Design of expert system to determine the proper diet using harmony search method

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Abstract. Excess or lack of nutrients contained in food will cause a problem in the body. To solve this problem easily, a computerized system is needed that can provide some advice on the amount and type of food that needed to be consumed. The aim of this study is to design an expert system which addresses individual diet based on calorie activities and body needs. This study uses the Prototype as a software development methodology and Data Flow Diagram (DFD) as a software model. This expert system uses a harmony search algorithm to determine the amount of food with Harris-Benedict formula to calculate the body's calorie needs. The results of functional system testing and based on the assessment of nutritionists, this expert system have been worked well for people with normal body metabolism.

1. Introduction
The right diet is one of the characteristics of healthy living. Applying this right diet so that the body is protected from various diseases. The body's work can be optimally well if the nutrients that enter are fulfilled properly. Just healthy and nutritious food is not enough to fulfill a healthy life, because the food consumed is not calculated properly and properly, it will only cause new problems, commonly referred to as malnutrition. Extermination of malnutrition is not only the condition of someone who gets less nutrition but also the condition of someone who gets excess due to consuming too many calories. A simple explanation of the causes of obesity, "Genes can be a factor in obesity or obesity, but your weight is mainly determined by your diet and physical activities. In the long term, consuming excessive calories, taking a sedentary lifestyle, or a combination of both results in obesity ". Finally, what determines the condition of the body is the choice of nutrition and activity [1]. The diet is not only an effort to reduce weight but also regulates the intake of nutrients in the body. The dietary formula can be described if the number of calories entered is greater than the number of calories that come out, this will be stored in the body. Conversely, if the number of calories entered is less than the number of calories that come out, it will be taken from the stored calories especially fat [2]. The harmony search method is inspired by the way musicians look for the combination of tones by making an impression consisting of 3 ways, namely selecting the tones they remember, selecting random tones, and making adjustments. In this way, you will get a tone combination that produces harmony. Solutions are done randomly, so the solutions obtained are very diverse [3]. Based on this, it is expected that an information system can facilitate someone who has problems regarding weight and provide information about the amount of food that he can consume.

2. Literature review
Expert systems are experiences of experts summarized and represented as data or rules and stored in programs so that the system can perform the same functions as experts [4] in working at the same level
and providing information to others [5]. Improvement of diet or diet is one alternative treatment to cure diseases that arise due to the wrong diet including decreased fitness, headaches, and migraines, prolonged fatigue, ulcers, overweight. But confusion often arises about the right diet because of limited information, causing people to choose a way of diet that is harmful to their own bodies, such as force diets or diets that want fast and instant results, using diet pills, slimming drugs, and laxatives. No wonder many people are dieting but are unsuccessful, even more, weight gain is gained [6]. Body Mass Index (BMI) or Body Mass Index (BMI) is one way to achieve energy equilibrium. Energy balance can be achieved if the food consumed can produce energy in the same amount as the energy released. BMI is determined by the measurement of weight and height, with the following formula [7].

\[
\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2 (\text{m}^2)}
\]

Category:

| BMI Category   | Description          |
|----------------|----------------------|
| BMI < 18.5     | Lack of weight       |
| BMI 18.5 – 24.9| Normal weight        |
| BMI ≥ 25.00    | Overweight           |
| BMI 25.00 – 29.9| Pre-Obesities       |
| BMI 30.0 – 34.9| Obesity Level 1      |
| BMI 35.0 – 39.9| Obesity Level 2      |
| BMI ≥ 40.0     | Obesity Level 3      |

The calories of each individual vary depending on gender, weight and height and type of activity that is often carried out. These calories must be fulfilled every day by consuming food. The minimum calorie recommended by health experts that we must apply because if it exceeds the body's calorie limit it will cause new health problems and other problems. In looking for caloric needs the body uses the Harris-Benedict formula [8] as follows:

\[
\text{Man} = (88.362 + (13.397 \times \text{W}) + (4.799 \times \text{H}) - (5.677 \times \text{Age})) \times \text{Activity Level} \quad \text{(2)}
\]

\[
\text{Woman} = (447.593 + (9.247 \times \text{W}) + (3.098 \times \text{H}) - (4.330 \times \text{Age})) \times \text{Activity Level} \quad \text{(3)}
\]

With the provisions of the activity level:

- Inactive = 1.2. Which they do not exercise/activity at all in a week (in sick conditions).
- Mild activity = 1.375. Intensive exercise for at least 20 minutes in 1-3 times per week. If you don't exercise regularly, but you maintain a busy lifestyle that requires you to walk frequently for a long time, you meet the requirements of this level
- Moderate activity = 1.55. Intensive exercise for at least 30-60 minutes in 3-4 times per week.
- Weight activity = 1.725. 60 minutes intensive or deeper 5 to 7 days per week
- Very heavy activity = 1.9. Activities that are very active or very demanding: Examples include: athletes with long training schedules, shovelling coal or working long hours on the assembly line

One of the optimization algorithms that can be used to solve everyday problems [9,10]. This algorithm is inspired by the behaviour of musicians in playing music. Each music player with his own musical instrument will play each other's tones until finally a tone match is found which is called the harmony of the strings [11]. It is analogous that there are 3 music players (saxophonist, double bassist, guitarist) presenting viable vaginal discharge (X1, X2, X3). A collection of sounds produced by each player (saxophonist: Do, Re, Mi. Double bassist: Mi, Fa, Sol. Guitarist: Sol, La, Si). states the value range of each variable (X1 = 100, 200, 300. X2 = 300, 400, 500. X3 = 500, 600, 700). For example, if Saxophone produces the sound of Do, Double bass produces the sound of the Mi and the Guitar produces the sound...
of Sol, then the third produces a new harmony (Do, Mi, Sol). And if this harmony is more beautiful than
the previous harmony eating new harmony is maintained. Produces a new vector f(x) = (100, 300, 500).

It is known that Jenni has a height of 163 cm, weighs 60 kg at the age of 22 years. And now he is
undergoing a dance class to become a pro dancer. Jenni Height: 163 cm, Weight: 60 kg, Age: 22 years.

\[
\text{BMI} = \frac{\text{Weight (kg)}}{\text{Height}^2 (\text{m}^2)} \\
\text{BMI} = \frac{60}{(1.63^2)} = 22.58 \text{ (Normal)}
\]

Calorie = BMR x Activity Level
\[
\text{Calorie} = (447.593 + (9.247 \times \text{BB}) + (3.098 \times \text{TB}) - (4.330 \times \text{Ages})) \times \text{Activity Level} \\
= (447.593 + (9.247 \times 60) + (3.098 \times 163) - (4.330 \times 22)) \times \text{Activity Level} \\
= (447.593 + 554.82 + 504.974 - 95.26) \times \text{Activity Level} \\
= 1412.127 \times 1.375 = 1.941,675 \text{ calories/day}
\]

3. Research method

Engineering Modelling and Design is a comprehensive system engineering text that focuses on
systematic principles for designing systems. Concurrent engineering, which requires that from the very
start of a project all players (e.g., engineering, maintenance, marketing, customers) are involved as all
facets of the system life cycle is considered, is skilfully illustrated through the use of two major case
studies. The text describes how a product design proceeds parallel to the process design, explains key
duties of systems engineers throughout the product life cycle, and examines the process of system design
in terms of life cycle requirements. Projects and problems are presented throughout the text. A
homework solutions/instructor's manual is available from the publisher upon request. Engineering
Modelling and Design is an excellent text for engineering design courses in industry and upper-
division courses on concurrent engineering or total quality management [12]. Data-flow diagrams (DFDs)
are system models that show a functional perspective where each transformation represents a single function
or process. DFDs are used to show how data flows through a sequence of processing steps. For example,
a processing step could be the filtering of duplicate records in a customer database. The data is
transformed at each step before moving on to the next stage. These processing steps or transformations
represent software processes or functions, where data-flow diagrams are used to document a software
design. The design of the context diagrams expert diet system can be seen as follows:

![Data flow diagram](image)

**Figure 1.** The design of the data flow diagrams expert diet system.

Harmony Search Method (HS) is a new population-based meta-heuristic method, which has a different
search mechanism compared to the classic population-based algorithms such as PSO, DE. Consider a
general optimization problem: Minimize f(x) subject to \( x_{j,L} \leq x_j \leq x_{j,U}, j=1,2,3,..., D \), where \( x_{j,L} \) and
\( x_{j,U} \) are the lower and upper bounds for the decision variables, respectively. Before implementing the
HS algorithm, we first initialize the algorithm parameters such as harmony memory size (HMS), harmony memory considering rate (HMCR), pitch adjusting rate (PAR) and bandwidth (BW). We then initialize the harmony memory. In an HS algorithm, a new harmony can be generated by using any combination of the three rules: harmony memory consideration, pitch adjusting, and random selection. At first, if a random number value R1 is smaller than the value of HMCR, then implement harmony memory consideration: \( x_{\text{new},j} = x_{r,j} \), where \( j \in (3, D) \), D is the maximum number of dimension. \( r \in (3, \text{HMS}) \), which is the index number of harmony [13].

![Figure 2. The harmony search expert diet system.](image)

4. Result and discussion

The front page when the user first enters after successfully logging in. This front page is the same between ordinary users and admin. On this page, the admin can monitor users who have used the application and can create a new user with access rights as a new admin.

![Figure 3. Front page expert system.](image)

This page is to see data on the type of activity and can change it which can only be done by the admin. This page is used to change the data type of activity by the admin. Admin can only change activity data but cannot add activity data.
System testing is a process to run software to look for errors or deficiencies in the software being tested and determine whether the software is feasible as desired system specifications. This test is divided into 2, namely black box testing and data testing.

### Table 2. Data test 1

| Time       | Breakfast                          | Lunch                      | Dinner                     |
|------------|------------------------------------|----------------------------|----------------------------|
| Rice (g)   | chicken’s liver (g)                | mushroom (g)               | banana (g)                 |
| Rice (g)   | rice (g)                           | omelette (g)               | banana (g)                 |
| Rice (g)   | vegetable stew (g)                 | banana (g)                 | rice (g)                   |
| Rice (g)   | omelette (g)                       | mushroom (g)               | banana (g)                 |
| 91.06      | 135.33 52.60                       | 183.60 154.62              | 347.38 39                  |
| 104.55     | 133.38 51                           | 111.80 156.66              | 344.30 146.80              |
| 104.54     | 130.43 55                           | 134.12 345.48              | 133 48.80                  |
| 104.67     | 133.33 55                           | 134.12 174.40              | 130.20 97                  |
| 104.14     | 133.33 102                          | 156.36 21.00               | 181.40 179.20              |
| 104.24     | 133.54 167                          | 83.80 155.46               | 549.37 111.40.00           |
| 104.24     | 133.54 176                          | 154.55 346.89              | 156.80 111                  |
| 104.85     | 133.02 104                           | 155.74 94                  | 152.40 59.60               |
| 104.38     | 133.25 148                          | 89 156.39 4.6              | 89.40 138                  |
| 104.44     | 133.54 190                          | 96.50 156.90               | 341.77 132.00.00           |
| 104.26     | 133.08 115                          | 88.64 156.39              | 256.91 116.34              |

### Table 3. Data test 2

| Time       | Breakfast                          | Lunch                      | Dinner                     |
|------------|------------------------------------|----------------------------|----------------------------|
| Rice (g)   | shrimp sauce (g)                   | apple (g)                  | rice (g)                   |
| Rice (g)   | vegetable stew (g)                 | boiled eggs (g)            | sautéed kale (g)           |
| Rice (g)   |                                  | apple (g)                  | rice (g)                   |
| Rice (g)   |                                  | boiled eggs (g)            | sautéed kale (g)           |
| Rice (g)   |                                  | apple (g)                  | rice (g)                   |
| 104        | 133.33 56.20                       | 183.60 154.62              | 347.38 39                  |
| 104.55     | 133.38 51                           | 111.80 156.66              | 344.30 146.80              |
| 104.54     | 130.43 55                           | 134.12 345.48              | 133 48.80                  |
| 104.67     | 133.33 55                           | 134.12 174.40              | 130.20 97                  |
| 104.14     | 133.33 102                          | 156.36 21.00               | 181.40 179.20              |
| 104.24     | 133.54 167                          | 83.80 155.46               | 549.37 111.40.00           |
| 104.24     | 133.54 176                          | 154.55 346.89              | 156.80 111                  |
| 104.85     | 133.02 104                           | 155.74 94                  | 152.40 59.60               |
| 104.38     | 133.25 148                          | 89 156.39 4.6              | 89.40 138                  |
| 104.44     | 133.54 190                          | 96.50 156.90               | 341.77 132.00.00           |
| 104.26     | 133.08 115                          | 88.64 156.39              | 256.91 116.34              |

### Table 4. Data test 3
5. Conclusion

From the data testing table, it was concluded that the greater the weight and height (BMI) of eating more caloric needs, and if the activities carried out more and more then the results of caloric needs are even greater when compared to someone whose activity is not much. So, with expert systems in determining the right diet this can help people who want to control the amount of food calories that go according to the caloric needs of each individual body. In addition, this expert system can provide recommendations on the amount of food to be consumed according to the body's calorie count.

References

[1] Soubry A, Guo L, Huang Z, Hoyo C, Romanus S and Price T 2016 Obesity-related DNA methylation at imprinted genes in human sperm: results from the TIEG study 8 1 51
[2] Fittiani S N, Yulidarsari F and Fakhriadi R J J P K M I 2016 Hubungan Antara Status Gizi, Kebiasaan Mengonsumsi Ketupat, Kebiasaan Merokok, Dan Lama Merokok Dengan Kejadian Hipertensi Pada Masyarakat Di Wilayah Puskesmas Kandangan, Kecamatan Kandangan 3 2
[3] Assad A and Deep K 2016 Applications of harmony search algorithm in data mining: a survey Proceedings of Fifth International Conference on Soft Computing for Problem Solving (Springer)
[4] Septiana I, Irfan M, Atmadja A R and Subaekti B J J O I 2016 Sistem Pendukung Keputusan Penentu Dosen Penguji Dan Pembimbing Tugas Akhir Menggunakan Fuzzy Multiple Attribute Decision Making dengan Simple Additive Weighting (Studi Kasus: Jurusan Teknik Informatika UIN SGD Bandung) 1 43-50
[5] Dewi R and Verina W J T C 2018 Rancang Bangun Sistem Pakar Penentuan Diet Sehat Berdasarkan Tipe Genotipe Menggunakan Teorema Bayes 17 2 111-121
[6] Özön A Ö, Karadas Ö and Özte AIAoN 2018 Efficacy of diet restriction on migraine 55 3 233
[7] Locke A E, Kahali B, Berndt S I, Justice A E, Pers T H and Day F R 2015 Genetic studies of body mass index yield new insights for obesity biology 518 7538 197
[8] Villarreal V and Otero M 2016 Development a Mobile System Based on the Harris-Benedict
Equation to Indicate the Caloric Intake

International Conference on Ubiquitous Computing and Ambient Intelligence (Springer)

[9] Suryani D, Irfan M, Uriawan W and Zulfikar W B J O I 2016 Implementasi Algoritma Divide and Conquer Pada Aplikasi Belajar Ilmu Tajwid I I 13-19

[10] Herdiana D, Yuniarto D and Firmansyah E J J 2019 Sistem Pendukung Keputusan dalam Penentuan Beasiswa dengan Logika Fuzzy Tsukamoto di STMIK Sumedang I I 23-30

[11] Lashkajani K H, Ghorbani B, Amidpour M and Hamedi M-H J E 2018 Superstructure optimization of the olefin separation system by harmony search and genetic algorithms 99 288-303

[12] Chapman W 2018 Engineering modeling and design (Routledge)

[13] Ouyang H-b, Gao L-q, Li S, Kong X-y, Wang Q and Zou D-xJASC 2017 Improved harmony search algorithm: LHS 53 133-167
