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Transformation of Periodic Fuzzy Membership Function to Discrete Polygon on Circular Polar Coordinates

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Abstract : Fuzzy logic has gained acceptance in the recent years in the fields of social sciences and humanities such as psychology and linguistics because it can manage the fuzziness of words and human subjectivity in a logical manner. However, the major field of application of the fuzzy logic is control engineering as it is a part of the set theory and mathematical logic. Mamdani method, which is the most popular technique for approximate reasoning in the field of fuzzy control, is one of the ways to numerically represent the control afforded by human language and sensitivity and has been applied in various practical control plants. Fuzzy logic has been gradually developing as an artificial intelligence in different applications such as neural networks, expert systems, and operations research. The objects of inference vary for different application fields. Some of these include time, angle, color, symptom and medical condition whose fuzzy membership function is a periodic function. In the defuzzification stage, the domain of the membership function should be unique to obtain uniqueness its defuzzified value. However, if the domain of the periodic membership function is determined as unique, an unintuitive defuzzified value may be obtained as the inference result using the center of gravity method. Therefore, the authors propose a method of circular-polar-coordinates transformation and defuzzification of the periodic membership functions in this study. The transformation to circular polar coordinates simplifies the domain of the periodic membership function. Defuzzified value in circular polar coordinates is an argument. Furthermore, it is required that the argument is calculated from a closed plane figure which is a periodic membership function on the circular polar coordinates. If the closed plane figure is continuous with the continuity of the membership function, a significant amount of computation is required. Therefore, to simplify the practice example and significantly reduce the computational complexity, we have discretized the continuous interval and the membership function in this study. In this study, the following three methods are proposed to decide the argument from the discrete polygon which the continuous plane figure is transformed into. The first method provides an argument of a straight line passing through the origin and through the coordinate of the arithmetic mean of each coordinate of the polygon (physical center of gravity). The second one provides an argument of a straight line passing through the origin and the coordinate of the geometric center of gravity of the polygon. The third one provides an argument of a straight line passing through the origin bisecting the perimeter of the polygon (or the closed continuous plane figure).

Keywords : defuzzification, fuzzy membership function, periodic function, polar coordinates transformation
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