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MODELS RELATING ACCIDENT PATTERNS OF MOTORCYCLES WITH CHAIN CODE TECHNOLOGY

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Abstract：The purpose of this research was to analysis the accident of the motorcycle in Taiwan. Chain code models were to relate the discrete accident data with driving explanatory variables. Following the procedure, an aspect described the chain code with the factors of accident, and the chain code was unitary. Results indicated that the existing inadequate habit of driving and inappropriate performance between a motorcycle and other vehicles depended on the design characteristics of motorcycles. The accident patterns corresponding each other the demand of safety systems, and we bring out fourteen items of advanced safety systems form the four major accident pattern.

Key words：Accident pattern, Chain code, Advanced safety systems

1. INTRODUCTION

In Taiwan, motorcycles had become the most popular mode in transportation systems. With the congenital defects of unbalanced character, there are more safety factors need to find out. The study of collision types is an important part in intelligent transportation systems vision. This work deals with direction representation based on chain coding. Chain-code techniques are widely used because its preserve information and considerable data reduction, chain codes are the standard input format for numerous shape analysis algorithms. The first approach for representing digital curves using chain code was introduced by Freeman in 1961 [1]. Many authors have been used chain coding techniques; these were due to the fact that various shape features may be computed directly from this representation [2-8]. In traffic accident, the injury of motorcycle driver is always more serious than the others, and various collision features should be computed directly from the field sheet of accidents. The aim of this study is intend to improve the current traffic situation, focus on the traffic accident of motorcycles. In order to build a safety environment, analysis of advanced traffic safety system is necessary.

2. CHARACTERISTICS OF MOTORCYCLE TRAFFIC

There are many motorcycles in Taiwan, complicated traffic flow lead to danger to use motorcycle, which have unstable driving environment, and hurt seriously when accidents happened. Now, the Gross National Product is more than 10,000 US dollars in Taiwan. To have a passenger car or motorcycle is so easy for a family. The growth-rate of motorcycle is from 4% up to 5% in recent years. Since Taiwan joined WTO formally and become a member of the international organization. On the same time, the import restriction of heavy motorcycles was removed. The use of motorcycle is various and hard to deal with several particular traffic problems in Taiwan As a result of traffic jam and inconvenient to park, the growth-rate of motorcycles is more than passenger car (Figure 1.).

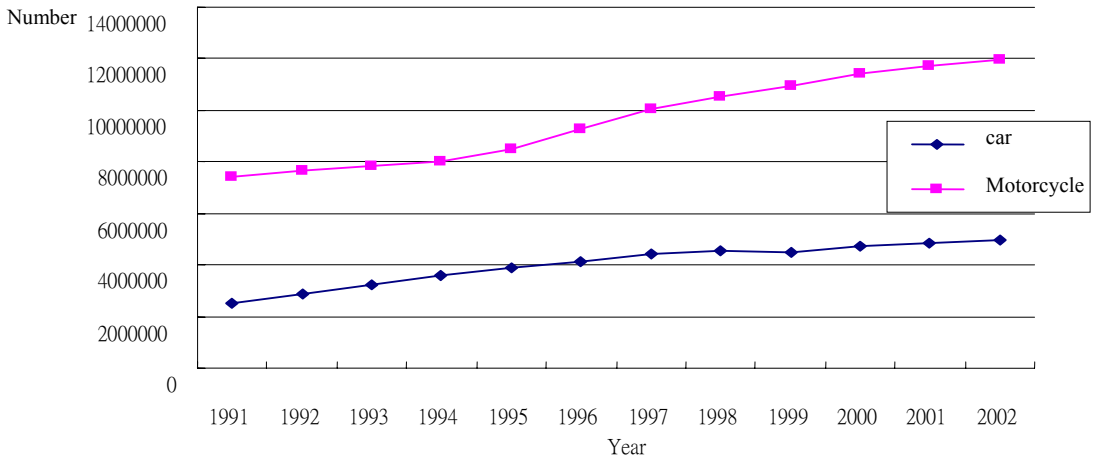


Figure 1. The growth of motorcycles and vehicles

The average travel distance of a motorcycle trip in one day is 12.9 kilometers in Taipei city. After all, having the rapid transit system in 1996, the amount of motorcycles and passenger cars still grow up year after year (Figure 2.). Motorcycle has powerful influence in short distance region. Strictly speaking, although the public transit system provided convenient transportation, fixed percentage of commuters still must commute by motorcycle for some purpose, such as high mobility (32%), reduce commuting time (23%), easy to park (18%), low commuting cost (18%), inconvenient to use public transportation (6%), others(3%), (shown in Figure 3.). This survey hold in 2001, there are 27,495 samples from 11,704,003 motorcycles, the effective samples are 11,028. There are 80.6% motorcycle users to own themselves, 19.4% users are not. The latter includes his wife or her husband (27.0%), father (26.4%), and relatives (21.2%). The investigation showed the use preference and characteristics of motorcycle as:

- Sex: The ratio of male users of motorcycles is increasing from 37.6% to 42.2%.

- Age: The majority of motorcycle users whose age are between twenty and fifty years old. It's more than 70% of all motorcycle users. Obviously, Motorcycle is pretty popular for all people in Taiwan.
- Education: The majority of motorcycle users are senior high school (35 %), college (19%), junior high school (16%), elementary school (16%) and others (14%).

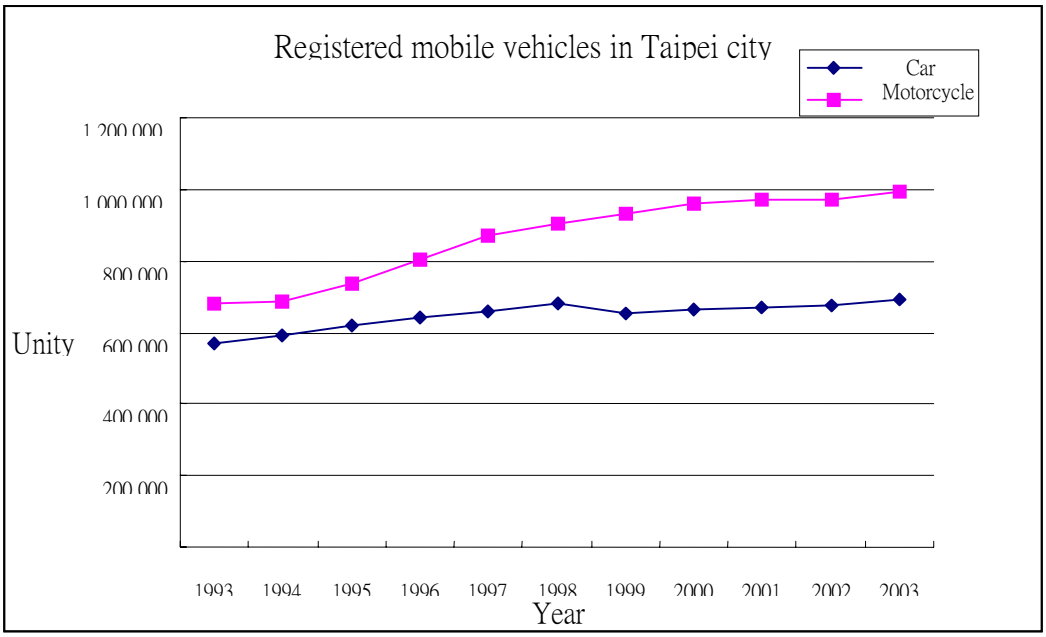


Figure 2. The passenger cars and motorcycles in Taipei city

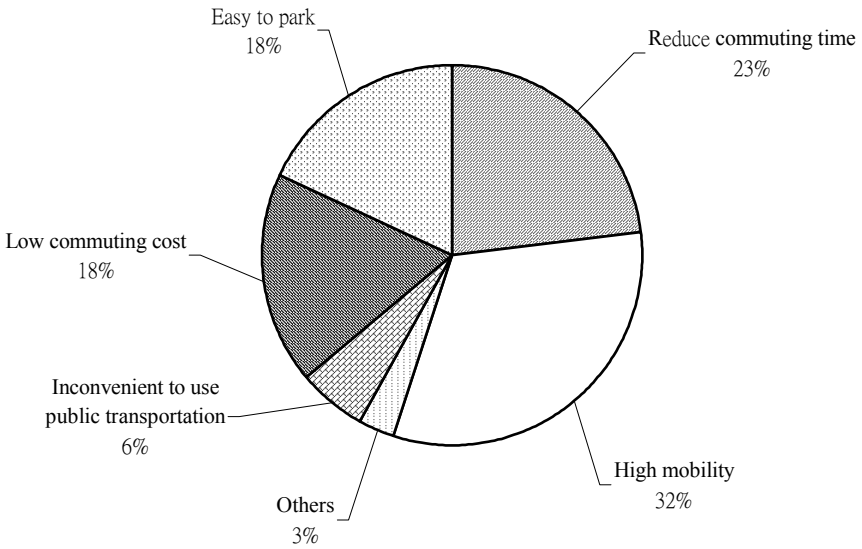


Figure 3. The major reason of using motorcycle in Taipei city

3. THE TRAFFIC ACCIDENTS OF MOTORCYCLE

In recent years, the standard safety equipment of passenger cars, such as air bag and Anti-lock Brake Systems, had equipped from high-price to normal cars. But less to equip for the huge motorcycles, a lot of motorcycles' driving safety is neglected. In the period from 1997- 2001, about 10% motorcycle users had the experience of slight collision in one year. We should pay attention to that more than 80% motorcycle accidents didn't deal with police (shown in Table 1.). The rate of motorcycle accident is to cut down, now. After all, the most of reason of accident is the unstable characteristics, high mobility, turn arbitrarily and to go through the motorcade arbitrarily.

Table 1. The experience of accident of motorcycle users

Year	Non-accident	Accident	Total	How to deal with accidents		Total
				by police	by others	
1997	84.6%	13.4%	100%	17.8%	82.2%	100%
1999	88.8%	11.2%	100%	19.9%	80.1%	100%
2001	89.8%	10.2%	100%	24.8%	75.2%	100%

Specially, study for the traffic accident data in 2001, the major pattern of accidents is two motorcycles collision (33.4%), collide with passenger car (32.6%), but collision by themselves (28.2%), pedestrians (4.4%) and truck or bus (1.4%), shown as Table 2.

Table 2. The patterns of accident of motorcycle

Collision	Self- collision	Pedestrians	Two motorcycles	Passenger Car	Truck or Bus	Total
Percentage	28.2%	4.4%	33.4%	32.6%	1.4%	100%

4. ANALYZE THE MOTORCYCLE ACCIDENTS WITH CHAIN CODE

The chain code method is a popular end efficient method for contour coding, and has a variety of research field. Freeman introduced the concept in 1961; who described a method with the encoding of arbitrary geometric configurations. The method is to combine series of unit vector. These vectors contain several directions, which can be four, six or eight vectors. The vector defines a code that can be simple and efficient to encode the grid, and various collision features should be computed directly from the field sheet of accidents. Shown as in Figure 4.

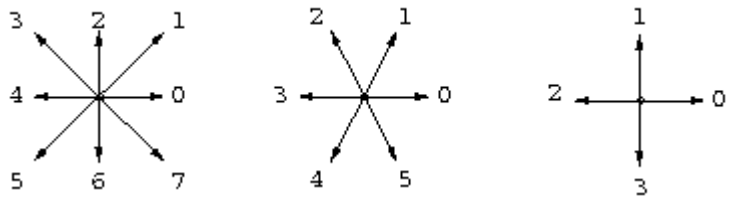


Figure 4. The vector encoding with chain code

In traffic accident, the cause reasons are complicated, and difficult to describe. There will be many different point of collision among the same pattern. The study for different point of collision in motorcycle accident, encode to chain code model, and find out the cause of accident in chain code, which can help us know how to enhance the driver security and develop the advanced safety system in motorcycle. According the types of collision of motorcycle in Taiwan, were divided to four categories, as opposite direction, same direction, crossing, and merging, shown as Table 3. From the summation the types respectively, shown as Table 4. The vector code number 2 and 3 occurred frequently, next were vector code number 4 and 1. The reason coursed with the driving along right-hand side in Taiwan, so the collision of the motorcycle had mostly with the chain code 1, 2, 3 and 4. The chain code 7 and 6 during back of right-hand side driving and the collisions were less than the chain code 1, 2, 3 and 4. In general, the side collision of motorcycle usually coursed serious injures to driver. The first job, now, what should to equip to prevent the collision of motorcycles. In the opposite collisions, were usually happened to change direction suddenly. The most important courser is not to find out the opposite direction condition, and change the direction. It's very dangerous to overtake a car at unsuitable time, the chain code distribution of this type shown as Figure 5. In the same direction collisions, were usually happen to a side collision and the rear collision of vehicle. The motorcyclists didn't pay attention to the some direction and chain code distribution of this type shown as Figure 6. In the crossing collisions, were usually happen to a turn on the corner. Basing the traffic law, the vehicle change direction must to turn on the signal of turning, but many drivers neglected to turn on the signal when change the direction. It's necessary to equip an automatic signal device of turning, and chain code distribution of this type shown as Figure 7. In the merging collisions, were usually happen to a side collision. Because the unstable characteristics of motorcycle come into motorcyclist fall down easily. It's necessary to equip a device to prevent falling down, and chain code distribution of this type shown as Figure 8.

Table 3. The type of collision in motorcycle to encode the chain code

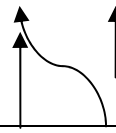
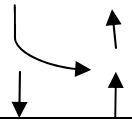
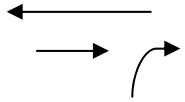
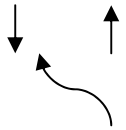
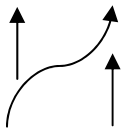
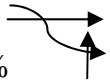
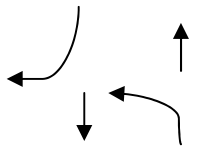
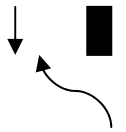
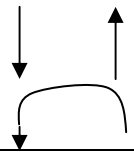
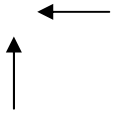
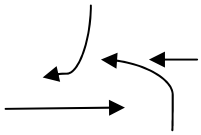
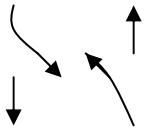
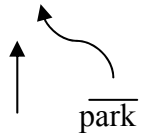
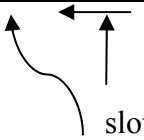
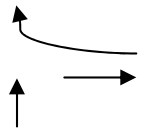
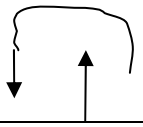
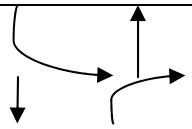
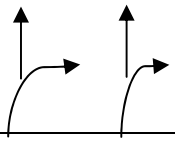
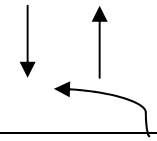
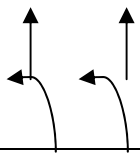
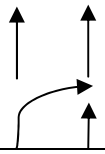
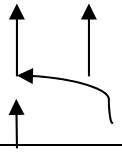
	Opposite direction	Same direction	Crossing	Merging
Type of collision				
Code	123	0123456512	232104	21073456
Type of collision			 35% no traffic signal	
Code	12323445	345123467	234210	34562017
Type of collision				
Code	12323443	123456321076	2103234	34561072
Type of collision		 park	 slow	
Code	0123401234	34561076	012234	2162560
Type of collision				
Code		123567	345612	34562107
Type of collision				
Code		1073456	234521307	
Type of collision				
Code		3451076	3211072	
Type of collision				
Code			1072345	

Table 4. The total encode chain code type of collision in motorcycle

Collision type	Chain code
Opposite direction	12312323445123234430123401234
Same direction	012345651234512346712345632107634561076123567107345634510 76
Crossing	232104234210210323401223434561223452130732110721072345
Merging	21073456345620173456107221325603456 2107

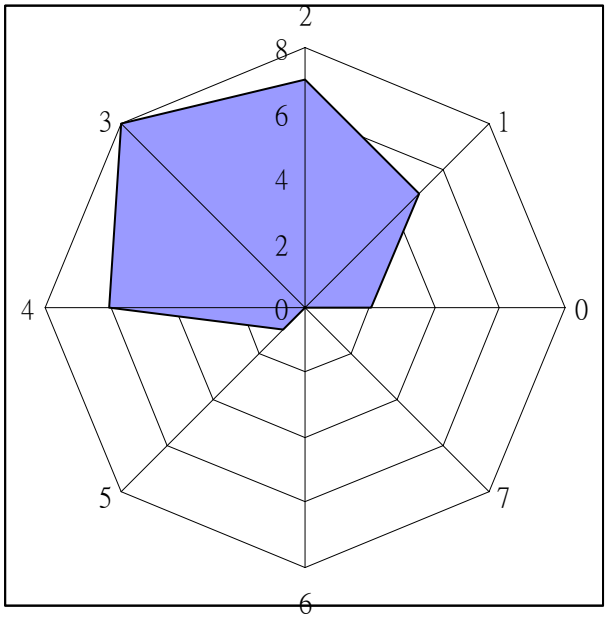


Figure 5. Chain code distribution of collision of opposite direction

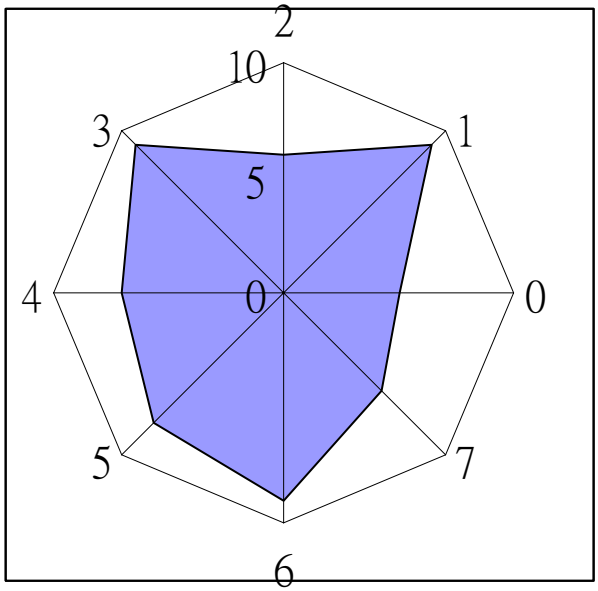


Figure 6. Chain code distribution of collision of same direction

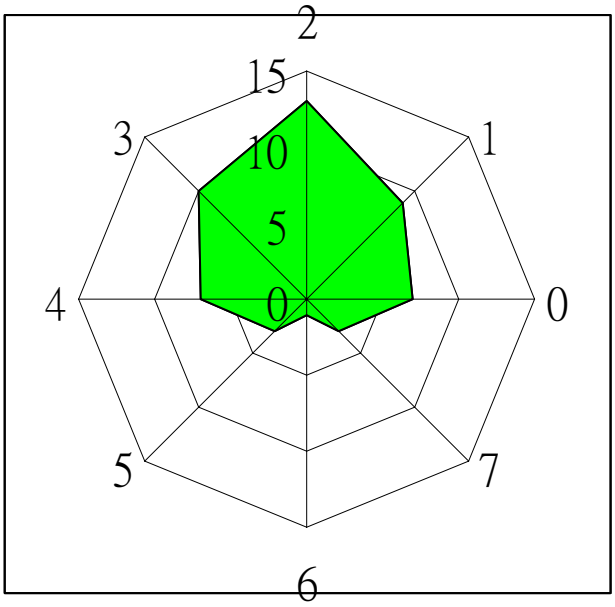


Figure 7. Chain code distribution of collision of crossing

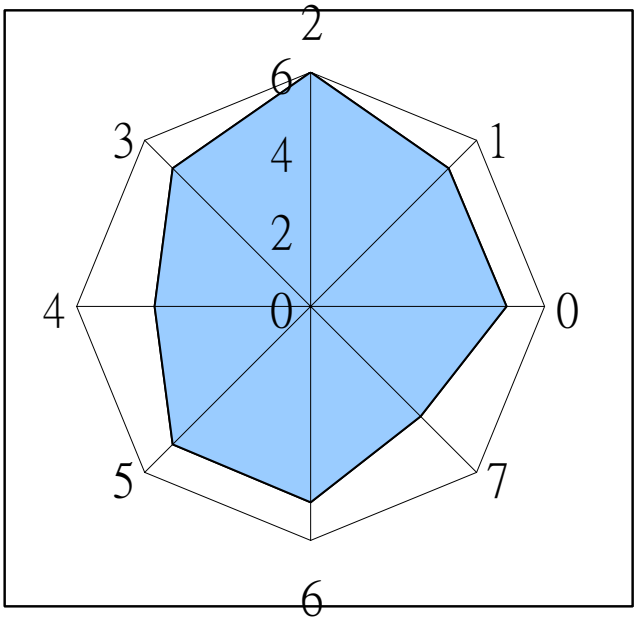


Figure 8. Chain code distribution of collision of merging

In the following, we give a brief description of the transformation strategies to be used in our proposed multiple safety devices classifier system. In the cases, the Freeman direction codes are represented in binary. (It is also possible to use other forms of binary notation to express the direction codes prior to decomposition and classifier performance is sometimes dependent on this choice). Since there are 8 possible distinct directions of motorcycle direction chain codes, 3-bit binary numbers are sufficient to represent them, for example, collision type of opposite direction chain code string, '1231232344512323443012340 1234' is decomposed

into 3 separate strings ‘00100101000001010010001000010’ on the directional layer-3 of the above, shown as Figure 9. The proposed approach in fact is a filter detecting the presence (as well as the location) of a particular direction code in a given chain. Since there are 8 possible Freeman directions, if C_i denote a chain code using directional code, such that,

$$C_i = d_1 d_2 d_3 \cdots d_n \tag{1}$$

where $d_i \in \{0,1,2,3,4,5,6,7\}$, n is the length of chain code. If we need some device prevent collision of j direction, then can transform as:

$$C_i^j = k_1 k_2 k_3 \cdots k_m \tag{2}$$

$$\text{where } k_m = \begin{cases} 0, & if\ d_n \neq j, or\ n \neq 3m \\ 1, & if\ d_n = j \end{cases} \tag{3}$$

The safe systems of the motorcycle, as characteristics are different from cars. Having the special requirement in safety system in motorcycle, so the safety devices in Table 5. A survey for user preference and demand was processed in 2002. It’s shown the safety system and the emergency support system in motorcycle, for example, such as Clearance Alarm Systems could provide the protection of train code ‘123’, transform to binary strings ‘001’ on the directional layer-3, compared with collision type of opposite direction code string ‘00100101000001010010001000010’, missing 6 units (also known as 6 divided 30 equal to 20%). That means Clearance Alarm Systems are supposed to prevent 80% of collision type of opposite direction in motorcycles.

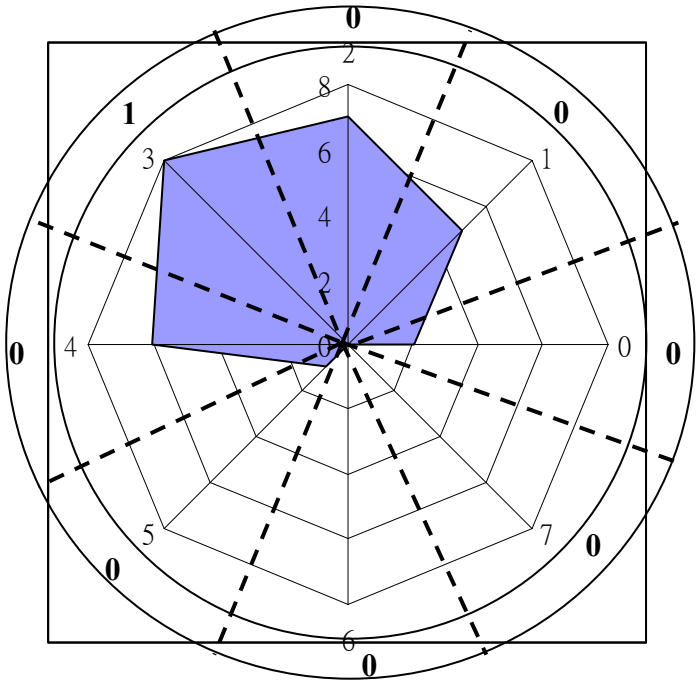


Figure 9. Directional quantization of chain-code string (example for direction/layer 3)

Table 5. The advanced safety systems for motorcycles and chain code

Safety systems	Devices	Prevent chain ode
Traffic environment wearing	Clearance Alarm Systems	123
	Collision Avoidance Systems	01234
	Cornering Collision Avoidance Systems	123
	Automatic Deceleration Systems	0134
	Road Pavement Monitor Systems	123
Vehicle condition detector	Motorcycle Condition Detectors	123567
	Intelligent Assistance Systems	123
	Light Control System	123567
	Fall Down Protection Systems	04
	Automatic Turn On Signal systems	1357
Driver assist system	Preventive Safety Systems	26
	Speed Warning Systems	123
	Visual Field Systems	04567
	Visibility Improved Systems of Helmet	123

Following the same procedure, collision type of same direction opposite direction chain code string, '012345651234512346712345632107634561076123567107345634510 76' is decomposed to '010100100010010101010100110100110011001101010100100110100100' on the directional layer-1,layer-3 and layer-6. Clearance Alarm Systems could provide the protection of train code '123', transform to binary strings '101' on the directional layer-1,layer-3 and layer-6, compared with collision type of opposite direction code string '010100100010010101010100110100110011001101010100100110100100', missing 9 units (also known as 9 divided 60 equal to 15%). That means Clearance Alarm Systems are supposed to prevent 85% of collision type of same direction in motorcycles.

Table 6. The effect of advanced safety systems for motorcycles

Devices	The effect in different collision types				Average
	Opposite direction	Same direction	Crossing	Merging	
Clearance Alarm Systems	80%	85%	81%	82%	81.50%
Collision Avoidance Systems	83%	76%	80%	82%	80.25%
Cornering Collision Avoidance Systems	79%	83%	81%	82%	81.25%
Automatic Deceleration Systems	83%	76%	74%	72%	76.25%
Road Pavement Monitor Systems	79%	83%	81%	82%	81.25%

Motorcycle Condition Detectors	76%	71%	76%	79%	75.50%
Intelligent Assistance Systems	79%	83%	81%	82%	81.25%
Light Control System	76%	71%	76%	79%	75.50%
Fall Down Protection Systems	72%	54%	74%	67%	66.75%
Automatic Turn On Signal systems	79%	69%	74%	56%	69.50%
Preventive Safety Systems	72%	83%	91%	90%	84.00%
Speed Warning Systems	79%	83%	81%	82%	81.25%
Visual Field Systems	72%	66%	74%	64%	68.00%
Visibility Improved Systems of Helmet	79%	83%	81%	82%	81.25%

5. CONCLUSION

The study of collision representations is an important part in intelligent transportation systems vision. This work deals with direction representation based on chain coding. Chain-code techniques are widely used because they preserve information and allow considerable data reduction. In the following, we give a brief description of the transformation strategies to be used in our proposed multiple safety devices classifier system. In the cases, the Freeman direction codes are represented in binary. It is also possible to use other forms of binary notation to express the direction codes prior to decomposition and classifier performance is sometimes dependent on this choice. Since there are 8 possible distinct directions of motorcycle direction chain codes, 3-bit binary numbers are sufficient to represent them. The study of accident patterns corresponding each other the demand of safety systems, and we bring out fourteen items of advanced safety systems form the four major accident pattern. Under Taiwan's complicated traffic situation, it is not enough to develop the safety vehicle and intelligent transportation system only. To provide a suitable safety system for motorcyclist is important now. The effect of advanced safety systems for motorcycles should be above 80% at least.

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