rate and the average productions rate. Then we compare all nutrient solutions flow rate and the productions to find out the best water nutrition's flow rate for getting high productions. For doing all the steps, we used strawberry greenhouse data, which has three beds and farmers used three different amounts of nutrient solutions with water flow rate for three different beds.

2. Related Works

In statistics, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data [3]. M.L.A.T.M. Hertog and et al, were published the predicting keeping quality of strawberries (cv. 'Elsanta') packed under modified atmospheres: an integrated model approach [4]. Carlos Mario Grijalba and et al, has published the yield of the strawberry crop under macrotunel and open field and its relation with vegetative and reproductive aspects of the plant [5]. Siyue Li and et al, has been published a paper about Water quality in relation to land use and land cover in the upper Han River Basin, China [6]. Gianulaca Caruso and et al,

has been published a paper about the effects of cultural cycles and nutrient solutions on plant growth, yield and fruit quality of alpine strawberry (*Fragaria vesca* L) grown in hydroponics [7]. Narges Banaeian and et al, has published a paper energy and economic analysis of greenhouse strawberry production in Tehran of Iran [8]. Giorgos Mountrakis and et al, has been published a review paper about support vector machines in remote sensing [9]. Kennedy Were and et al, has been published A comparative assessment of support vector regression, artificial neural networks, and random forests for predicting and mapping soil organic carbon stocks across an Afromontane landscape [10]. Thomas Graham and et al, has been published a paper about Response of hydroponic tomato to daily applications of aqueous ozone via drip irrigation [11]. Huihui Yu and et al, has published prediction of the temperature in a Chinese solar greenhouse based on LSSVM optimized by improved PSO [12]. Karen Smeets and et al, has been published critical evaluation and statistical validation of a hydroponic culture system for *Arabidopsis thaliana* [13]. Weitang Song and et al, has been published a paper, tomato fusarium wilt and its chemical control strategies in a hydroponic system [14]. Dietmar Schwarz and et al, has been published a paper about the influence of nutrient solutions concentration and a root pathogen (*Pythium aphanidermatum*) on tomato root growth and morphology [15]. Erik A and et al, has been published a paper about closed soilless growing systems: A sustainable solution for Dutch greenhouse horticulture [16]. Roland De Marco

and et al, has been published a paper about Hydroponic nutrient solutions using flow injection potentiometry and a cobalt-wire phosphate ion-selective electrode [17]. Ming Xie and et al, has been published a paper about Membrane-based processes for wastewater nutrient recovery: Technology, challenges, and future direction [18].

2.1 Support Vector Regression

In machine learning, support vector machines (SVMs, also support vector networks) are supervised learning models with associated learning algorithms that analyze data. Support Vector Machine can also be used as a regression method, maintaining all the main features that characterize the algorithm (maximal margin). The Support Vector Regression (SVR) uses the same principles as the SVM for classification, with only a few minor differences. First of all, because output is a real number it becomes very difficult to predict the information at hand, which has infinite possibilities. In the case of regression, a margin of tolerance (epsilon) is set in approximation to the SVM which would have already requested from the problem. But besides this fact, there is also a more complicated reason, the algorithm is more complicated therefore to be taken in consideration. However, the main idea is always the same: to minimize error, individualizing the hyperplane which maximizes the margin, keeping in mind that part of the error is tolerated. Equation of Support vector regression;

$$y = wx + b \quad \dots\dots\dots (1)$$

Here, y - is the output variable, x -is the number of input variable, w -is the slope of the line and b -is the error term.

3. Materials and Methods

In this study, we use the year 2015 September to 2016 May strawberry data, which is gained from a greenhouse strawberry farm in South Korea named Mebangsuliang. There are two types of parameters are available in the greenhouse data, first one is nutrient solutions with water flow and another one is the production rate of strawberries. Three beds are available in this greenhouse, and beds names are MBSul_A, MBSul_B, and MBSul_C. In every bed, there are six plots and in each plots, twelve plants are available. Total seventy-two plants are available in each bed. Farmers used three different types of nutrient solutions with water flow for three different beds and they got three different types of productions from three individual beds.

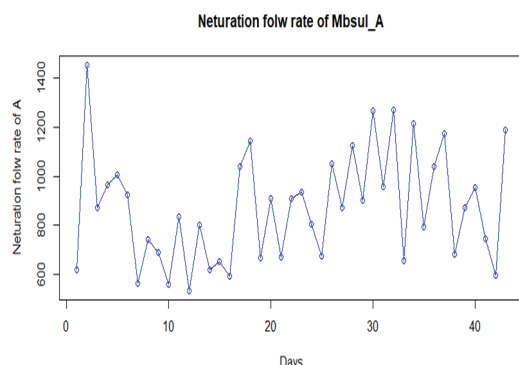


Figure 1: Total water nutrition flow rate for Mbsul_A

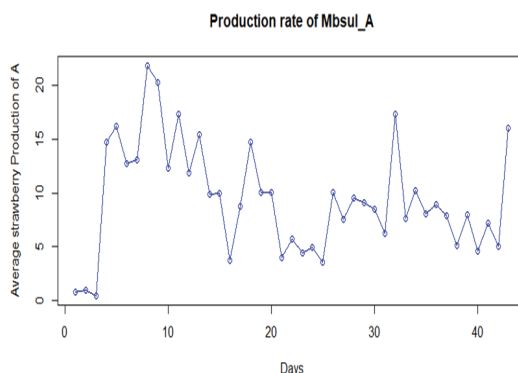


Figure 2: Total production rate Mbsul_A

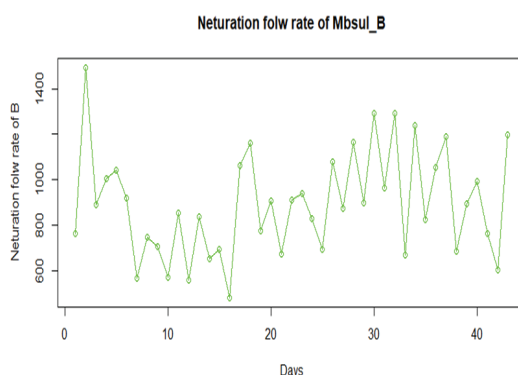


Figure 3: Total water nutrition flow rate for Mbsul_B

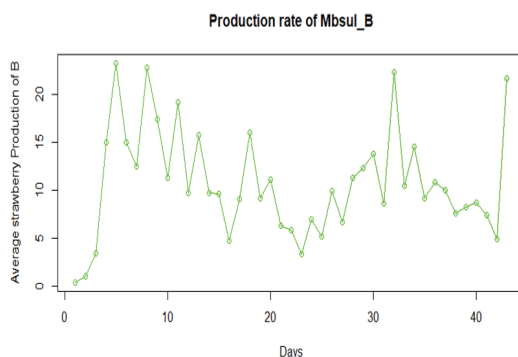


Figure 4: Total production rate Mbsul_B

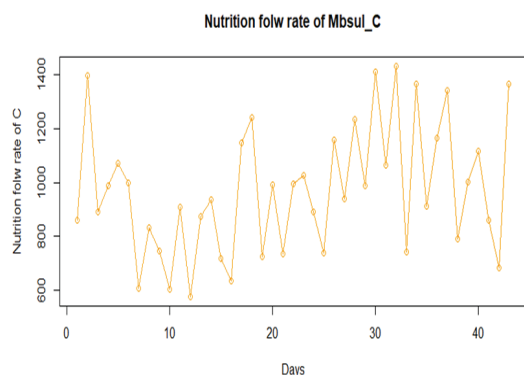


Figure 5: Total water nutrition flow rate for Mbsul_C

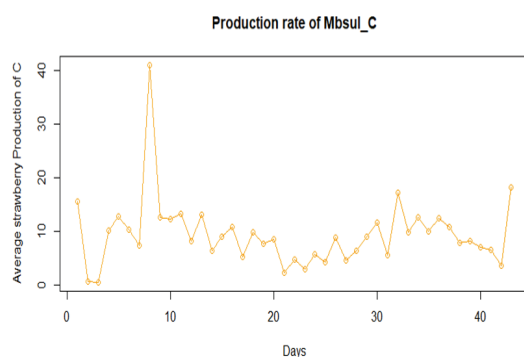


Figure 6: Total production rate Mbsul_C

From, <figure 1>, 3&5 we can see the water nutrition flow rate of beds Mbsul_A, Mbsul_B& Mbsul_C and <figure 2>, 4&6 shows the production rate of beds Mbsul_A, Mbsul_B& Mbsul_C. In the result part, we analyzed the nutrition flow rate and the production rate of Mbsul_A, Mbsul_B& Mbsul_C by using support vector regression algorithm to find out the fitting average productions of strawberries. We make a comparison of water nutrition's follow rate among three beds and also make a comparison between the three productions rate. Finally, we find out the good nutrition

flowrate for high productions.

4. Result and Discussion

In result and discussion part, we use the support vector regression for predicting average water nutrition's flow rate for three beds and the average productions rate of three beds. From these results, we find out the best water nutrition's flow rate from among three for getting high productions.

4.1 Analysing of nutrient solutions flow rate and Productions

In this study, we use one greenhouse data, which has three beds Mbsul_A, Mbsul_B& Mbsul_C. From this greenhouse, we got two types of data one is nutrient solutions with water flow rate for every beds and another one is productions rate of every beds.



Figure 7: Nutrient solutions flow with fitted SVM line of Mbsul_A

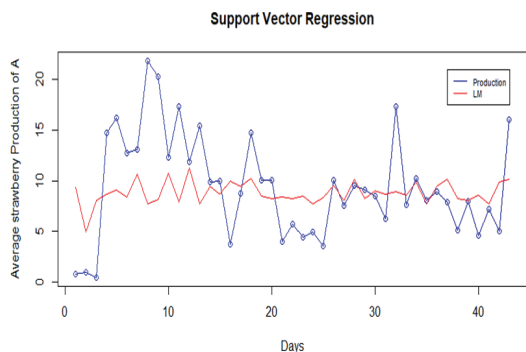


Figure 8: Total production with fitted SVM line of Mbsul_A

From <figure 7>, we can see the amount of nutrient solutions flow rate of bed Mbsul_A with support vector regression fitted line and <figure 8>, shows the amount of productions rate with support vector regression fitted line. Here blue line shows for absorbed data for Mbsul_A and the red line shows for the fitted line of support vector regression.



Figure 9: Nutrient solutions flow with fitted SVM line of Mbsul_B

From <figure 9> we can see the nutrient solutions flow rate amount of bed Mbsul_B with support vector regression fitted line and <figure 10> shows the amount of productions rate with

support vector regression fitted line. In the <figure 9&10>, green line shows for the absorbed data Mbsul_B and the red line shows for the fitted line of support vector regression.



Figure 10: Total production with fitted SVM line of Mbsul_B



Figure 11: Nutrient solutions flow with fitted SVM line of Mbsul_C



Figure 12: Total production with fitted SVM line of Mbsul_C

From <figure 11>, we can see the nutrient solutions flow rate amount of bed Mbsul_C with support vector regression fitted line and <figure 12> shows the amount of productions rate with support vector regression fitted line. In the 11&12 orange line shows for the absorbed data of Mbsul_C and the red line shows for the fitted line of support vector regression.

4.2 Comparison of three beds about nutrient solutions with water flow and the fitted curve of support vector regression model

From <figure 13&14> we can know about the comparison of nutrient solutions with water flow and the comparison between three fitted support vector regression lines for three beds Mbsul_A, Mbsul_B, and Mbsul_C.

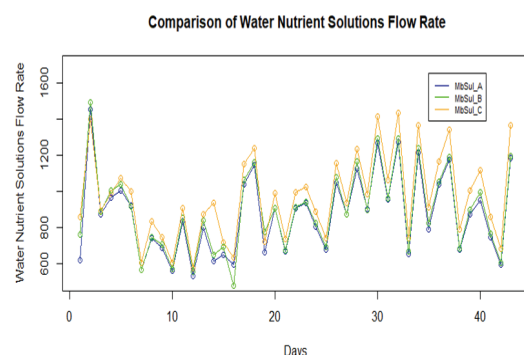


Figure 13: Comparison of Nutrient solutions flow

<Figure 13> shows the results of comparison between three beds nutrient solutions with water flow rate and <figure 14> shows the results of the comparison of fitted support vector regression

line between three beds. Blue line shows for nutrient solutions with water flow and fitted support vector regression line for Mbsul_A, green lines show for nutrient solutions with water flow and fitted support vector regression line for Mbsul_B, orange line shows for nutrient solutions with water flow and fitted support vector regression line for Mbsul_C in <figure 13&14>.



Figure 14: Comparison of Nutrient solutions flow fitted SVM line

4.3 Comparison between three beds productions rate and the fitted curve of support vector regression model

From <figure 15&16> we can know about the comparison of production rate and the comparison between three fitted support vector regression lines for three beds Mbsul_A, Mbsul_B, and Mbsul_C.

<Figure 15> shows the comparison results between three beds strawberry productions amount and <figure 16> shows the comparison of fitted support vector regression line between three beds. Blue lines show for strawberry productions

amount and fitted support vector regression line for Mbsul_A, green line shows for strawberry productions amount and fitted support vector regression line for Mbsul_B, orange lines show for strawberry productions amount and fitted support vector regression line for Mbsul_C, in <figure 15 and 16>.

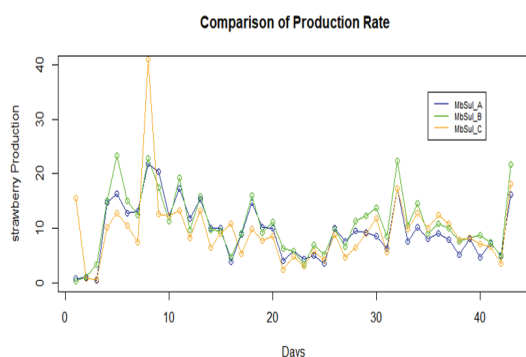


Figure 15: Comparison of production between three bed



Figure 16: Comparison of production of fitted SVM line

Here we find out total amount of nutrient solutions with water flow rate and total amount of strawberry productions. From <figure 17> and <figure 18> we can know about the details of total water nutrient solutions and about the total strawberry productions.

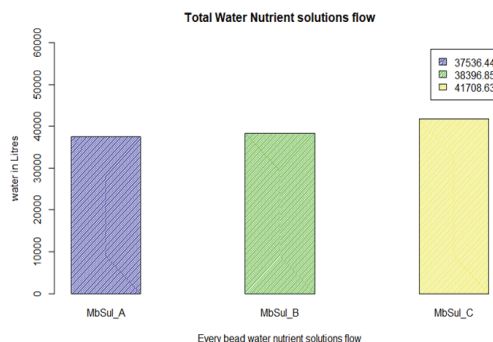


Figure 17: Total Water Nutrient Solutions

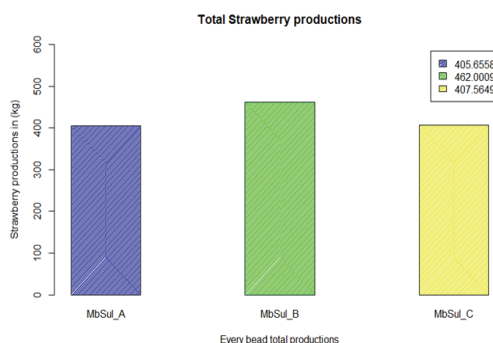


Figure 18: Total Strawberry Productions

<Figure 17> shows the total nutrient solutions with water flow of three beds, which are Mbsul_A, Mbsul_B, and Mbsul_C. Blue plot shows the total amount of nutrient solution flow of Mbsul_A. Green plot shows the total amount of nutrient solution flow of Mbsul_B, and green plot shows the total amount of nutrient solution flow Mbsul_C. Total nutrient solution flows of Mbsul_A, Mbsul_B, and Mbsul_C are 37536.44L, 38396.85L, and 41708.63L respectively.

<Figure 18> shows for the total productions of three beds Mbsul_A, Mbsul_B, and Mbsul_C. Blue plot shows for the total productions of Mbsul_A, green plot shows for total productions of Mbsul_B,

Table 1: Total water nutrient solutions and productions

Beds	Maximum water nutrient solutions(L)	Average water nutrient solutions(L)	Total Water Nutrient Solutions(L)	Average Strawberry Productions(kg)	Total Strawberry Productions(kg)
Mbsul_A	1452.096	872.94	37536.44	9.433855	405.6558
Mbsul_B	1492.778	892.95	38396.85	10.74421	462.0009
Mbsul_C	1431.25	969.96	41708.63	9.478254	407.5649

and green plot show for total productions of Mbsul_C. Total productions of Mbsul_A= 405.6558kg, Mbsul_B= 462.0009kg and Mbsul_C= 407.5649kg.

From table1 we can easily find out the best productions of strawberry among three beds. From this table, we can know about the total strawberry productions, average productions of strawberry, average water nutrient solutions for per bed, maximum water nutrient solutions for every bed and about the total nutrient solutions with water flow for three beds are Mbsul_A, Mbsul_B, Mbsul_C. Table1 shows that Mbsul_B gives the best strawberry productions among three beds. Mbsul_B bed total strawberry productions are 462.0009(kg), average strawberry productions are 10.74421(kg) and total nutrient solutions flow is 38396.85 (L). Total productions of Mbsul_A and Mbsul_C are 405.6558(kg) & 407.5649(kg). Average strawberry productions and total nutrient solutions flow of two beds accordingly 9.433855(kg)&37536.44(L) for Mbsul_A and 9.478254(kg)& 41708(L) for Mbsul_C.

5. Conclusion

This paper focused on to find out high productions of strawberries based on water nutrient solutions flow. All results and analyze provided us acuteness between nutrient solutions with water flow and strawberry productions. All results about three different types of nutrient solutions with water flow with three different productions and this work drills to find out high productions of strawberries based on water nutrient solutions flow. We analyze absorbed data with the fitted line of support vector regression. We compare three different types of nutrient solutions with water flow among them and compare three fitted lines of support vector regression. We compare three different productions and the fitted line of support vector regression. After comparing all three beds nutrient solutions flow and productions we find out that bed Mbsul_B gives us the best strawberry productions among three beds also with an optimal water nutrient flow. The total production rate and nutrient solutions of bed Mbsul_B are 462.0009(kg) & 38396.85 (L). On the other hand, total productions of Mbsul_A and Mbsul_C are 405.6558(kg) & 407.5649(kg). Average strawberry productions and total nutrient solutions flow of

two beds accordingly 9.433855(kg) & 37536.44(L) for Mbsul_A and 9.478254(kg) & 41708(L) for Mbsul_C. So, the production of Mbsul_B is far better than Mbsul_A& Mbsul_C also the nutrient solutions flow of Mbsul_B is an optimum nutrient solution. Mbsul_B nutrient solutions flow is close to nutrient solutions of bed Mbsul_A and less than Mbsul_C water nutrient solutions flow. From <Figure 18>, we can know about the three beds water nutrient solutions flow. Average nutrient solutions flow also shows the difference between three beds, average nutrient solutions of Mbsul_A = 872.94(L), Mbsul_B= 892.95(L), Mbsul_C =969.96(L). After analysing all results, it also shows that the high amount of nutrient solutions flows not able to give high productions. For getting high productions, we need an optimum level of water nutrient solutions flow.

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영양수 흐름의 변화에 따른 SVR기반의 딸기 생산량 변화 비교 연구

A.B.M. 살만 라흐만¹, 이명배¹, 바산트 라구¹,
조용윤², 박장우², 신창선²

¹순천시 순천시 정보 통신 공학과 연구원

²순천시 순천시 정보 통신 공학과 교수

요 약

딸기는 전 세계적으로 가장 선호하는 과일 중 하나이며, 딸기 생산은 전 세계에서 가장 큰 healthy economies 중 하나로 급속히 성장하고 있다. 딸기에 대한 수요가 높기 때문에 온실 딸기 재배가 급속히 증가하고 있으며 농부들은 높은 생산량을 얻기 위해 온실 재배를 위한 여러 유형의 방법을 사용하고 있다. 본 연구의 목적은 영양수의 유속에 따른 딸기의 높은 생산율을 알아내는 것이다. 농부들은 딸기 생산을 위해 다른 양의 영양 용액을 사용하지만 대부분 유속에 따라서 얼마나 많은 양의 영양분이 공급되는지, 공급하는 양의 적고 많음에 따라서 딸기에 긍정적, 부정적 영향을 미치는지 모른다. 농부들은 좋은 생산물을 얻기 위해 물의 흐름에 따른 양분 용액의 양을 알아야 하며, 농민들이 기술 지원을 통해 딸기 생산량을 늘릴 수 있도록 지원해야 할 때가 되었다. 따라서 본 연구에서는 딸기 테스트 베드에 주는 양분 용액의 유속에 따른 딸기 생산율을 분석 하였다. 마지막으로 지원 벡터 회귀 모델로부터 얻어낸 결과와 논의를 통해 딸기의 높은 수확량을 얻는 데 필요한 양분용액의 유속을 분석하였다.

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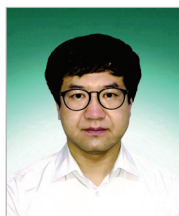


A B M Salman Rahman

received the Bachelor degree on Electronics and Telecommunication Engineering from Southeast University, Dhaka,

Bangladesh. Currently pursuing Masters leading Doctorate degree in information and Communication Engineering at Sunchon National University in South Korea. His area of interest includes Forecast Model, Ubiquitous Computing, and Big Data Processing.

E-mail address: salman01717@gmail.com



Myeongbae Lee completed Bachelor degree in Computer Engineering from Korea. He received Master degree on Computer Science in South Korea. And currently

pursuing Doctorate degree in the Information and Communication Engineering. He area of

interest includes Advanced Agriculture Technology, IT Convergence, Cloud and Ubiquitous Computing.

E-mail address: lmb@snu.ac.kr



Vasanth Ragu completed Master of Computer Application (MCA) degree at Indo-American College from India. He is pursuing a

Doctorate degree in information and Communication Engineering at Sunchon National University in South Korea. His area of interest includes Forecast Model, Ubiquitous Computing, Machine Learning, and Big Data Processing.

E-mail address: vasanth4224@snu.ac.kr



Yongyun Cho received the PhD degree in computer engineering at Soongsil University. Currently, he is an assistant professor of the Department of Information &

communication engineering in Sunchon National University. His main research interests include System Software, Embedded Software and Ubiquitous Computing.

E-mail address: yycho@sunchon.ac.kr



Jangwoo Park received the BS, MS and PhD degrees in Electronic engineering from Hanyang University, Seoul, Korea in 1987, 1989 and 1993, respectively. In 1995,

he joined the faculty member of the Sunchon National University, where he is currently a professor in the Department of Information &

Communication engineering. His research focuses on Localization and SoC and system designs and RFID/USN technologies.

E-mail address: jwpark@sunchon.ac.kr



Changsun Shin received the PhD degree in Computer Engineering at Wonkwang University. Currently, he is a professor of the Dept. of Information &

Communication Engineering in Sunchon National University. His researching interests include Distributed Computing, IoT, Machine Learning, and Agriculture/ICT Convergence.

E-mail address: csshin@sunchon.ac.kr