Bicycle Frame Prediction Techniques with Fuzzy Logic Method

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***Abstract*—In general, an appropriate size bike frame would get comfort to the rider while biking. This study aims to predict the simulation system on the bike frame sizes with fuzzy logic. Testing method used is the simulation test. In this study, fuzzy logic will be simulated using Matlab language to test their performance. Mamdani fuzzy logic using 3 variables and 1 output variable intake. Triangle function for the input and output. The controller is designed in the type mamdani with max-min composition and the method deffuzification using center of gravity method. The results showed that height, inseam and Crank Size generating appropriate frame size for the rider associated with comfort. Has a height range between 142 cm and 201 cm. Inseam has a range between 64 cm and 97 cm. Crank has a size range between 175 mm and 180 mm. The simulation results have a range of frame sizes between 13 inches and 22 inches. By using the fuzzy logic can be predicted the size frame of bicycle suitable for the biker.**

***Key words*— Bicycle, height, inseam, Crank Size, frame size, fuzzy logic**

I. INTRODUCTION

Now days, the development has a wide range of bike models on the global market, including the type of mountain bike itself has begun to emerge that other models of models normally. Therefore, in order to force its design must be taken into account, the design of the bike which not only has a great design, but also has good strength, because it may be dangerous for the rider.

There are several factors that must be considered in the design of the bike. Aside from the aesthetics and ergonomics, power factor components should also be considered, especially the bicycle frame. Bicycle frame is the main component and is the parent of all the components installed on the bike. Since all, load supplied by the rider and the environment through other components such as wheels, steering stem, and saddle accepted by the order so that the power of the framework must be considered. The failure of a bicycle frame has direct impact on the rider.

According to [1] a biomechanical analysis at the segment's back, apparently rise Seat Tube Angle (STA) resulted in the forces acting on the back of the smaller segment. As for the foot segment, the opposite occurs, which forces the greater work.

Therefore, the authors wanted to investigate more about the simulation to determine the size of the frame (frame) bike by using fuzzy logic.

II. REVIEW OF LITERATURE

A. Bicycle Mountain Bike.

Mountain Bike is a common type of bicycle used by many of today's society. Own mountain bike type, there are two kinds of models, namely the model of rigid body and full suspension models. For a bike with a rigid body models generally have a mild nature, strong and sturdy. As for the kind of full suspension is more likely designed for rough terrain, such as adventure, dirt trial, and other fields are also heavy.

In Figure 1 shows the position of the rider while riding a bicycle in the normal position.

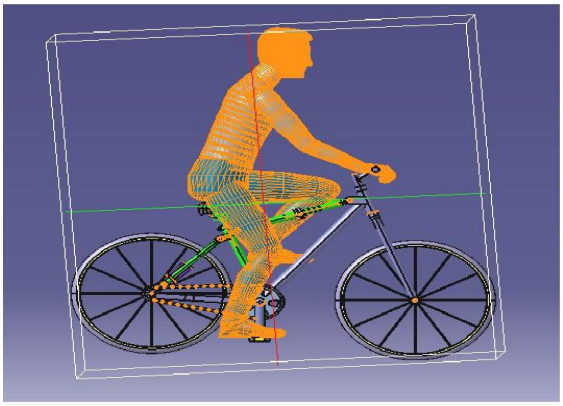

Figure 1 Position cyclists

In figure 2 shows the parts of the bike mountain bike consisting of 8 parts each: the top tube, SEAD tube, head tube, seat stays, dropounts, chain stays, botton bracket and down tube .

B. Fuzzy Logic.

Fuzzy Logic is something that is related to the formal principle of an estimate of the consideration, the consideration of fuzzy logic considerations similar to those of humans**.** Logic is only based on the truth value TRUE 2 (1) and FALSE (0) is

sometimes perceived to be inadequate to express the logic of human thinking. Developed so that not only the logic value 0 or 1 but using the logic that has the interval value between [0,1] is called the vague logic (Fuzzy logic).

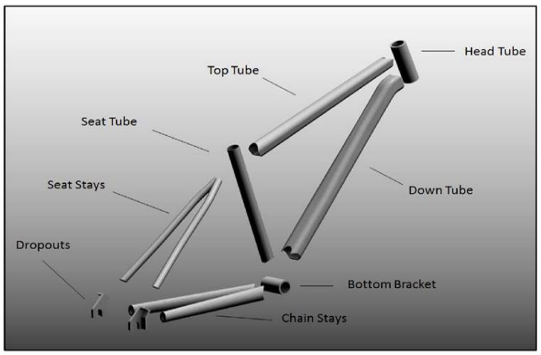

Figure 2 Components of the framework bike Mountain Bike

Fuzzy Logic (FL) was introduced in 1965 by Lotfi A. Zadeh, a professor in the field of computer science, University of California, Berkeley. FL is used to declare the data or information that is uncertain or vague. But the real history of FL began long before that when the days of Ancient Greece. Aristotle and several other philosophers, in order to find the logic theory he proposed laws called "Laws of Thought". One of them is the "Law of excluded Middle" which states that every statement (proposition) must be TRUE (T) or FALSE (F). Even when Parmenides propose the first version of the law (400 BC) directly gets opposition from Heraclitus which states that every statement only TRUE and NOT TRUE. At the time it was Plato who laid the foundation for Fuzzy Logic, stated that there is a third area (in addition to TRUE and FALSE). One of the statements of different alternatives with 2 logic with truth value (Aristotle) was first proposed by Lucasiewicz (1920). He pointed out the logic with 3 values along with an explanation of mathematical truth. Value 3rd he called by the term "may" (possible). And given a numerical value that is between TRUE (1) and FALSE (0). Furthermore Lucasiewicz argued about the truth value logic with 4, 5 the value of truth, and then stated that logic has an infinite value (infinite). With 3-value logic and the logic of the infinite value of the most interesting. But then he prefers logic with 4 values of truth because most easily adapted to the logic of Aristotle (2 truth value). Also note Knuth, also expressed logic with three truth values is almost the same as Lucasiewicz. Knuth speculated that mathematics would be more comfortable when compared to traditionally with only 2 values of truth.

The idea of logic with infinite value has been Introduced by [3] in his article titled of "Fuzzy sets" (fuzzy sets) along with an explanation of the mathematical theory of Fuzzy Association and also on Fuzzy Logic. In this theory also explained about the formation Membership Function (MF), the which operates in the range of values between [0,1]. Besides, it is also proposed mathematical logic an operation on which in principle is an extension of the logic classic.

Fuzzy logic has given the changes in the decision-making where the ability to think humans can certainly be used in a knowledge-based system. FL theory already provides a mathematical theory to accommodate the uncertainty of the human thinking process. Some characteristics of FL [3] are:

- In FL, surely logic (exact) is considered as a limiting case of logic is uncertain (approximate)
- In FL, all things (statement) is determined based on the level (degree)
- In FL, knowledge is a collection of elastic limits or uncertain (fuzzy)
- Decision-making is a process of transition from elastic boundaries or uncertain
- All system logic can be made into a vague (fuzzy)

There are two main characteristics of fuzzy systems so that these systems can be implemented well in some specific applications:

- The system is very suitable for fuzzy logic thinking uncertain, especially for systems modeled mathematically difficult.
- FL allows decision making with estimated values or based on information that is incomplete or uncertain.

Fuzzy Logic Toolbox (FLT) has 5 types of GUI to design Fuzzy Inference System (FIS), they are FIS Editor, Membership Function Editor, Rule Editor, Rule Viewer, and Surface Viewer.

C. Ergonomics.

The term "ergonomics" is derived from the Latin is Ergon as Work and Nomos as Natural Law that can be defined as the study of human aspects in the work environment are reviewed in anatomy, physiology, psychology, engineering, management and design. The application of ergonomics in general is an activity design or redesign.

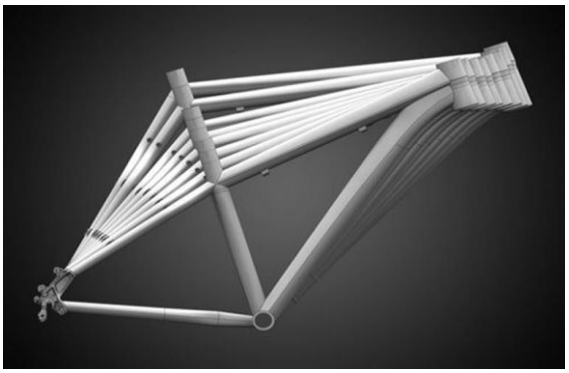
Figure 3 Scheme of differences in the size of the bike frame Mountain Bike

Besides ergonomics this theory also provides an important role in improving the health and safety factors, for example: the design of a working system to reduce pain and soreness pda human skeletal system and muscles, work station design for visual props, visual display unit station.

D. Mountain Bike framework.

Figure 3 shows the change in the size of the bike frame size of the smallest to the largest sizes. Intention of bike frame size is the length Center to Top or Seat Tube length or the length of

the hole Bottom Bracket to the end of the hole to insert Seat Post as figure 4:

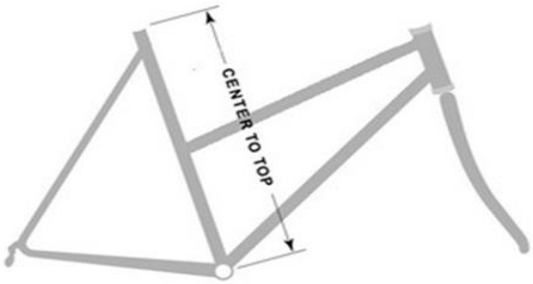

Figure 4. mean size bicycles Center to Top

III. Analysis And Discussion

The problem is simplified using three inputs:

1. Height (cm)
2. inseam (cm)
3. Crank size (mm)

Fuzzy Controller takes three inputs as above, then will process the information and provide the output frame size (inches).

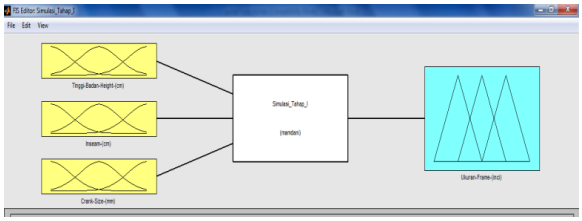

Figure 5 FIS editor in MATLAB

Figure 5 shows a diagram of the input and output in matlab, fuzzy logic here using mamdani.

For data input consisting of height, inseam and crank size can be described as follows:

Table 1: Inputs to the fuzzy system

No.	height	Inseam	Cranksize
1	Short	short	Small
2	Medium	Medium	Medium
3	High	Length	Large

In Table 1 describes the alternatives given in the input data associated with height, inseam and crank size.

While the resulting output frame size consists of three alternatives, namely Small, Normal, Large.

The decision given by the fuzzy contoller derived from the rules which exist in the database. These decisions are stored as a set of rules. Basically the rule-rule is an if-then rule is intuitive and easy to understand, because it is only a word. There are 11 rules that will produce the output, namely:

1. If height (cm) is short (cm) and inseam (cm) is short (cm) and crank size (cm) is small (mm) than frame size (inches) is small (inches)
2. If height (cm) is short (cm) and inseam (cm) is medium (cm) and crank size (cm) is small (mm) than frame size (inches) is small (inches)
3. If height (cm) is medium (cm) and inseam (cm) is medium (cm) and crank size (cm) is medium (mm) than frame size (inches) is normal (inches)
4. If height (cm) is medium (cm) and inseam (cm) is Length (cm) and crank size (cm) is medium (mm) than frame size (inches) is normal (inches)
5. If height (cm) is high (cm) and inseam (cm) is lenght (cm) and crank size (cm) is medium (mm) than frame size (inches) is large (inches)
6. If height (cm) is high (cm) and inseam (cm) is length (cm) and crank size (cm) is large (mm) than frame size (inches) is large (inches)
7. If height (cm) is short (cm) and inseam (cm) is short (cm) and crank size (cm) is medium (mm) than frame size (inches) is normal (inches)
8. If height (cm) is short (cm) and inseam (cm) is short (cm) and crank size (cm) is large (mm) than frame size (inches) is large (inches)
9. If height (cm) is medium (cm) and inseam (cm) is medium (cm) and crank size (cm) is small (mm) than frame size (inches) is small (inches)
10. If height (cm) is medium (cm) and inseam (cm) is medium (cm) and crank size (cm) is large (mm) than frame size (inches) is large (inches)
11. If height (cm) is high (cm) and inseam (cm) is length (cm) and crank size (cm) is small (mm) than frame size (inches) is small (inches)

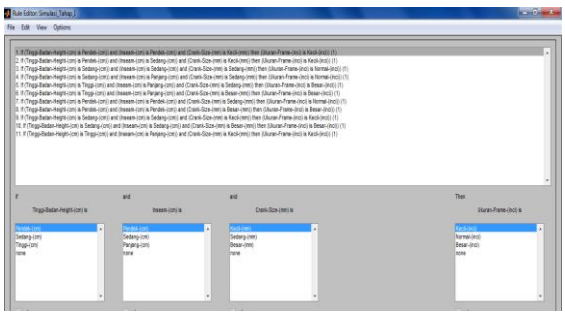

Figure 6 Rule editor in MATLAB

Figure 6, presents a collection of some rules on matlab. before any rule is already defined function members. Range function in the input member using cm height is 142-201 cm. In figure 7 shows the input member function of height, divided into short size, medium and high.

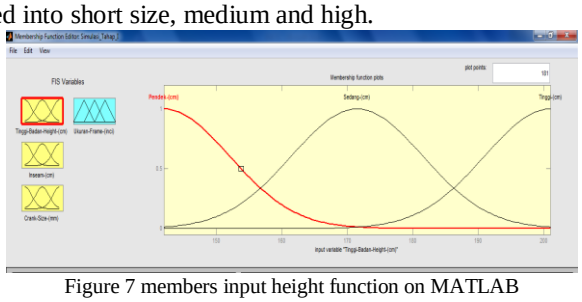

Figure 7 members input height function on MATLAB

Range function in the input member using cm inseam is 64-97 cm. In figure 8 shows the member functions of the input size inseam is divided into short, medium and long

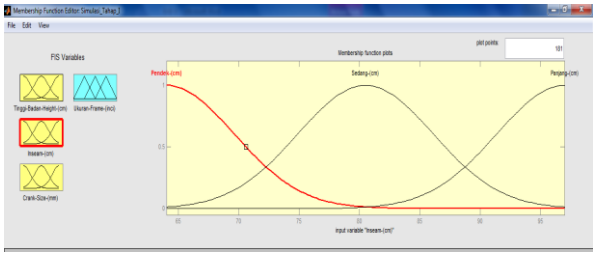

Figure 8: The function of the input members inseam on MATLAB

Range of input crank size member function using the 170 mm -180 mm. In figure 9 shows the member functions of the input crank size, divided into small, medium and large.

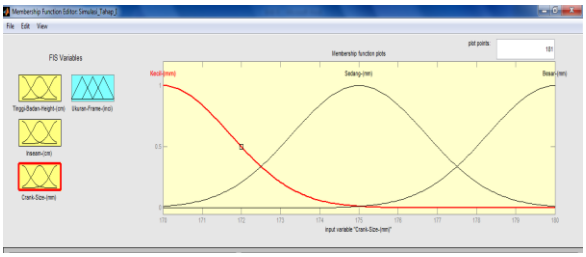

Figure 9: The function of the input members inseam on MATLAB

Range function uses the output member in inches is 13-22 inches. In figure 10 shows the function of the frame size of the output member that is divided into small, medium and large

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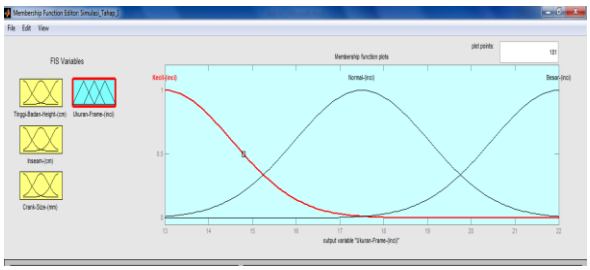

Figure 10: The function of the frame size of the output member in MATLAB

After all the member functions are defined and some rules have also been defined based on the results it can be seen that there are some rules. The results can be seen in the image below:

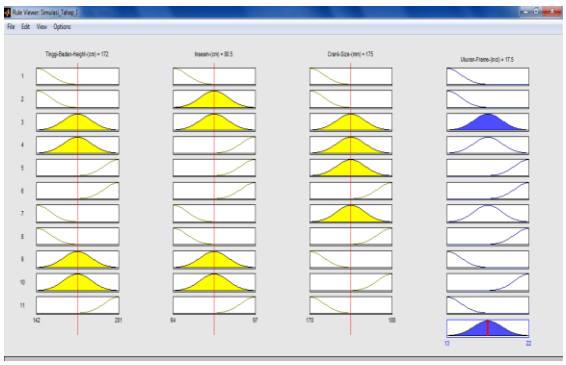

Figure 11. Rule viewer

In figure 11 can be seen in view of the rule if the height of 172 cm, inseam 80.5 cm and size 175 mm crank acquired frame size of 17.5 inches. And in 3 dimensions can be seen as in Figure 12 below:

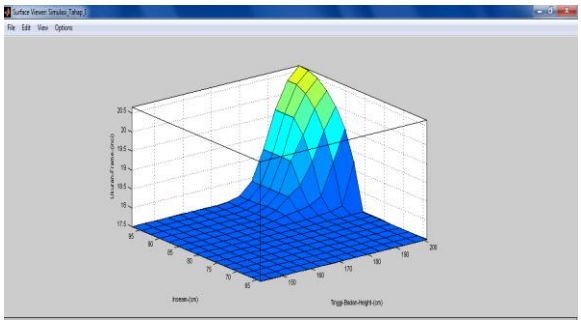

Figure 12. Surface viewer

IV. Conclusion

From the simulation results obtained using information that is data and inseam rider's height and size crank bicycle frame size can be obtained in accordance with the riders, all of this is obtained by application of fuzzy logic. If a person with a height of 172 cm, 80.5 cm inseam and crank size 175 mm frame size will be obtained appropriate based on the data input of 17.5 inches.

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