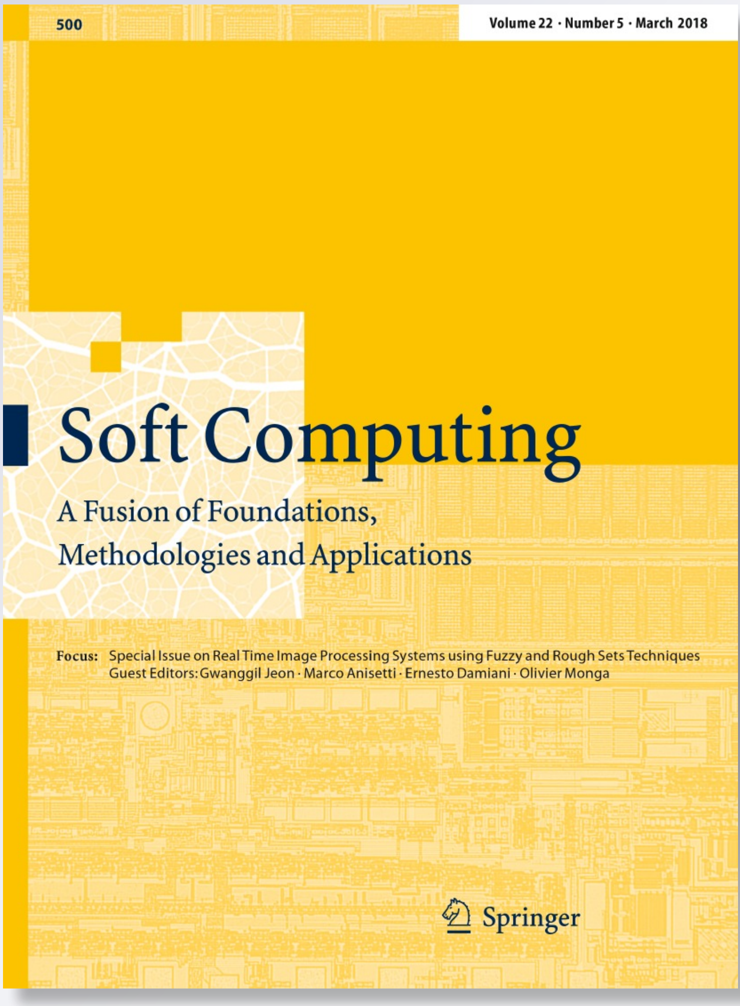
Chameleon-like weather presenter costume composite format based on color fuzzy model

Pyoung Won Kim

Soft Computing
A Fusion of Foundations,
Methodologies and Applications

ISSN 1432-7643
Volume 22
Number 5

Soft Comput (2018) 22:1491-1500
DOI 10.1007/s00500-017-2868-0



Springer

Soft Comput (2018) 22:1491–1500
https://doi.org/10.1007/s00500-017-2868-0

FOCUS

Chameleon-like weather presenter costume composite format based on color fuzzy model

Pyoung Won Kim[1]

Published online: 6 October 2017

Abstract Online weather forecasts and weather apps enable viewers to actively retrieve information; however, television weather forecasting uses a format, which allows viewers to unilaterally receive information from presenters speaking fast for a short period of time. In comparison with the infographic-oriented format, the weather presenter-oriented format has the problem of making viewers excessively focused on weather presenters. In this study, an alternative method of weather forecast is proposed, consisting of using the presenter's clothes as a tool for providing information by exploiting the reactions of viewers focusing on the presenter. Specifically, this study constructed the color fuzzy model to represent temperature, fine dust level, and humidity by hue, saturation, and value, respectively. The weather presenter's clothing transforms like a chameleon, in real time, according to content and provides emotional information to viewers.

Keywords Color fuzzy model · Infographic · Immersion · Weather forecast · Weather presenter

1 Introduction

Television weather forecasting is a popular program that effectively makes weather information released by the Meteorological Administration more compact and tailored to the interest of viewers. Contemporary television weather reports have evolved from drawing weather maps in the 1950s to using magnetic symbols in the 1970s and to displaying infographics with a weather presenter on the same screen in the 1990s. Weather forecasts use a format that maximizes information transfer because it must provide a brief summary of national weather, marine weather, and weekly forecasting within a short period of time. Contemporary television weather presenters, who are mostly female, are typically very attractive. Viewers are more focused on weather presenters rather than on obtaining weather information. Surprisingly, brilliant infographics and numerical information interfere negatively with viewer involvement (Kim et al. 2016).

The purpose of this study is to propose an alternative to the current weather report format and to analyze its effects by criticizing the problems related to excessive information and obstacles to viewer involvement. In Sect. 2, an overview of the developmental history of television weather forecasting is presented, focusing on television programs by the BBC and South Korean broadcasters. In addition, problems present in South Korean weather forecasting are discussed. In Sect. 3, a fuzzy model, which represents temperature, fine dust level, and humidity by hue, saturation, and value, respectively, is proposed. In Sect. 4, a method of expressing meteorological information, in an analog way, using color-coded information, is proposed. In Sect. 5, fuzzy inference cases of representing temperature, fine dust level, and humidity, through the color of the weather presenter's clothing, are investigated.

2 The development of weather forecasting

Contemporary Korean weather reports have become important and are placed at the end of television news programs.

Communicated by M. Anisetti.

✉ Pyoung Won Kim
pwkim@inu.ac.kr

[1] Department of Korean Language Education, College of Education, Incheon National University, 12 Gaetbeol-ro, Yeonsu-gu, Incheon, Republic of Korea

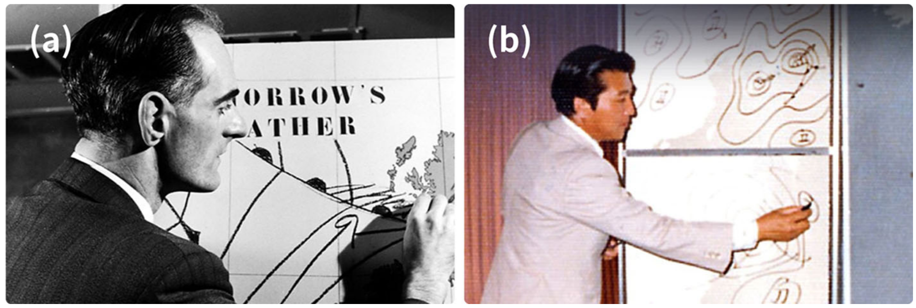


Fig. 1 George Cowling presented the first television forecast in 1954 (**a**) and Dong-wan Kim was the Korea's first weather presenter (**b**)

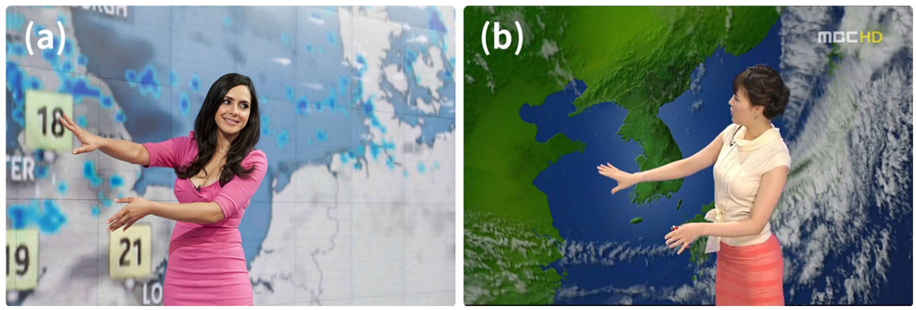


Fig. 2 Nazaneen Ghaffar is the BBC weather presenter at Sky News (**a**) and Eun-ji Park was a Korean female weather presenter in the MBC News (**b**)

The early format of weather reports consisted of reading weather information on radio broadcasted weather news. This later transformed to a briefing format on the BBC evening news, in January 1954, wherein George Cowling described the weather on his own, by drawing weather changes on paper (Cowling 1957). In 1974, 20 years after the first format change, Barbara Edwards became the first female weather presenter at BBC; Dong-wan Kim became the first meteorologist and weather presenter to work in South Korea (Chun 2007). In 1974, while the BBC used magnetic rubber symbols depicting sunny intervals, showers, and snowstorms in their program, Dong-wan Kim, similar to George Cowling, explained weather conditions and presented forecasts by drawing on paper maps using a marker. The weather forecast format adopted by George Cowling and Dong-wan Kim dramatically improved weather reporting, since the presenters were able to explain the basis of weather reporting through their drawings. Their weather forecasts provided viewers with the opportunity to learn how to predict the weather based on scientific information (Figs. 1, 2).

As computational technology improved, so did graphics technology. Early hand-drawn maps gave way to magnetic symbols, which in turn gave way to blue screen computer-generated visual technology. In recent years, with the development of media application technologies, a wide variety of weather information is available online through the Internet and smartphone applications.

Since the 1990 s, weather presenters, much more than meteorologists, used their brilliant verbal skills to draw attention to weather reporting. Like Nazaneen Ghaffar, a BBC weather presenter, and Eun-ji Park, an MBC weather presenter, female weather presenters have attracted the public's attention. Scientific analysis using weather maps has disappeared after being replaced with well-spoken weather presenters and information graphics. The problems of contemporary Korean weather reports, led by weather presenters, are summarized below.

First, the femininity of the weather presenter is overemphasized. Contemporary weather reports emphasize the presenter's femininity rather than their expertise. This is displayed by nonverbal cues such as gestures, facial expressions, and clothing. Similar to fashion models, weather presenters occupy approximately one-third of the screen, make attractive gestures, and maintain a certain look. Viewers inevitably lose interest in the infographic.

Second, computer graphics are used excessively. Although realistic backgrounds can have a certain aesthetic appeal, they are irrelevant to the content and overly complex; colorful graphic materials hinder the viewer's ability to absorb information. Too much or too little information does not help viewers absorb information. Despite the use of high-quality infographics, viewers lose sight of critical information by not knowing what to focus on.

Third, weather forecasting is centered on numerical data. People naturally express and perceive temperature, fine dust level, and relative humidity in terms of language rather than numerically. For example, rather than expressing temperature as 22 °C, people generally express the feeling as "warm." Due to this tendency, emphasis on numerical data, such as expected temperature (°C), relative humidity (%), and precipitation (mm), does not contribute to the viewers' understanding of the weather.

Fig. 3 Solar (weather application software)

3 The color model of weather information

3.1 Color and weather information

One method is to use color to minimize meteorological information while providing an emotional substitute. A typical example is Solar, a smartphone-based weather application. Solar is a simple utility app, which intuitively represents complex weather conditions as colors; therefore, it avoids the use of complex meteorological information, such as those used by meteorologists. Solar's interface represents information using beautiful colors. Solar does not provide users with a great deal of details, but it provides them with the current weather, temperature, and forecast (Solar 2016) (Fig. 3).

Met Office is another example of using color to convey weather information. Since 2011, Met Office has predicted risk, based on probability, using the Risk Matrix. It started the National Severe Weather Warning Service and is being used by the BBC for weather forecasting (Met Office 2016). The horizontal axis of the Risk Matrix represents the degree of potential impact; its vertical axis represents the degree of likelihood of disaster. Both the axes are divided into four warning levels. Although the number of possible cases is 16, the degrees are largely divided into four levels according to color (green, yellow, amber, and red). For example, if the information is related to snow, the vertical axis represents the amount of snowfall and the horizontal axis represents the area's vulnerability to snow. The information displayed on the map, in four different colors, helps viewers understand quickly and intuitively the impact of weather on their area (Neal et al. 2014) (Fig. 4).

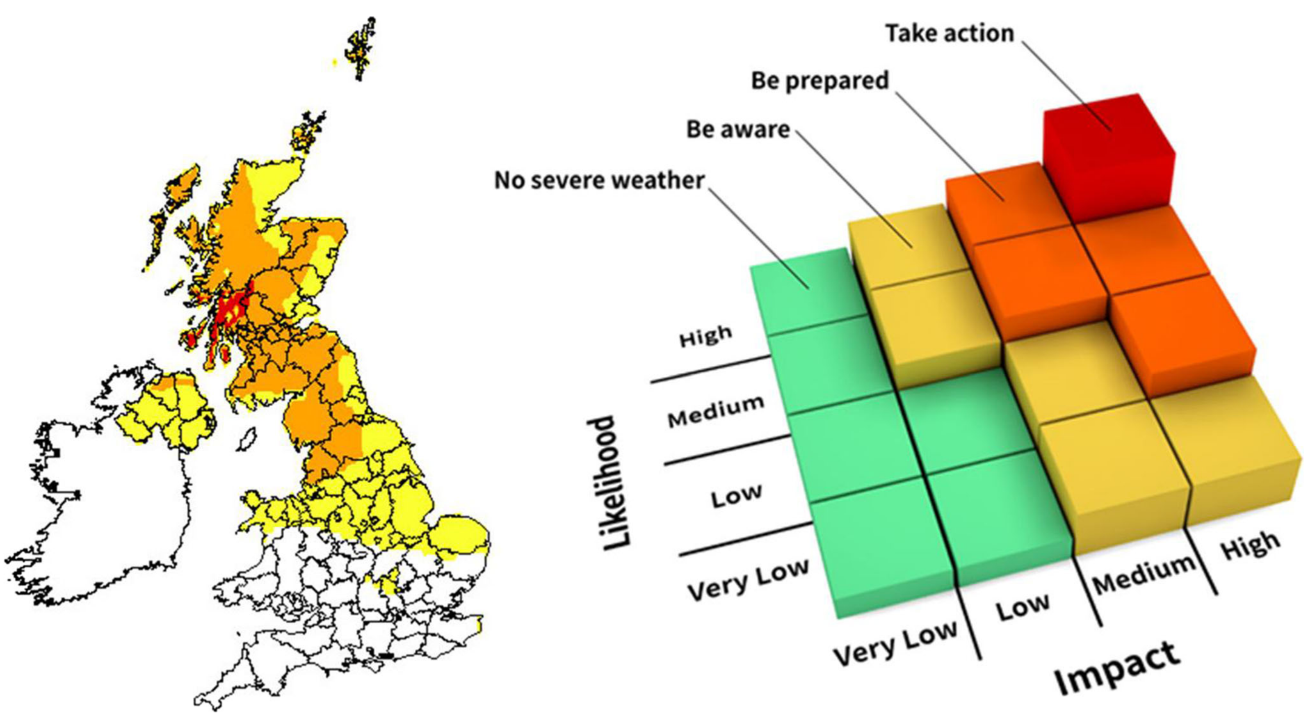


Fig. 4 Likelihood-impact matrix (the Met Office)

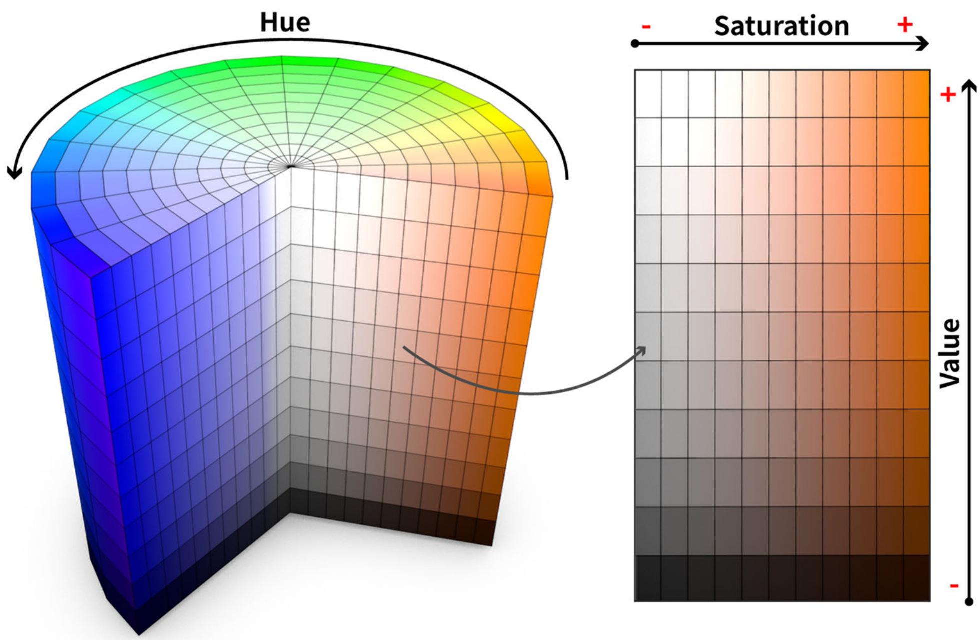


Fig. 5 HSV color model (cylinder type) (color figure online)

3.2 The HSV color model

A color space is a specific organization of colors. A color model is an abstract mathematical model describing the way colors. The Munsell color system is a color space, which specifies colors based on three color dimensions: hue, value (lightness), and chroma (color purity) (Kuehni 2002). Color models are ways to describe colors numerically. The HSV color model is an intuitive way to describe color using three parameters (hue, saturation, and value), in which the color space is represented by a single cone or cylinder. Hue is defined using an angular integer ranging from 0 ° to 360 °. This represents a base color from the HSV cylinder ranging from red (0 °) to green (120 °) to blue (240°) and then back to red. Saturation and value are defined using percentages from 0 to 100% and complement the hue in creating the full color (Fig. 5).

The hue and saturation components are intimately related to the way human eye perceives color. They have been the basis of processing algorithms with a physiological basis. The technical definition of "Color temperature" and "The temperature of a color" is different. The former is a measurement in degrees Kelvin, indicating the hue of a specific type of light source. The latter refers to the visual and emotional effects of combining different colors. The terms "warm" and "cool" are often used to describe a color. In general, blue, green, and purple are considered cool colors, whereas yellow, orange, and red hues are considered warm. The temperature of a color is based on its association with certain physiological and psychological feelings rather than with actual temperature.

Table 1 Color parameters of climatic elements

Color parameter		Climatic elements
Hue	The main properties of a color	Temperature
Saturation	The intensity of a color	Fine dust level
Value	The darkness of a color	Relative humidity

This study proposes an emotional way to express weather information through the weather presenter's clothes based on the fact that ordinary people discern colors according to the degree of saturation and brightness. In particular, based on the HSV color model, temperature may be represented through hue, fine dust level through saturation, and relative humidity through value (Table 1).

4 Fuzzy model of climatic elements

4.1 Fuzzy model of temperature

The fuzzy color model has been used in the field of image processing (e.g., Küçüktunç et al. 2009; Konstantinidis et al. 2005). The Republic of Korea lies in the temperate zone and has four distinct seasons. Geographically, it is located in the middle latitudes of the Northern Hemisphere, on the east coast of the Eurasian Continent and is also adjacent to the Western Pacific. Therefore, it shows complex climate charac-

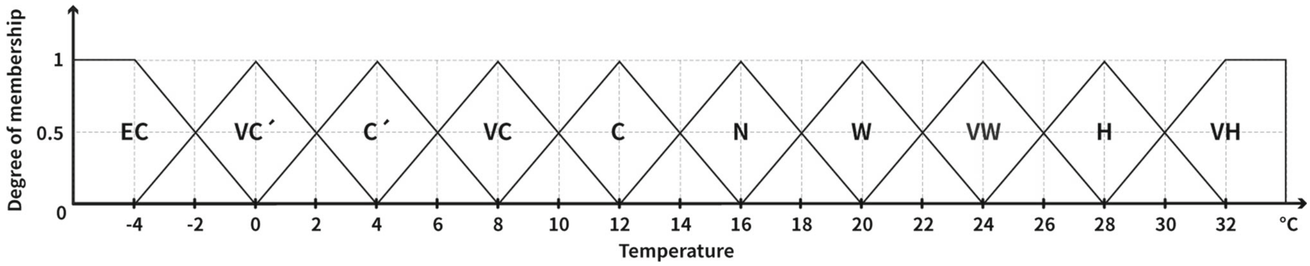


Fig. 6 Membership function of the temperature

Table 2 Linguistic terms of temperature

Linguistic term		°C
VH	Very hot	≥ 28
H	Hot	24 to 32
VW	Very warm	20 to 28
W	Warm	16 to 24
N	Normal	12 to 20
C	Cool	8 to 16
VC	Very cool	4 to 12
C′	Cold	0 to 8
VC′	Very cold	− 4 to 4
EC	Extremely cold	≥ 0

Table 3 Linguistic terms of the fine dust level

Linguistic term		μg/m^3
G	Good	0–30
N	Normal	20–80
SB	Slightly bad	70–130
B	Bad	110–210
VB	Very bad	≥ 190

teristics, which exhibit both continental and oceanic features. It has a wide temperature difference between the summer and winter seasons (Korea Meteorological Administration 2017), and because of this, the vocabulary relevant to temperature, as perceived by Koreans, is very sensitive and complex. Figure 6 shows temperature, perceived by Koreans, as a fuzzy membership function.

Korea's annual mean temperature ranges from 10 to 16 °C, with the exception of high mountain areas. The warmest month is August, whereas January is the coldest. The monthly mean temperature ranges from 23 to 27 °C in August and from − 6 to 7 °C in January (Korea Meteorological Administration 2017). In this membership function, if X has a numerical value of 18 °C, we can say that the temperature is "normal" (with a membership value of 0.5) and "warm" (with a membership value of 0.5) (Table 2).

4.2 Fuzzy model of fine dust level

Fine dust particles are threatening to the human respiratory and immune systems. The concentration of fine dust particles smaller than 10 μm in diameter, or PM10, is increasing rapidly. The concentrate ion increases the fine dust alert level to "very bad," the highest level considered by the National Institute of Environmental Research (Korea Meteorological Administration 2017). A value within the scale of zero to 30 is "good," 31–80 is "normal," 81–120 is "slightly bad," 121–200 is "bad," and 201–301 is "very bad." The membership function of the fine dust level is shown in Fig. 7.

In this membership function, if X has a numerical value of 120 μg/m^{-3}, we can say that the temperature is "slightly bad" (with a membership value of 0.5) and that it is "bad" (with a membership value of 0.5) (Table 3).

4.3 Fuzzy model of the Relative Humidity

Annual precipitation ranges from 1000 to 1800 mm in the southern part of Korea and from 1100 to 1400 mm in the central part. More than half of annual precipitation falls dur-

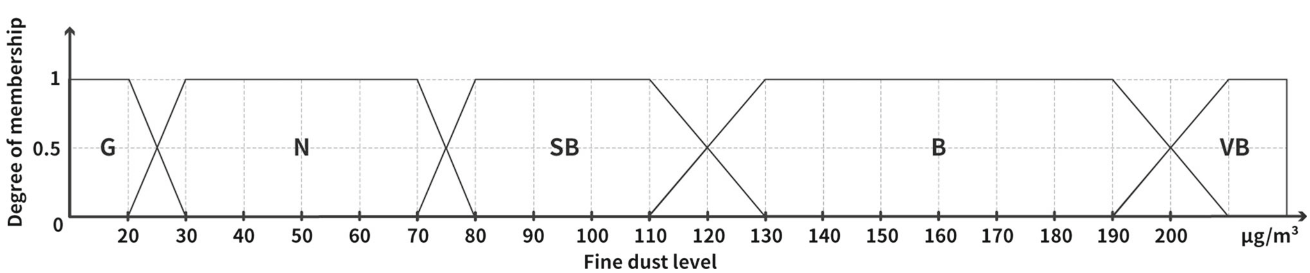


Fig. 7 Membership function of the fine dust level

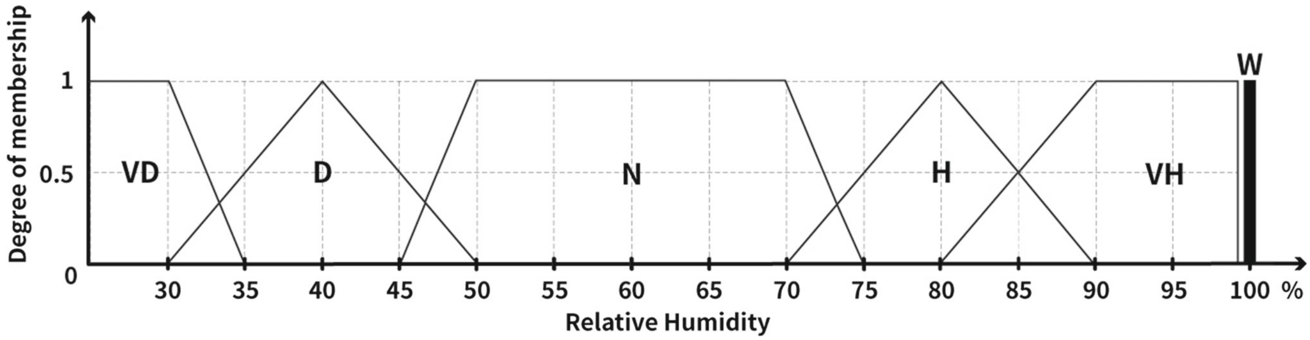


Fig. 8 Membership function of the relative humidity

Table 4 Linguistic terms of the relative humidity

Linguistic term		°C
VD	Very dry	0–35
D	Dry	30–50
N	Normal	45–75
H	Humid	70–90
VH	Very humid	80–100
W	Wet (rain)	100

Table 5 Linguistic terms of the hue space (color table online)

Color	Linguistic term		Hue space (π rad)
	R	Red	0–0.11
	O	Orange	0.06–0.28
	Y	Yellow	0.22–0.44
	YG	Yellow–green	0.39–0.61
	G	Green	0.56–0.78
	GC	Green–cyan	0.72–0.94
	C	Cyan	0.89–1.11
	CB	Cyan–blue	1.06–1.28
	B	Blue	1.22–1.44
	BM	Blue–magenta	1.39–2

ing the "Changma" season, when a stationary front lingers across the Korean Peninsula for approximately a month during the summer season. Winter precipitation is $< 10\%$ of total annual precipitation (Korea Meteorological Administration 2017). The membership function of relative humidity is shown in Fig. 8.

In this membership function, if X has a numerical value of 85%, we can describe relative humidity as "humid" (with a membership value of 0.5) and as "very humid" (with a membership value of 0.5) (Table 4).

5 Fuzzy inference model for weather

5.1 Output membership function of climatic elements

First, the color membership function is constructed, as described below, by matching temperature and color, with consideration to the human perception of warm and cool colors. The continuity of colors in the HSV color space is represented as a membership function, which results in continuous representation (Fig. 9; Table 5).

The saturation of a color can be naturally associated to the saturation of air. Therefore, it is useful to express fine dust information as color saturation. In the HSV color space, the saturation is continuously distributed between 0 and 1, which is equivalent to what is shown in Fig. 10 and expressed in the membership function (Table 6).

Brightness is naturally associated with cloudy or sunny weather. The relative humidity on a rainy day is 100%; thus,

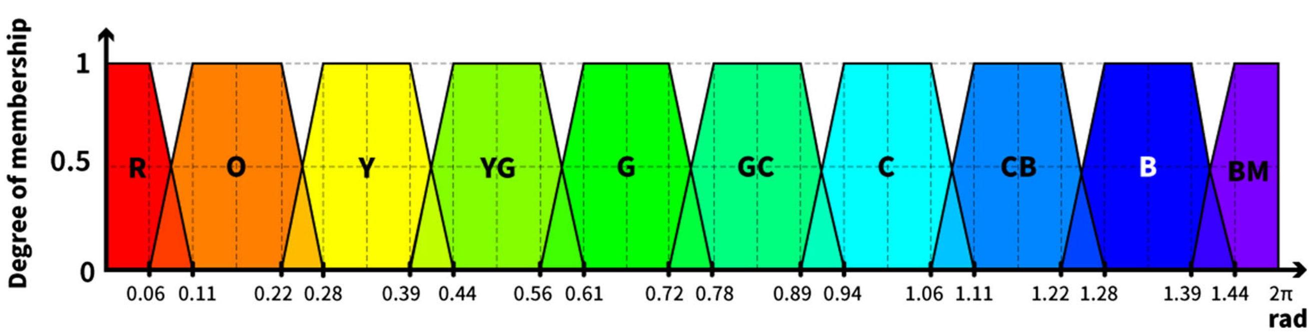


Fig. 9 Membership function of the hue (color figure online)

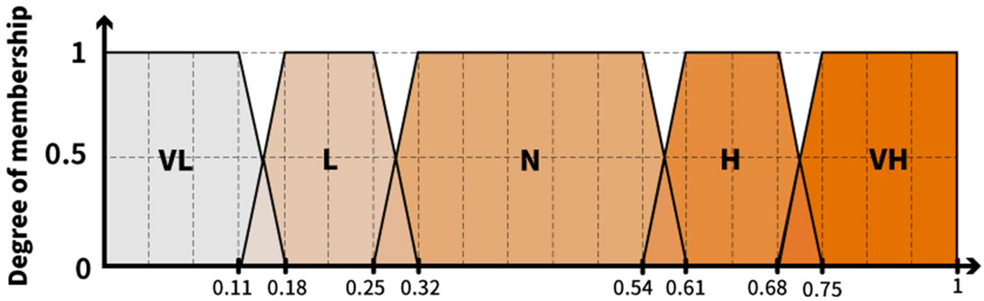


Fig. 10 Membership function of the saturation (color figure online)

Table 6 Linguistic terms of the saturation space (color table online)

Color	Linguistic term		Saturation space
	VH	Very high saturation	0.68–1
	H	High saturation	0.54–0.75
	N	Normal saturation	0.25–0.61
	L	Low saturation	0.11–0.32
	VL	Very low saturation	0–0.18

Table 7 Linguistic terms of the value space (color table online)

Color	Linguistic term		Value space
	B	Bright	0.86–1
	VH	Very high value	0.75–0.92
	H	High value	0.64–0.81
	N	Normal value	0.42–0.69
	L	Low value	0.31–0.47
	VL	Very low value	0.08–0.36
	D	Dark	0–0.14

it may be expressed by the color black. In the HSV color space, brightness is continuously distributed between 0 and 1, which is equivalent to what is shown in Fig. 11 and expressed in the membership function (Table 7).

5.2 Fuzzy inference for weather forecasting

The fuzzification of the input is accomplished by using membership functions as the three input components (temperature, fine dust level, and relative humidity). The fuzzification of the output is achieved using membership functions as the three output components (hue, saturation, and value). The fuzzy inference engine produces twenty-one rules by matching three input and output membership functions. The color is selected in step 1, the level of saturation of the selected color is determined in step 2, and the level of value is determined in step 3.

Twenty-one fuzzy rules are as follows:

Rule 1 If [temperature] is [very hot] then [the hue] is [red]

Rule 2 If [temperature] is [hot] then [the hue] is [orange]

Rule 3 If [temperature] is [very warm] then [the hue] is [yellow]

Rule 4 If [temperature] is [warm] then [the hue] is [yellow–green]

Rule 5 If [temperature] is [normal] then [the hue] is [green]

Rule 6 If [temperature] is [cool] then [the hue] is [green–cyan]

Rule 7 If [temperature] is [very cool] then [the hue] is [cyan]

Rule 8 If [temperature] is [cold] then [the hue] is [cyan–blue]

Rule 9 If [temperature] is [very cold] then [the hue] is [blue]

Rule 10 If [temperature] is [extremely cold] then [the hue] is [blue–magenta]

Rule 11 If [the fine dust level] is [good] then [the saturation] is [very high]

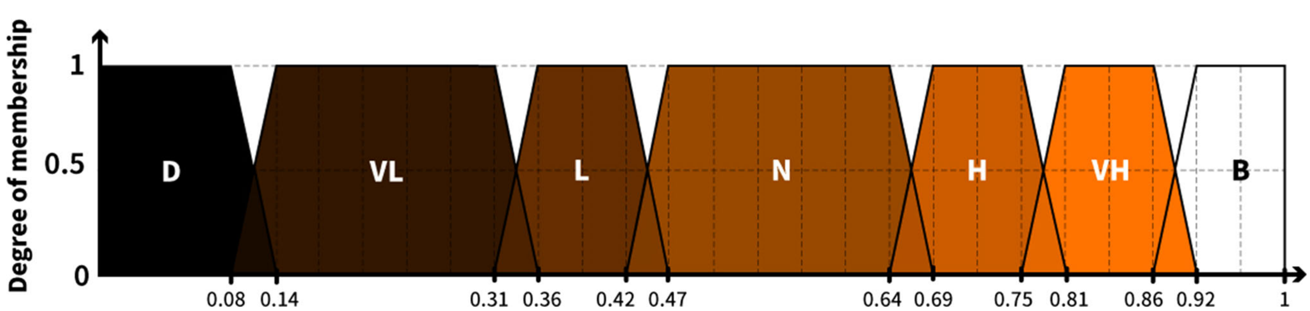


Fig. 11 Membership function of the value (color figure online)

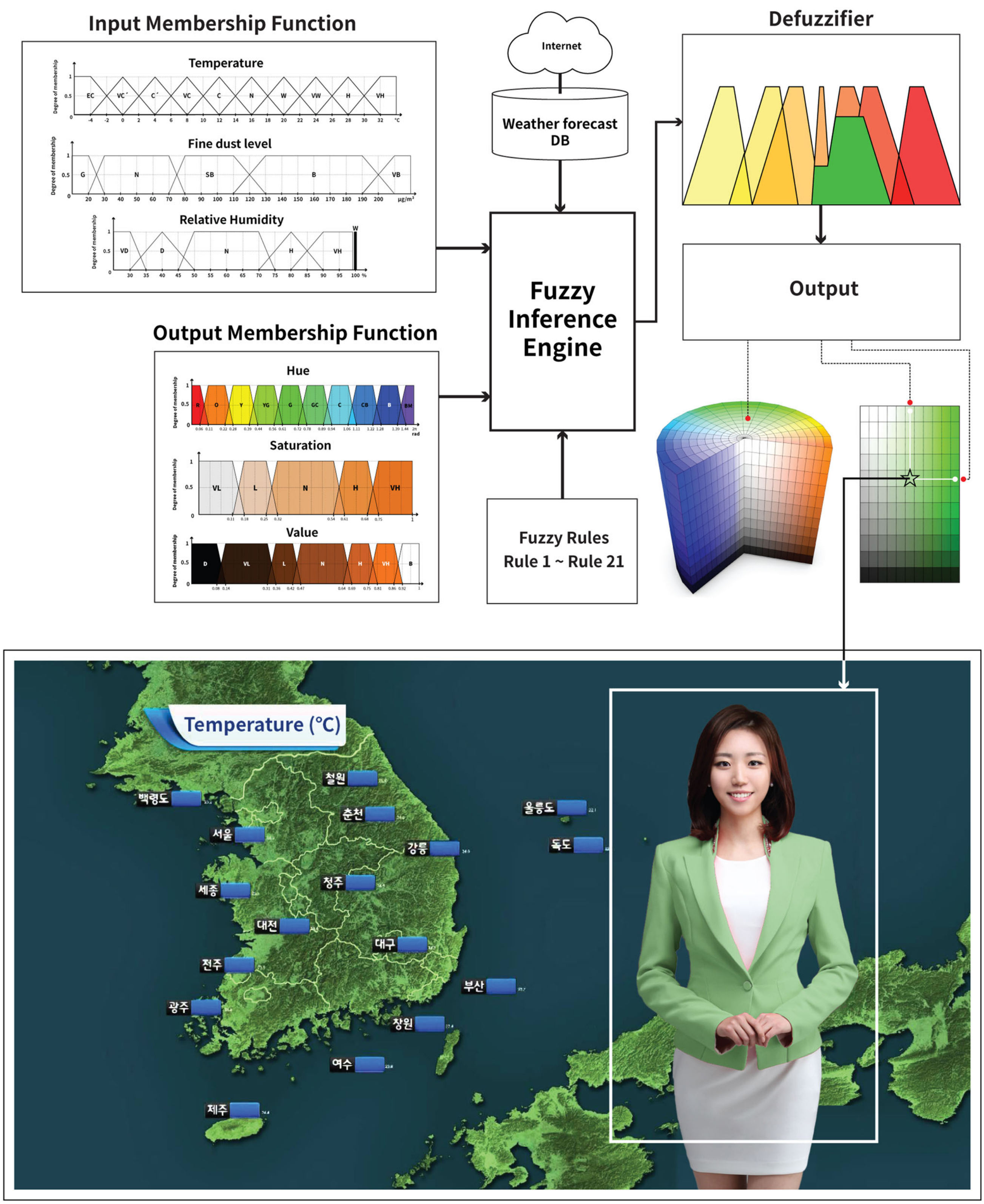


Fig. 12 Process of weather presenter's clothing transform

Fig. 13 Real-time weather presenter's costume compositing

Rule 12 If [the fine dust level] is [normal] then [the saturation] is [high]

Rule 13 If [the fine dust level] is [slightly bad] then [the saturation] is [normal]

Rule 14 If [the fine dust level] is [bad] then [the saturation] is [low]

Rule 15 If [the fine dust level] is [very bad] then [the saturation] is [very low]

Rule 16 If [the relative humidity] is [very dry] then [the value] is [very high]

Rule 17 If [the relative humidity] is [dry] then [the value] is [high]

Rule 18 If [the relative humidity] is [normal] then [the value] is [normal]

Rule 19 If [the relative humidity] is [humid] then [the value] is [low]

Rule 20 If [the relative humidity] is [very humid] then [the value] is [very low]

Rule 21 If [the relative humidity] is [wet (rain)] then [the value] is [dark]

Mamdani's fuzzy inference method is used, in which the three input membership functions, from the three output membership functions of each rule, are combined through an aggregation operator, which is set to max (Jeon et al. 2009). The resulting fuzzy set is defuzzified in order to produce the output of the system. Through the defuzzification process, accurate values corresponding to hue, saturation, and value in the HSV color space are finally determined. The weather presenter's clothing may be composed with colors reflecting these final values (Fig. 12).

The weather presenter simultaneously describes both the numerical data and linguistic information while their clothing changes colors, in real time, according to temperature, atmospheric conditions, and humidity data. The following example describes the application of this system to the KBS weather report on April 4, 2016 (Fig. 13).

6 Conclusions

While online forecasts are suitable for providing professional and detailed weather information, Internet and smartphone weather applications are suitable for providing weather information quickly. Users actively search for information using the Internet and smartphones, whereas television weather forecasting is targeted to unspecified viewers. Therefore, the format and content of the program should be different to the format and content used by Internet and smartphone applications. This study proposed a method to use color as a tool for weather forecasting. This method consists of utilizing a fuzzy inference engine, which matches the temperature, fine dust level, and humidity-related single words with the HSV color model.

In conclusion, television weather forecasting could provide emotional information to viewers using the weather presenter's clothing, since viewers are inevitably focused toward the presenter. This system could be utilized as another tool for providing weather-related information.

Acknowledgements This study was not funded by any research grant. I would like to thank for the contributions of Hyeon Seo Wee (Kyung Hee University), who participated as a Graphic Editor, and Young Eun Lee (Sookmyung Women's University), who participated as a weather presenter.

Compliance with ethical standards

Conflict of interest Author Pyoung Won Kim declares that he has no conflict of interest.

Ethical approval This article does not contain any studies with human participants or animals performed by any of the authors.

7 Appendix: Weather forecast video clip

The current weather report format https://youtu.be/yLzGn2nood8

Chameleon-like weather presenting format https://youtu.be/3yyIw7K5IQY

References

Chun S (2007) A weatherman knows that rain and snow fall on the bad and the good. Korea JoongAng Daily. http://mengnews.joins.com/view.aspx?aId=2881079. Accessed 31 May 2017

Cowling G (1957) TV Weatherman. Weather 12:22–26. doi:10.1256/wea.138.05

Jeon G, Anisetti M, Bellandi V, Damiani E, Jeong J (2009) Designing of a type-2 fuzzy logic filter for improving edge-preserving restoration of interlaced-to-progressive conversion. Inf Sci 179(13):2194–2207

Kim P, Lee S (2016) Audience real-time bio-signal-processing based computational intelligence model for narrative scene editing. Multimed Tools Appl. doi:10.1007/s11042-016-4144-1

Konstantinidis K, Gasteratos A, Andreadis I (2005) Image retrieval based on fuzzy color histogram processing. Opt Commun 248:375–386. doi:10.1016/j.optcom.2004.12.029

Korea Meteorological Administration (2017) Climate of Korea. http://web.kma.go.kr/eng/index.jsp. Accessed 31 May 2017

Küçüktunç O, Güdükbay U, Ulusoy Ö (2009) Fuzzy color histogram-based video segmentation. Comput Vis Image Underst. doi:10.1016/j.cviu.2009.09.008

Kuehni RG (2002) The early development of the Munsell system. Color Res Appl 27(1):20–27. doi:10.1002/col.10002

Met Office (2016) Weather warnings guide. http://www.metoffice.gov.uk/guide/weather/warnings. Accessed 31 May 2017

Neal RA, Boyle P, Grahame N, Mylne K, Sharpe M (2014) Ensemble based first guess support towards a risk-based severe weather warning service. Meteorol Appl 21:563–577. doi:10.1002/met.1377

Solar (2016) A cool, minimalist weather app for iOS. https://solar-weather.en.softonic.com/iphone. Accessed 31 May 2017