Communication Support Tool With Data Glove Concept For People With Hearing Disability Using Kansai Engineering Method

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Abstract. The difficulty of communication that faced by the deaf and mute people make them complicated in doing activity like normal people. Sign language as a communication tool that has been formed at this time has not yet been able to connect communication with the community yet. It is only able to bridge communication among those fellow deaf and mute people. Therefore a tool which is able to translate sign language used by people with disabilities is needed. The tool which able to translate sign language was created by Data Glove concept in design which can translate the word visually. Using the assistance of the Semantic Differential questionnaire, we can get the emotion level from user based on 12 Kansei words. The response in emotion form which is expressed by users is one of the elements of the Kansai Engineering Method. Thus product adjustment to Kansai engineering is advisable and society.

1. Introduction
According to the World Health Organization [1], more than 5% of the world's population, which is 360 million people have an inability to hear sound well. Therefore, some of the people feel discriminated and hampered to socialize with social activities in general. In addition, such disability makes them often rejected from the rights to live independently, work, or even to move freely in a different social world than they are [2].

The formation of sign language as a medium of communication for the deaf and mute people at this time is really helping them interact with others. However, some people are not familiar with the use of sign language [3]. This proves that the use of sign language has not been able to connect the interaction between people with deaf-mute people to society. Thus can be the basis of the importance of making a tool that can support the deaf and mute people in communicating.

Making a product or a tool, of course, can not be separated from the method or technique that is able to support the process of designing and developing the product itself. The use of the method aims to create products that can be in accordance with the wishes of consumers themselves. In this research the method used is Kansai Engineering method. This method has been widely used, including in the development of robots for therapy and friends for elderly people (seniors) in Malaysia [4], a learning mediator robot for people with autism developed in Malaysia [5], and alarm clock made of bamboo developed in Indonesia [6]. The development of the three products using the Kansai Engineering method aims to meet the needs of consumers based on the emotions they
show by using these products. The emotion shown by the user is called Kansei [7]. By using Kansei Engineering method, it will be developed a product as a translator tool that will be tailored to the user's emotions in the form of a sign language interpreter.

Technological development in the form of sign language interpreter is now developed, but the price offered is so high in result to not able to reach the market well. In addition, the design of this translator tool has also been done in Indonesia, but the tool has not been quite successful. Translation of sign language with Kinect (microsoft products in the form of sensors) has not been able to detect the movements of the fingers, resulting in many non-translatable vocabularies [8]. Translation by using OpenCV software is only capable of detecting hand movements in an upright state with a distance not exceeding 90 cm [9]. Translation by using the concept of Data Glove is a concept which is able to translate sign language well by using gloves that have been embedded with sensors to detect the movement of human fingers on both hands of the user [10]. Therefore the selection of the concept of Data Glove is very appropriate to be used to detect the movement of sign language by pinning the sensor.

This concept selection is tailored to the relationship between designed products and the needs of consumers who generally tend to use the movement of the finger in communicating compared with other limbs. Therefore the concept of Data Glove is the proper concept and it able to solve the problem of sign language translation widely without any limitations caused by certain factors. To accomplish the design of this translator product, the researcher chose Kansei engineering concept to adapt the customer's emotion to the designed product so that it can meet the customer's need well.

2. Research method
The initial step of this research is identifying the problem. This is preceded by looking directly at how the interaction is done by the person in the use of sign language as the primary language in order to solve the problem. This problem solving is done by collecting data in the form of sign language and Kansei Word as seen in Table 1 as secondary data of research. In addition, the primary data contained in this study is the data from questionnaires on Kansei Word filled in by respondents after the respondent using a translator tool that has been designed.

| No | Kansei Word | Definition | Kansei Word | Reference |
|----|-------------|------------|-------------|-----------|
| 1  | Cheap       | Cheaper price | Expensive   |           |
| 2  | Simple      | Simple shape and ergonomic | Complex     |           |
| 3  | Light weight | Has light size | Heavy       |           |
| 4  | Practical   | Easy to use  | Difficult   | [11]      |
| 5  | Innovative  | Innovative  | Plain       |           |
| 6  | Rigid       | Rigid and stiff | Flexible   |           |
| 7  | Futuristic  | Modern and sophisticated | Conventional |           |
| 8  | Informative | Giving the impression fits data needed | Confusing   |           |
| 9  | Natural     | Giving a natural impression | Engineered  | [12]      |
| 10 | Comfortable | Brings calm and comfort feeling | Uncomfortable |           |
| 11 | Enthusiastic| Gives a vibrant and passionate effect when using it | Boring     |           |
| 12 | Colorful    | Full of color, using eye-catching color | Plain color |           |
3. Hardware design
The design of hardware is the most important thing to start the process of making this sign language interpreter. This design consists of Arduino design which acts as a master against 5 flex sensor units, DFplayer Mini, Light Computer Display (LCD), and Buzzer Speaker. Figure 1. shows the overall hardware design contained in the sign language interpreter tool.

![Figure 1. Hardware Design of the Sign Language Interpreter Tool.](image1)

4. Glove design
These translator gloves are designed using motorcycle gloves that are already on the market. Next the hardware shown in Figure 1. werepaired on the glove as shown in Figure 2. Flex sensor as placed on each finger, so that every movement of the fingers that occurs can be detected directly. In addition, other hardware such as the Arduino, LCD, Buzzer Speaker, and mini Dfplayer are placed on the wrist that has been coated by a 15 cm hand bracelet. Fig. 2 is a translator glove prior to repair.

![Figure 2. Glove Sign Language Translator.](image2)
5. Result and discussions
The data processing performed on the results and the discussion consists of two outcomes, namely the result of the design of the sign language interpreter and the method of Kansei engineering.

5.1. Declaration of the code
In the declaration of the code, previously identified the digital code displayed by the Arduino display based on finger movements made. Figure 3. Indicates the digital code generated by the flex sensor. The value is a digital code generated from the user’s finger gestures. The code is the data entered in the main coding as shown in Figure 4.

![Figure 3. Digital code on Arduino view.](image)

```
void setup () {
  Serial.begin (9600);
  mp3_set_serial (Serial1);  // set Serial for DEPlayer-mini mp3 module
  mp3_set_volume (20);
  // initialize serial communications at 9600 bps
  lcd.begin(16, 2);
}

void loop () {
  // read the analog in value:
  sensorValueKelingking = analogRead(analogInKelingking);
  sensorValueManis = analogRead(analogInManis);
  sensorValueTengah = analogRead(analogInTengah);
  sensorValueTelunjuk = analogRead(analogInTelunjuk);
  sensorValueTempol = analogRead(analogInTempol);
  if (sensorValueKelingking >= 155 && sensorValueKelingking <= 170) {
    if (sensorValueManis >= 170 && sensorValueManis <= 185) {
      if (sensorValueTengah >= 105 && sensorValueTengah <= 205) {
        if (sensorValueTelunjuk >= 165 && sensorValueTelunjuk <= 205) {
          if (sensorValueTempol >= 150 && sensorValueTempol <= 190) {
            Serial.println("TRANSLATOR IS ON");
            lcd.clear();
            lcd.setCursor(0, 0);
            lcd.print("TRANSLATOR IS ON");
          }
        }
      }
    }
  }
```

![Figure 4. Primary coding on the Sign Language Translator.](image)
Figure 4 is the main programming coding of sign language translators. The coding is formed in order to declare the order shown on the display by using the digital code value limit on the If program structure. If the digital code is within these limits, then the micro-controller will call the command and produce the output in the form of sound through speaker buzzer and display text on the Liquid Crystal Display (LCD).

5.2. Kansai engineering method

Table 2 shows recapitulation of results obtained from semantic differential questionnaires that have been filled by experts consisting of 3 persons and 3 teachers of Special School.

| No | Kansai Word | Scale | Kansai Word |
|----|-------------|-------|-------------|
|    |             | 1     | 2 | 3 | 4 | 5 |             |
| 1  | Cheap       | 0     | 2 | 4 | 0 | 0 | expensive   |
| 2  | Simple      | 2     | 2 | 0 | 2 | 0 | complex     |
| 3  | Light weight| 1     | 3 | 1 | 1 | 0 | heavy       |
| 4  | Practical   | 2     | 2 | 2 | 0 | 0 | difficult   |
| 5  | Innovative  | 5     | 0 | 1 | 0 | 0 | plain       |
| 6  | Rigid       | 0     | 3 | 3 | 0 | 0 | flexible    |
| 7  | Futuristic   | 5     | 0 | 1 | 0 | 0 | conventional|
| 8  | Informative | 0     | 3 | 2 | 1 | 0 | confusing   |
| 9  | Natural     | 3     | 0 | 1 | 2 | 0 | engineered  |
| 10 | Comfortable | 2     | 3 | 1 | 0 | 0 | uncomfortable|
| 11 | Enthusiastic| 2     | 4 | 0 | 0 | 0 | boring      |
| 12 | Colorful    | 0     | 0 | 5 | 1 | 0 | plain color |

Table 2. Shows the answers that respondents fill in based on the emotions they feel. The lower the scale chosen by the respondent, the Kansai word tends to correspond to the left side. However, the scale of the selected respondents will be in accordance with the Kansai word on the right side. While the value 0, 2, 1, 3, and other values contained in the column scale are the number of respondents who choose the scale.

5.3. Preference analysis based on kansai word categories

5.3.1. Cheap category

Sign language interpreters have prices ranging from RP 1,500,000.00 to RP 1,700,000.00. The bid price provides different preferences among the people, but the community assumes that the product has a cheap and normal price, as shown in Figure 5. Figure 5. shows that as many as 67%, respondents tend to choose a 3rd scale stating that the price offered tends to be at a standard or normal price, neither cheap nor expensive. However, as many as 33% of respondents think that translator tool products have low prices. While the scale 4 and 5 indicate that the product has a high price and no respondent chooses the scale. The large number of respondents who say that the product is at a standard price, indicating that the price of the product does not need to be changed.
5.3.2. Simple-complex category
This category shows the shape of the sign language translator tool tend to be simple or complex when the respondent use it.

Figure 6 shows that 67\% of respondents tend to say that the sign language interpreter has a simple form. The ease of using a sign language interpreter tool like using ordinary gloves makes the respondents choose scale 1 as much as 34\% and scale 2 as much as 33\%. However, as many as 33\% of respondents feel disturbed by the cables that are on the upper side of the hand that makes the user difficult to move freely due to fear if the cable will break or electro-cut the user so that respondents choose a scale of 4 to express the emotion that is felt when using the tool.

5.3.3. Light-Heavy category
Figure 7 demonstrates the respondent’s tendency on the light-weightedness of the sign language interpreter when used.

Figure 7 shows that respondents tend to choose a scale of 1\% to 16\% and a scale of 2 as much as 50\% which leads to lightweight product traits. The lightness of the sign language interpreter tool affects the feelings of consumers who are not easily tired or stiff when using the tool of sign language interpreter in a long time. While 17\% of respondents chose scale 3 which stated that the weight of the product is in normal position, not too heavy or not too light and 17\% of respondents chose scale 4 which stated that the product is in heavy size. This indicates that the product of the sign language interpreter does not need improvement in this category.
5.3.4. Stiff-flexible category
This category tends to focus on the stiffness of gloves when users move their fingers to signal. This is shown in Figure 8.

Figure 8 shows that 50% of respondents chose scale 2 because they thought that the gloves were rigid, so the fingers were not free when moved and formed language signals so that repairs needed to be re-applied to the gloves. In addition, the movement of the finger is not free, influential with the finger gesture to be shown. This is evidenced by the inconsistency of the results displayed by the screen on Alphabets E and O. The screen sometimes displays the letter O when the respondent's practices the Alphon E signals. While the other 50% respondents chose a scale of 3 indicating that the product is normal. Scales 1, 4 and 5 are not an answer choice that suits the user's emotions when using a sign language translator product.

5.3.5. Color category
Figure 9 shows the trend toward the color of the sign language translator tool that has been designed by the researcher.

Based on figure 9, 83% of respondents chose a scale of 3 that explains that the sign language interpreter has a normal color or is on a standard scale. However, 17% of respondents thought that the color of the glove is too monotonous, namely black colored so that the impression given on the glove tends to be casual when viewed in the colour side of the tool. Therefore, it is necessary to improve the gloves of translators with colors that are not monotonous.
Based on the results of the discussion on the user, obtained some product evaluation results disclosed by the user when using the product Translator tool language that has the concept of data glove. Table 3 shows an evaluation of the Sign Language Tool.

Based on Table 3, it can be seen, there are several proposed improvements proposed by experts both on the tool form and function. Therefore, some basic improvements that have been done do not change the aesthetics of the initial design of products that can disrupt the system work itself. Here are the improvements made and can be seen in Figure 10.

1. Stiff gloves were replaced with flexible and blue color’s gloves. According to Cerrato [13], the blue color is able to provide calmness, relieving stress and fear. In addition, it can slow down the heart pressure and help to reduce appetite. Due to this reason, the researcher supports the respondent's suggestion to use blue-colored gloves.

2. Electronic components contained on the wrist closed with a small box.

| No | Kansei Word | Product Evaluation | Improvements to the Product |
|----|-------------|---------------------|-----------------------------|
| 1  | Cheap-expensive | Prices are convenient with the economic standards of society | - |
| 2  | Simple-complex | The shape of the product is appropriate and not complicated | - |
| 3  | Light-heavy | The product tends to be heavy due to the Mechatronic device attached to the user's arm | - |
| 4  | Practice-difficult | The use of the product is very easy and appropriate. | - |
| 5  | Inovative-conventional | Products are innovative and new | - |
| 6  | Stiff-Flexible | Need to make changes to the gloves, the user is difficult to move the finger because the gloves are stiff. | Gloves have been replaced with gloves that are more flexible and adjust the user's hands |
| 7  | Futuristic-old fashion | The product is already futuristic because it is able to detect alphabetic shape well using sensor help. | - |
| 8  | Informative-confuse | The translator tool has not been able to detect hand movements and is only able to detect letters only | - |
|   | Natural - artificial | Comfortable - uncomfortable | Colourful - plain |
|---|---------------------|-----------------------------|-------------------|
| 9 | Natural             | The product is natural      | -                 |
| 10| Comfortable         | Cable on the back of the palm should be closed because the user is afraid if the cable can make the user electrocuted | -                 |
| 11| Anthesiastic - boring | The product gives the user a passion when using it | -                 |
| 12| Colourful - plain   | Preferably the color of the gloves is adjusted more colored so that the product is able to provide an attraction for the user when viewing. | The color of the gloves has been replaced with a blue color adjusted by the user's wishes. |

**Figure 10. Improved Sign Language Improvement Tool.**

Figure 10 represents an improvement that has been made on the glove sign language interpreter in accordance with the proposed improvement of the respondents. These improvements are made taking into consideration the product functions and needs of the users. In addition, these improvements are made on demand from consumers so that the product has been adapted to the consumer's emotions.

### 6. Conclusion

This research has been successfully done by designing a sign language interpreter tool tailored to the needs, wants, and emotion of users when using the product. The design of the tool using the glove data concept was done by identifying the value of digital code displayed by Arduino, so that the value can be a limitation in the formation of signal letter. In addition, the translation done by this tool only focuses on the vowels only, namely A, I, U, E, and O and has provided positive emotions from the main user of the signal interpreter tool. However, some users propose better improvements to the gloves to be flexible, light, and fashionable so that users are able to move their fingers freely. The suggestion is implemented by the researcher so that the sign language translator is really in accordance with the wishes of the customer.
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