PERSONNELDETECTIONSYSTEM

Issomeoneinthebuildingor not?

Your task is to create an automated personnel detection system that detects for the presence of a person in a warehouse of IPB Corporation, a business entity for selling Rice andCopra.In the opinion of thecompany’sowner,theexistingsensorsbeingusedatthismomentaren’tparticularlyaccurate.So,you need to improve the existing process using fuzzy logic.

One of the two inputs is an **optical sensor** whose fuzzy sets are named *Slow, Medium,* and *Fast.* It is measured in miles per hour from 0 to 9. The other input is an **infrared sensor**, with fuzzy sets named *Very Low, Low, Medium, High,* and *Very High.* Its units are temperatures from 94to 108Fahrenheit. The output is an audible signal with adjustable-length sound pulses. Its fuzzy sets are named *Very Low, Low, Medium,* and *Very High,* measured in milliseconds from 500 to 2000.

# Sensors’inputrangeandaudiblesound’soutput

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Units Name** | **Min** | **Max** |
| Input: |  |  |  |
| Opticalsensor | Mph | 0 | 9 |
| Infraredsensor | Degrees Fah | 94 | 108 |
| Output: |  |  |  |
| Audiblesignal | Milliseconds | 500 | 2000 |

Suppose that at the same time, you are the expert assigned to determine the membership function of the valuerangesofthetwoinputsandoneoutput.So,usingthetablebelow,youneedtosupplythetriangular membershipvaluesforeachrange.Theshapeofthemembershipfunctionwouldbeentirelyuptoyouas long as the correct range of the inputs and output are properly maintained.

# Themembership functionsandtheirvalues(developer-defined)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Name** | **Description** |  | **Values** |  |
| Input: | | Left | Center | Right |
| **Opticalsensor** | Slow |  |  |  |
| Medium | | 4 | 5 | 9 |
| Fast | |  |  |  |
| **Infrared sensor** | Very Low | 94 | 96 | 106 |
| Low | |  |  |  |
| Medium | |  |  |  |
| High | |  |  |  |
| VeryHigh | |  |  |  |
| Output: | |  |  |  |
| **Audible signal** | Very Low | 500 | 600 | 1000 |
| Low | |  |  |  |
| Medium | |  |  |  |
| High | |  |  |  |
| VeryHigh | |  |  |  |

Ascanbeseenfrom thetable,themembershipvalues ofthethreevariablesare left blank because you will be the oneto set itand whatever values you set willbe applied toyour fuzzy logic code.On the other hand, the rules construction matrix is shown below.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Infrared** |  | **VLOW** | **LOW** | **MED** | **HIGH** | **VHIGH** |
| **Optical** | **SLO** | Very low | Low | Very low | Low | Verylow |
| **MED** | Low | Medium | Low | Medium | Low |
| **FAST** | Medium | High | Medium | Low | Very low |

To demonstrate these rules, if the optical sensor detects fast movement and the infrared sensor sensed low temperature, then the alarm (audible sound) is High, etc.

# LO1 Tasks:

**FuzzyControllerDesign&DevelopmentinPython(80%)**

SampleInteraction:

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\* Optical Sensor (0-9) in miles/hr:

Infrared Sensor (94-108) in Degrees Fah: Audiblesignal(milliseconds):<Fuzzylogicoutput>

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# Design&DevelopmentDocumentation(20%)

1. Document briefly the steps that you have developed in solving the given problem starting from the design of the membership functions to the rule’s creation. Also, include the screenshot of the membership functions of the 2 inputs and 1 output.

The first step in solving the problem is to design the membership functions for the inputs (optical sensor and infrared sensor) and the output (audible signal). This involves identifying the linguistic variables, determining the range of each variable, and designing triangular membership functions to represent the degree of membership for different values.

Next, the rules are created to define the relationship between the inputs and the output. A rule matrix is constructed, specifying the the output for each combination of input values. The linguistic terms from the rule matrix are converted into fuzzy sets using the membership functions defined earlier.Once the membership functions and rules are established, a fuzzy controller is developed using a programming language python. The membership functions for the inputs and output are implemented in the code, and the fuzzy rules are applied to determine the output based on the input values. Fuzzy logic operations, such as fuzzy AND and fuzzy OR, are used to combine the fuzzy sets and make accurate decisions decisions.

To interact with the system, an interface is created where the user can input the values for the optical sensor and infrared sensor. The fuzzy logic inference system calculates the output, which is the audible signal, based on the user's's input. The output is then displayed to the user.

1. Inthegivenproblem,canyouadjustthemembershipvaluesofthe3variablestosuityourneeds? Yes or No. Explain your answer. Yes, the membership values of the three variables (optical sensor, infrared sensor, and audible signal) can be adjusted to suit specific needs. The membership values determine the shape and range of the fuzzy sets and can be customized based on the problem requirements and desired characteristics of the membership functions.By adjusting the membership values, you can fine-tune the the behavior of the fuzzy logic system and make it more suitable for the specific application or problem at hand. For example, you can adjust the membership values to make the system more sensitive or less sensitive to certain ranges of input values, or to emphasize certain linguistic terms over others.It is important to carefully consider the specific requirements and objectives of the problem when adjusting the membership values. The adjustments should be based on domain knowledge, expert judgment, and the desired behavior of the system. It may require experimentation and iteration to find the optimal membership values that yield the desired results.
2. Explain what difficulties can be encountered when this particular problem is solved using crisp logic. Handling Uncertainty: Crisp logic relies on precise thresholds and crisp decision-making, which may not be suitable for situations where there are uncertainties or variations in the measurements from the optical and infrared sensors. In real-world scenarios, the measurements may not always be exact, and there can be variations due to factors like noise, lighting conditions, or sensor inaccuracies. Crisp logic struggles to handle these uncertainties effectively.

Lack of Flexibility: Crisp logic operates on binary values (true or false) based on strict thresholds. This lack of flexibility can be problematic when dealing with ambiguous or overlapping situations. In the personnel detection problem, there can be situations where the measurements from the sensors fall in between the defined thresholds, making it difficult to make precise decisions using crisp logic.

Complex Relationships: The relationship between the inputs (optical sensor and infrared sensor) and the output (audible signal) in the personnel detection problem may not be easily represented by simple, linear rules. Crisp logic relies on explicit rules and thresholds, which may not capture the complex relationships and nuances present in the problem. Fuzzy logic, on the other hand, allows for more flexible and nuanced representations of these relationships.

Difficulty in Threshold Determination: Determining the precise thresholds for the crisp logic rules can be challenging. The choice of thresholds can significantly impact the system's performance and may require extensive domain knowledge and expertise. Finding the optimal thresholds that accurately represent the presence or absence of a person in the warehouse can be a complex task.

1. Aside fromthe requiredoutputs which isanaudible sound foralarm, whatother outputs doyou think can be used here. Justify your answer.

In addition to the required audible alarm, there are other outputs that can be used in the personnel detection system to enhance its functionality. Visual alerts, such as flashing lights or LED displays, can provide a visual indication of the presence of a person. Notifications can be sent to relevant individuals through email, SMS, or instant messaging platforms to inform them about the detection event. Logging and recording capabilities can be implemented to track and analyze personnel detection instances, including timestamps and location information. Integration with other security systems, such as CCTV cameras or access control measures, can be utilized to trigger specific actions or responses. These additional outputs improve the overall effectiveness of the personnel detection system by leveraging different sensory modalities, facilitating real-time communication, enabling data analysis, and enhancing integration with existing security infrastructure.

# Deliverables:

Inzipfile –Ex.BENITEZ.zipthatcontainsthe following:

* + Thedevelopedfuzzycontrolsystem(Ex.BENITEZ\_detection.py)
  + ThedocumentationinPDF format(Ex.Benitez\_docu.pdf)