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HAZARD DETECTION PREDICTION MODEL FOR RURAL ROADS BASED ON HAZARD AND ENVIRONMENT PROPERTIES

ABSTRACT

A driver's reaction time encountering hazards on roads involves different sections, and each section must occur at the right time to prevent a crash. An appropriate reaction starts with hazard detection. A hazard can be detected on time if it is completely visible to the driver. It is assumed in this paper that hazard properties such as size and color, the contrast between the environment and a hazard, whether the hazard is moving or fixed, and the presence of a warning are effective in improving driver hazard detection. A driving simulator and different scenarios on a two-lane rural road are used for assessing novice and experienced drivers' hazard detection, and a Sugeno fuzzy model is used to analyze the data. The results show that the hazard detection ability of novice and experienced drivers decreases by 35% and 64%, respectively, during nighttime compared to daytime. Also, moving hazards increase hazard detection ability by 9% and 180% for experienced and novice drivers, respectively, compared to fixed hazards. Moreover, increasing size, contrast, and color difference affect hazard detection under nonlinear functions. The results could be helpful in safety improvement solution prioritization and in preventing vehicle-pedestrian, vehicle-animal, and vehicle-object crashes, especially for novice drivers.

KEY WORDS

hazard detection; hazard properties; prediction model;

1. INTRODUCTION

Driving accidents mostly result from four main reasons—human, vehicle, road and environment, human factors being the most common [1]. However, causes of accidents are not exactly known in many cases. Road crashes are the cause of most fatalities in Iran. More than 220,000 fatalities and more than 2 million injuries have been caused by road crashes in Iran in the last 10 years [2], and most of them involve youth with an average age of 35. This puts the country under economic and social pressure. Young and novice drivers cannot detect hazards and react in appropriate time due to less experience, hence they are more likely to have accidents. Hazard detection and perception should happen quickly enough to enable reducing the chance of an accident.

Hazard detection and perception are driving skills [3]. Hazard perception includes awareness of hazard types, hazard prediction, and visual perception. McKenna and Crick (1990) define hazard perception as the ability to detect dangerous traffic situations. Hazard perception is the time and situation in which drivers detect danger in a driving region [4, 5].

The first step in hazard perception is on-time detection, followed by hazard perception, decision making, and reaction. Hazard detection and perception are not given enough attention and are not part of driving license tests. Various parameters affect drivers' hazard perception. Literature mostly focuses on human factors such as experience, age, gender, and psychological parameters, whereas detection factors are studied less. For example, Borowsky et al. (2013) did a comparative and sensitivity analysis of hazard perception among novice and experienced drivers [6]. In addition, many studies show that age, driving skill, and education affect drivers' hazard perception. In some recent studies, psychological tests were carried out to show the effect of drivers' psychological condition on hazard perception [7, 8, 9].

There are also some studies considering traffic signs and warning properties. Wogalter et al. (1977) showed that words, colors, and symbols affect Spanish drivers' hazard perception. They also concluded in 1998 that a red-colored "danger" word alerts drivers the most [10]. Tonya L. Smith-Jackson (2000) showed that color change in symbols can affect hazard perception. She also compared her results with the Wogalter (1997) study. The study was done on people whose mother tongue was English. The results have shown that the most effective colors are red, followed by yellow, black, and orange, and the most effective symbols are a skull, prohibition (circle-slash), and shock symbols [11, 12].

Another parameter that impacts drivers' hazard perception is object size. Bigger objects are detected by drivers sooner. The studies show that hazard detection time is dependent on object size. In addition, changes of the angle of hazard location are of importance [13].

Moreover, object size has an impact on drivers' decisions about overtaking. For instance, a driver estimates overtaking time and distance based on the size of the approaching vehicle. Smaller approaching vehicles, such as motorcycles, can cause misjudgment and increase the chance of an accident [14].

Another hazard factor is the contrast between the hazard and the environment. Based on the Highway Safety Manual (HSM), contrast sensitivity is defined as "the ability to detect small differences in luminance (brightness of light) between an object and the background." Although contrast is a hazard factor, drivers should be able to detect it. A study done in 1994 showed the importance of contrast, especially in traffic signs. The results have shown that fully retro-reflective, high-contrast signs are more legible [15].

Studying driver reactions using driving simulators and monitors has shown that a driver's hazard perception is different in various situations. For example, driver reaction is faster when the hazard is located in the center of the monitor. Also, the reaction is faster when three monitors are used to show the road compared with using one monitor. Moreover, increasing monitor width and showing more parts of the environment, especially in the center of the monitor, decreases driver reaction time [16].

Being predictive is another factor of hazard detection. Studies have shown that sudden events increase reaction time in drivers along with the chance of a crash. A study done in 2015 concluded that perception time is significantly affected by predictive happenings; for example, perception time is shorter when the driver faces a left-turning vehicle for the second time [17].

There are also some factors that make hazard detection harder, such as poor vision due to hills, road curves, and snowy or foggy weather. Poor light (like nighttime driving) also makes drivers estimate vehicle speed and distance using head or rear lights of vehicles [13].

Experimental tests done on novice drivers have shown that some hazards due to poor vision situations, such as a pedestrian coming out from behind a parked car, are not detected by drivers in enough time to prevent accidents, and more training and experience are needed [18].

Moreover, hazards are not detected if they are too small, have low contrast with the environment, are out of the driver's vision line, are fixed (not moving), are sudden, and if there is glare [19].

Previous studies have been mostly focused on drivers, and hazard properties have been considered less often. Thus, this paper tries to pay more attention to hazard properties. Moreover, driver's license tests are done on urban roads in Iran, whereas more than 70% of fatalities occur on rural roads. Therefore, this paper focuses on rural road hazard properties and their effect on driver hazard detection. The main question focuses on which properties of hazards affect driver hazard detection and how. A scoring model is suggested to predict driver detection based on hazard properties. The main hazard properties—color, size, contrast with the environment, whether it is moving or fixed, hazard location, and warning signs—are taken into account in daytime and nighttime and for experienced and novice drivers. Due to interactions among hazard properties and intermediate stages for contrast, size, and daytime/nighttime, the Takagi-Sugeno fuzzy system is used for scoring models. The inputs are the hazards' fuzzy properties, and the output is the score. The results could help in road safety improvement plans, driver hazard perception tests, and novel road safety audit methods.

2. METHODOLOGY

A driving simulator is used to provide a close-to-real situation for drivers. The simulator's name is Nasir, which was designed and made by Khaje-Nasir University's virtual reality group. The device contains structure and environment simulation software. The structure is a half-body of a car named Pride, and the simulated environment is shown on three LG 25" LCDs that form a 135° angle with each other. All mechanical parts of the car, such as the steering wheel, accelerator, break, and clutch, are similar to those of a real vehicle.

The software includes a vehicle dynamic model (14 degrees of freedom), real-time calculation, and differential equations. Panel information like vehicle speed is shown on the monitor. Vehicle produces sounds in different situations, such as gear changing, motor running, and collisions.

The simulated road is a two-lane plain highway of 23.5~31.5 km in length (different for each scenario) surrounded by flat ground covered by plants and trees, some hills, and traffic signs related to the simulation scenario. Next, simulation is done on objects considering their properties, such as maximum distance in which the object is visible and having a hard surface that deviates the vehicle in case of a collision. The 3-D Max and simulation supporting software are used in this step.

The hazards are different in size, color, contrast with the environment, motion, and contain humans, animals, and objects. The hazards are an adult pedestrian, child pedestrian, camel, cow, cat, dog, and rock, described as follows:

- Adult pedestrian 175 cm tall with dark or light shirt
- Child pedestrian 100 cm tall with dark or light shirt
- Black or white cow
- Camel
- Black or white cat
- Dark or light rock

There were 90 examinees (47 men and 43 women), including 45 experienced drivers (driving experience of 1 to 15 years) and 45 novice drivers (driving experience of less than 1 year and no experience of driving on rural roads). Examinee vision and hearing were normal. None had been injured in an accident before, and all lived in Tehran. In total, 1,178 occurrences were recorded during the tests.

The examinees were instructed to sound the horn when they noticed a hazard. The time of horn pressing and other reactions (hazard detection) and the time of hazard trigger (the hazard exposure time, that is, when the simulator creates it) were recorded. The shorter the temporal or spatial distance between these two points, the earlier the driver noticed the hazard. Another recorded time was when the car arrived at the hazard location. A lower ratio of the distance between hazard detection and hazard trigger to the distance between hazard trigger and arriving at the hazard location indicates a lower chance of accident and better hazard detection. An indicator is based on this definition and is used as the main hazard detection indicator, as follows:

$$RI = \frac{t_d - t_v}{t_h - t_v} \qquad [1]$$

t_v - Hazard trigger time
t_h - Time of arrival at hazard location
t_d - Hazard detection time
RI - Hazard detection indicator

RI varies from 0 to 1, and a lower RI means a higher hazard detection score. Hence, the detection score corresponding to RI is chosen as a dependent variable that varies from 0 to 100 (the detection score is a unitless variable). A detection score of 0 is equivalent to RI=1, and a detection score of 100 is equivalent to RI=0. The linear equation between RI and the detection score is used to figure out the score corresponding to each RI value. Generally, a higher detection score means quicker hazard detection.

Two kinds of fuzzy systems are popular: the Mamdani fuzzy system and the Takagi-Sugeno-Kang fuzzy system (TSK). These two systems will be described shortly. *Figure 1* shows the main structure of the Mamdani fuzzy system. A fuzzy decision-making unit combines input matrices and produces a set of numbers as output. The main problem of the Mamdani fuzzy systems is that both the input and output are fuzzy sets.

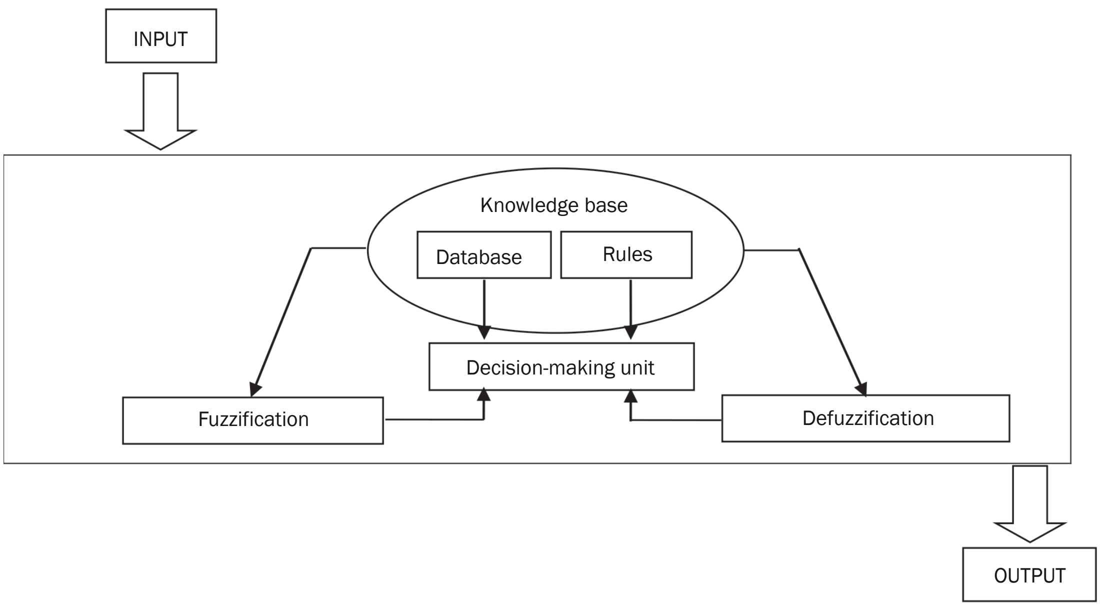


Figure 1 – Main structure of a fuzzy system

Table 1 – Example of fuzzy rules

Number of rule	Size (3)	Color (2)	Day/Night (2)	Contrast (2)	Prewarned (2)	Moving/ Fixed (2)	Experience	Detection score
1	1	1	1	1	1	1	1	58
2	1	1	2	1	2	1	1	12
3	1	2	1	2	1	2	1	36
4	2	1	1	1	1	1	1	71
5	2	1	2	1	1	1	1	61
6	3	1	1	2	1	1	1	78
7	3	2	1	1	2	2	1	92
8	1	1	2	1	2	2	2	15
9	1	2	1	2	1	1	2	32
10	2	2	2	2	2	1	2	23
11	3	1	2	1	1	1	2	40
12	3	2	2	2	2	2	2	38

A solution provided by Sugeno uses a fuzzification interface to transform inputs into fuzzy sets and uses a defuzzification interface to transform the output into actual values. The TSK system is based on the following principle: if the car speed (X) is high, then the force applied to the accelerator is $Y=CX$. In this statement, the word "high" means 1, and C is a constant value. The then statement here is a simple mathematical relation rather than a descriptive statement. This simplifies the fuzzy statement combination. The TSK fuzzy system is a weighted average of then statement values.

The Sugeno system is used in this paper for predicting driver hazard perception grades. First, the input is identified. The input includes environment properties, hazard main properties, and driving experience, which are all independent variables. Driver perception grade is valued from 0 to 100 by a hazard perception test run using a driving simulator. The main input elements are as follows:

Hazard size: Hazard size is an effective parameter in driver hazard perception. Hazard size is defined based on its area, and a size of small, medium, or large is chosen for writing fuzzy system rules. Because size is an aggregate variable, each size has its own hazard detection score.

Mobility: This parameter is considered as a dummy parameter of moving or nonmoving. It affects driver perception.

Warning or sudden hazard: The existence of warning signs to inform the driver before a hazard causes drivers to be more cautious. Hence this parameter is considered in driver hazard perception evaluation.

Hazard color: Various colors impact perception differently. Starting and ending wavelength is considered as hazard color in this paper.

Daytime/nighttime: Environment lighting is an effective parameter in hazard perception. Therefore, the parameter of daytime/nighttime will help considering a low environment lighting (night) or high environment lighting (day) effect on hazard perception.

Contrast: Besides hazard color and environment lighting, the difference between the hazard and environment color is also important and could change between 0% and 100%. Complete contrast and no contrast between the hazard and the environment are considered in this paper.

Experience: Driver experience has also been considered in the literature about hazard perception, in addition to hazard and environment properties. In this paper, two levels—experienced and novice—are considered.

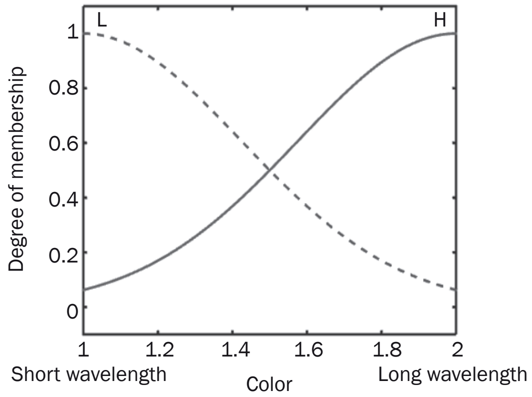
An indicator valued from 0 to 100 is defined based on the hazard trigger time, driver hazard detection time (stated by sounding the horn), and the time the driver reaches the hazard in the driving simulator. The indicator is calculated for each driver using hazard perception test data and the hazard and environment properties in the test. Next, the fuzzy rules table is made. Some of the principles are shown in *Table 1*.

3. RESULTS

A Sugeno fuzzy model with Gaussian inputs was developed using Matlab software. Gaussian functions are demonstrated by membership function center and width.

Figure 2 shows the membership function of two input parameters (hazard size and color).

As shown in *Figure 2*, color has two classes of short wavelength and long wavelength and size has three classes of small, medium, and big. Other independent variables also have a membership function similar to color.



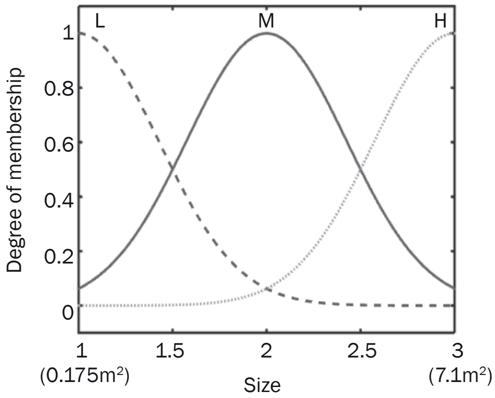


Figure 2 – Gaussian membership functions for size and color

3.1 Variables' individual effect

Model outputs are studied to find each variable's effect. First, the variables are considered individually, and the effect of each variable on hazard detection score is studied. The first variable is hazard size. It is assumed that a bigger size results in easier and faster detection by drivers. A hazard score diagram for different hazard sizes (other parameters are not changed) is gained as an output. The best and the worst hypothetical conditions other than size are shown in *Table 2*.

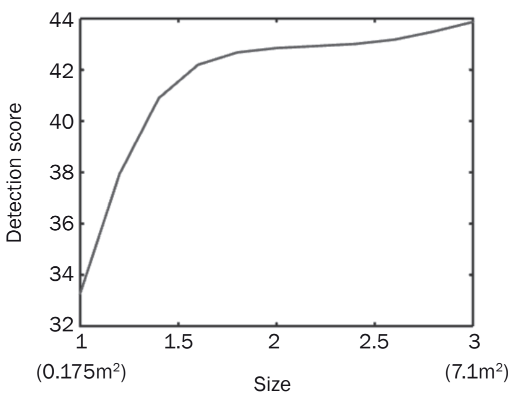
The diagrams of the best and the worst hypothetical conditions are shown in *Figure 3*.

Size 1 in the diagrams in *Figure 3* means an area of 0.175 m^2, and size 3 means an approximate area of 7.1 m^2. As seen in *Figure 4*, under all conditions, as hazard size increases, hazard detection scores increase. Under the best conditions (daytime, dark color, full contrast, warning, and moving hazard), the detection score increases, whereas the hazard size increases to 2.1 (equivalent to 3.75 m^2 area). Higher hazard sizes do not affect the detection score significantly. Under the worst conditions, the detection score rises sharply, whereas hazard size increases to 1.7 (equivalent to 2.5 m^2 area); after this point, the detection score rate gradually decreases to 0. However, at last, the detection score increases again. Another point is that under the best conditions, the detection score varies from 34 to 59, and under the worst condition it is 33 to 44.

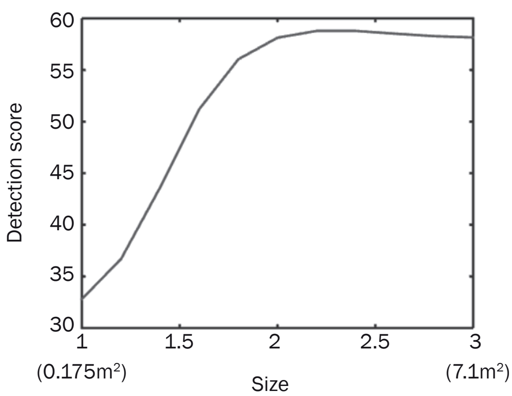
Hazard color and contrast between hazard and the environment effects on the detection score are also studied individually. In order to assess these effects in scenarios, different wavelengths and examined their various combinations were used. Finally, after removing some scenarios and rules for the input of the fuzzy system, we carried out the tests. To control the variables, the type of texture, different colors of asphalt, and night/day light were also used.

Table 2 – The best and worst conditions of variables other than size

	Experience	Moving/Fixed	Warning	Contrast	Daytime/Nighttime
The best condition (diagram in *Figure 3a*)	Experienced	Moving	Warning	Maximum contrast	Daytime
The worst condition (diagram in *Figure 3b*)	Novice	Fixed	No warning	No contrast	Nighttime



a) Under the best condition



b) Under the worst condition

Figure 3 – Hazard detection score vs. hazard size (all other parameters are unchanged)

The best and worst conditions for these variables are assumed based on daytime and nighttime. For example, a dark color has higher contrast in daytime and lower contrast in nighttime. The best and worst conditions of variables other than contrast and color are stated in *Table 3*.

The diagrams in *Figures 4* and *5* are drawn for the changes in hazard detection score based on color variations and contrast in the best and worst conditions of other variables (specified in *Table 3*).

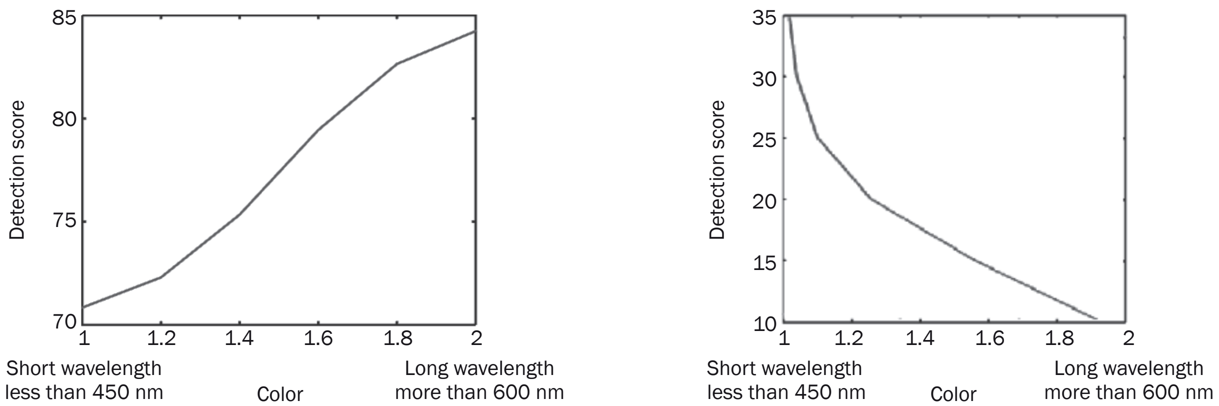
Diagrams in *Figure 4a* and *4b* show that longer wavelength color hazards are easier to detect in daytime, when the detection score varies from 71 to 84 (see *Figure 4a*). Of course, this was not true for colors with wavelengths greater than 650 nm, such as red. As seen from the diagram in *Figure 4b*, a longer color wavelength is harder to detect at nighttime. The detection score varies from 10 to 35 under the worst conditions.

Figure 5 shows that lower contrast results in a lower detection score. The diagram in *Figure 5b* shows that under the worst conditions the detection score varies from 10.5 to 12.5, whereas under the best conditions it increases significantly to 63–84 (diagram in *Figure 5a*).

One of important environmental variables is lighting (daytime/nighttime). This variable was studied under different conditions with other variables. The detection score is lower at nighttime under all conditions using other variables. Only a few experienced drivers earned similar detection scores in nighttime and daytime. *Figure 6* compares the novice drivers' average detection scores in day and night.

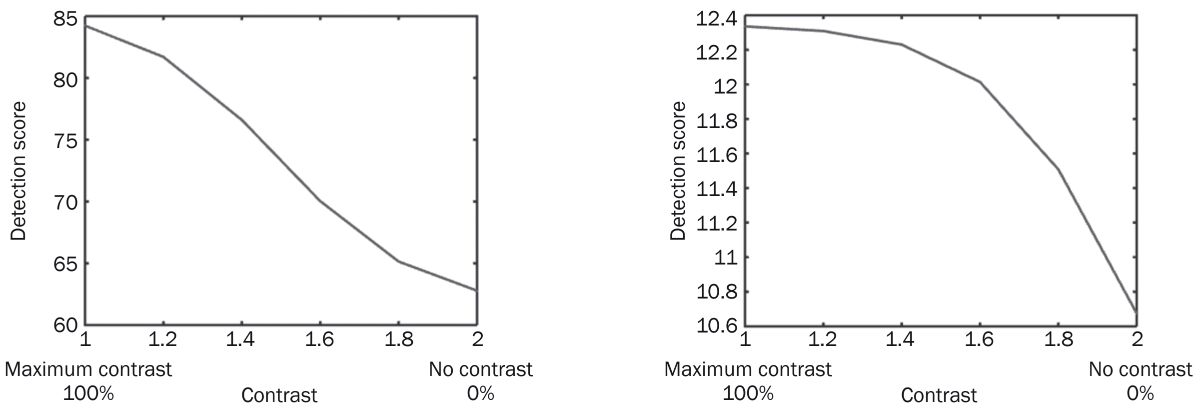
Table 3 – The best and worst conditions of variables other than contrast and color

	Experience	Moving/Fixed	Warning	Size	Daytime/Nighttime
The best condition (diagrams in *Figure 4a* and *5a*)	Experienced	Moving	Warning	Big	Daytime
The worst condition (diagrams in *Figure 4b* and *5b*)	Novice	Fixed	No warning	Small	Nighttime



a) Under the best condition *b) Under the worst condition*

Figure 4 – Hazard detection score changes as hazard color varies



a) Under the best condition *b) Under the worst condition*

Figure 5 – Hazard detection score changes as hazard contrast varies

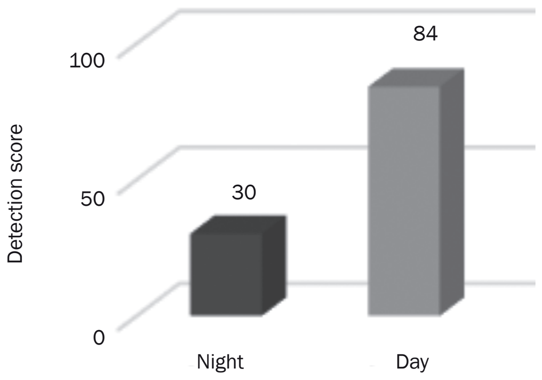


Figure 6 – Average hazard detection score in night and day

As shown in *Figure 6*, the drivers' detection score at nighttime was 36% of that during daytime.

Comparing moving and fixed hazards shows that moving hazards result in a higher detection score. *Figure 7* compares detection scores for moving and fixed hazards.

Figures 7a and *7b* show that mobile hazard increases driver hazard detection score under any condition. Of course, the ratio of driver hazard detection score between mobile and fixed hazard is higher when other variables are in worst condition.

Presence of warning signs is not statistically significant for all scenarios, especially for novice drivers. Matlab software outputs were also studied, and two variables were changed.

3.2 Variables' surface figure

Four sample surface figures are shown in *Figure 8*.

As seen in *Figure 8*, the detection score is higher when size, contrast, and experience are increased, in daylight, and a color with shorter wavelength at nighttime. Under opposite conditions, the hazard detection score decreases, and sometimes parameters balance each other. The parameters that affect increasing detection score the most are size, motion, and daytime/nighttime.

3.3 Validation

Thirty-five real detection scores are compared to Sugeno model outputs. *Figure 9* demonstrates the results.

As seen in *Figure 9*, the prediction error for many values is minimum, and RMSE (root-mean-square error) is acceptable.

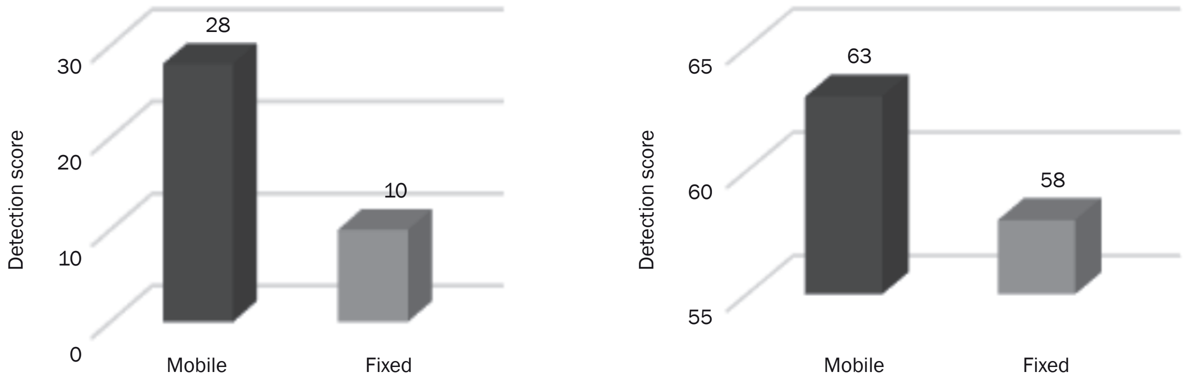
4. DISCUSSION AND CONCLUSION

Because driver hazard perception and decisions are related to correct hazard detection, studying effective variables on hazard detection could be helpful in safety planning. The main goal in this paper is assessing the effects of hazard characteristics on driver hazard detection. Different potential dangers of rural roads, such as crossing pedestrians, animals, or objects, were used as hazards. Various hazard properties were considered and studied.

One of the main limitations of the research was the number of examinees, given that the tests were using the simulator. The examinees had to be referred to the test site, and the duration of the tests was prolonged. The financing of the tests was an important limitation as well.

This study and other research agree in the concept of hazard perception defined by McKenna and Crick as the ability to detect hazardous traffic situations and detection time of a hazard proposed by Horswill and McKenna [4, 5].

One of the most important differences between this research and other studies is the type of variables. In this study, in addition to paying attention to driving experience, which is one of the most important variables affecting hazard perception in other research, hazard characteristics were considered. The variables studied in this research included size, color, contrast between the hazard and the environment, whether the hazard was moving or fixed, warning/no-warning and daytime or nighttime. There were some dummy



a) Under the worst condition *b) Under the best condition*

Figure 7 – Hazard detection score for moving and fixed hazards

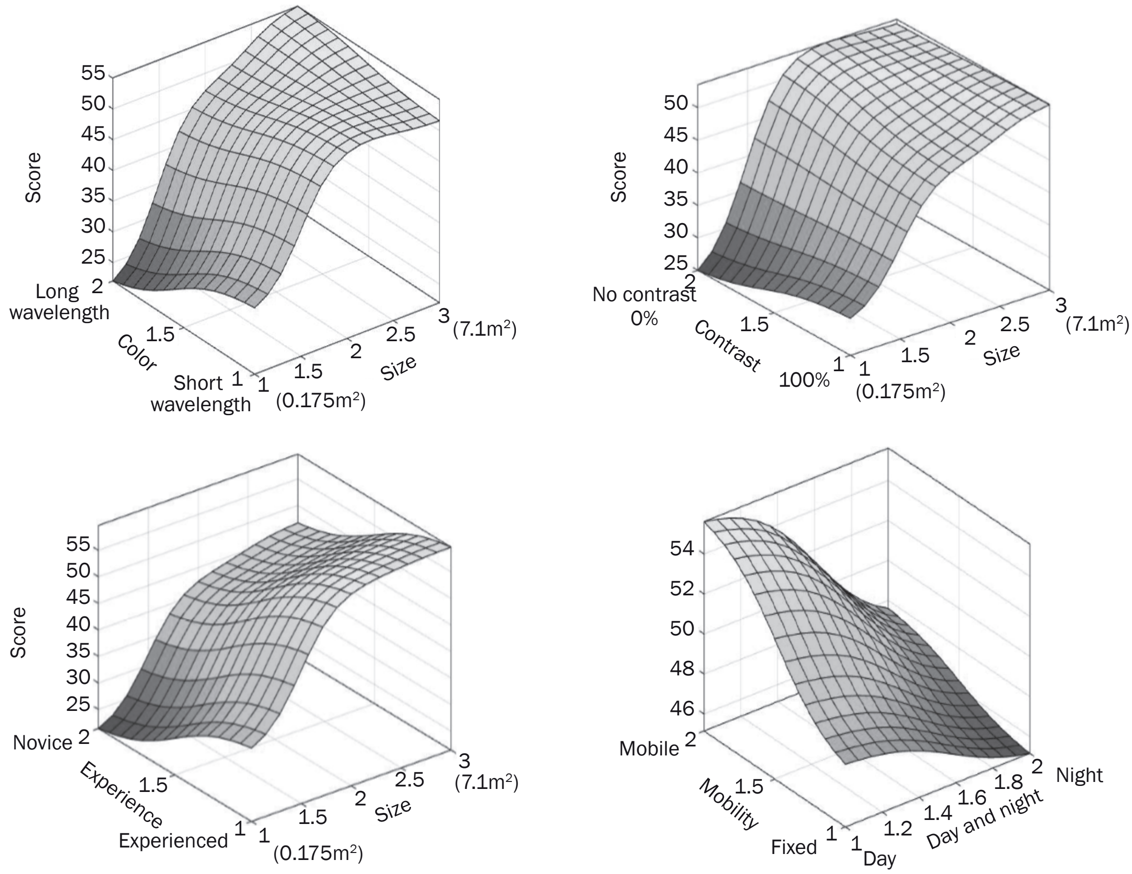


Figure 8 – Hazard detection score vs. two hazard parameters

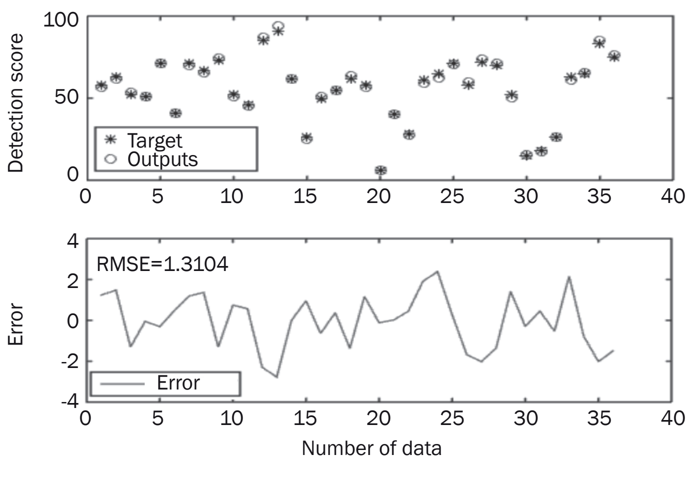


Figure 9 – Comparing Sugeno fuzzy model output with real detection score values

variables like moving/fixed hazard or daytime/nighttime in addition to some aggregate variables, such as size and contrast (0% to 100%).

Some hazard perception tests for other countries, such as the United Kingdom and New Zealand, as well as some papers, have identified the 5-point scoring method as a hazard detection option, and in this regard they have defined a range for mouse clicks by examinees [5, 20], but in this case hazard detection indicator is a unitless score between 0 and 100, derived from the division of two time scales. The advantage of this method is that the proposed hazard detection indicator includes all three time points: trigger time, detection and reaction time, and time of arrival at hazard location.

The results have shown that hazard detection in low light (nighttime) is harder for both novice and experienced drivers, and that in some cases hazards are not detected in nighttime. The average hazard detection score decreases by 35% and 64% for experienced and novice drivers, respectively, in nighttime compared to daytime. This variable has the biggest effect on hazard detection and detection time. Thus, paying attention to road lighting and nighttime driving training could be useful in safety improvement programs.

Moving hazards are detected more easily and sooner in all scenarios. Hazard detection ability increases 9% and 180%, respectively, for experienced and novice drivers when hazards are moving compared to fixed. These findings indicate that improving the visibility of fixed hazards and relocating fixed and unsafe hazards should be considered, and attention should be paid to this type of hazard in training programs for novice drivers.

Our findings have proven the effect of size in hazard detection, as demonstrated in research by Krauss et al. and Levulis et al., with respect to overtaking time detection [13,14]. Of course, our selective levels for research included the size of a variety of hazards, and there were three main levels in the fuzzy model. Hazards that are bigger in size are detected more easily. However, experienced or more careful drivers notice smaller hazards too. Increasing hazard size to 0.68 m^2 improves hazard detection in experienced drivers by 12%, bigger sizes up to 2.5 m^2 improve detection by 51%, and increasing to 3.75 m^2 improves detection by 4.5%. Sizes bigger than 3.75 m^2 slightly affect the detection score. For novice drivers, increasing hazard size to 1.7 m^2 improves detection score by 27%, and increasing hazard size results in a rapid growth in the detection score after initial slow growth. Thus, it is important to pay more attention to hazard size in driving hazard perception tests. Also, removing small objects from roads is necessary because although crashing into small objects does not cause casualties or injuries, it could cause deviation, a rollover, driver nervousness, and other dangerous consequences.

The main difference between this research and the studies by Wogalter et al. was that their studies focused on the colors of the signs [10,11,12], but we looked at the colors of other fixed and moving hazards.

Hazard color and contrast between the hazard and the environment are also highly related. High contrast makes the hazard easier to detect, whereas hazard color is different in daytime and nighttime. Color's impact is totally different in day and night, and the diagrams are nonlinear. Decreasing the wavelength of light colors changes the detection score by 10% to 14%, whereas for dark colors the detection score changes by 7% or more. The results have shown that colors with a wavelength of 450–550 nm and 600–650 nm are easier to detect in nighttime and daytime, respectively. Our findings confirm the result of Wogalter et al. about the yellow and orange in daytime [12], but we did not get the results for the red color, neither day nor night.

Lower contrast results in more difficult hazard detection in both daytime and nighttime. In daytime, decreasing contrast between the hazard and the environment from 100% to 80% reduces the detection score by 4%; decreasing contrast to 20% causes a sharp reduction in detection score (20%). A contrast lower than 20% reduces the detection score 4% more.

Detection score reduction for novice drivers is less than 1% in the case of contrast decrease from 100% to 60% in nighttime. Decreasing contrast to 40% causes a detection score reduction of 2%. Contrast lowering from 20% to 0% causes a 7% reduction in the detection score. Hence, making objects and crossing animals more visible, improving lighting, and modifying roadside views to increase contrast could be helpful in crash reduction. Moreover, making pedestrian crossing places more visible, instructing pedestrians, especially school children, to use phosphorescent clothing, and training drivers in the field of front attention could help in improving safety on roads.

Carrying out all steps of this research is not possible due to scenarios of high risk collision in real road conditions, but its results can be applied to real roads. The most important use of the research is to reduce the likelihood of accidents due to weaknesses in driver perception. For this purpose, special attention should be paid to safety audits for fixed, small-size, low-contrast, non-recognizable colors (for example, high-wavelength colors at night), and undetectable hazards at night. The engineering approach to these problems is identifying them so that they can be recognized by drivers. If it is not possible to improve the visibility of hazards, they should be removed or repaired in some way or through environmental modification. It is also possible to consider the color of clothes for children going to schools located near roads and trainings needed for these arrangements.

The hazard detection indicator has been proven as acceptable, and most of the hypotheses about hazard properties' effects on hazard detection have been confirmed. The indicator could be used in hazard perception and driving license tests. In addition to the studied properties here, hazard location in the driver's field of view (center or side) could be studied too. Also, the effects of training, expert actions (other than warning signs), such as road view modification, visibility improvement, and safety improvement of accident-prone places and construction zones, could be studied. Moreover, the results could be used in research about road safety audits; front-to-rear crashes; vehicle-pedestrian, vehicle-animal, and vehicle-object crashes; and rollover accidents.

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چکیده

در ایران هر سال تعداد زیادی از مردان و زنان بدلیل تصادفات رانندگی جان خود را ازدست می‌دهند. در نتیجه هر روشی برای کاستن از تعداد تصادفات و تلفات ناشی از آن حایز اهمیت می‌باشد. در بسیاری از تصادفات اگر راننده در شرایط مناسبی باشد و به موقع عکس العمل نشان دهد ان تصادف اتفاق نمی افتد و یا در صورت وقوع شدت آن پایین خواهد بود. یکی از گام های اصلی قبل از واکنش مناسب در برابر خطرات درک آن خطرات می‌باشد. عوامل مختلفی بر در ک خطر راننده موثر می‌باشد که اکثر آنها از ویژگیهای خود راننده میباشد. در این تحقیق فرض این بود که ویژگیهای مختلف راننده شامل ویژگیهای کیلومتراژ رانندگی در سه سال گذشته، تأثیر در زمان تشخیص خطر خواهند داشت . در این ر4استا شبیه ساز رانندگی بکار گرفته شد و سناریوهای مختلف خطر در راه دو خطه جدا شده برون شهری و برای دو گروه رانندگان کم تجربه و با تجربه مورد بررسی قرار گرفت و برای ارزیابی تشخیص خطر یک سیستم امتیازی فازی سوگنو بکار گرفته شد. نتایج نشان داد قدرت تشخیص رانندگان با تجربه و کم تجربه به ترتیب در شب به نسبت روز حدود 35 و 64 درصد کاهش پیدا می‌کند و تحرک خطر حدود 9 درصد برای رانندگان با تجربه و 180 درصد برای رانندگان کم تجربه قدرت تشخیص را افزایش می‌دهد. علاوه بر آن افزایش سایز خطر، افزایش کنتراست خطر نسبت به محیط اطراف و تغییرات رنگ موجب تغییر امتیاز تشخیص رانندگان با روابط غیرخطی ویژه‌ای خواهد شد. نتایج این تحقیق در اولویت‌بندی راهکارهای ایمن‌سازی و همچنین آموزش رانندگان و آزمون‌های رانندگی و توسعه ممیزی ایمنی کاربرد خواهد داشت و می‌تواند از بسیاری از تصادفات با عابر پیاده، حیوانات و موانع ثابت بخصوص در مورد رانندگان جوان و کم تجربه پیشگیری نماید.

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