Malaysian Traffic Sign Dataset for Traffic Sign Detection and Recognition Systems

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***Abstract*—Traffic Sign Detection and Recognition (TSDR) plays a crucial role in driver assistance systems, and provides drivers with safety and precaution information. It is part of the computer vision which requires a dataset for training and testing the detection and recognition techniques. In this paper, a dataset for Malaysian TS (MTSD) is proposed in order to eliminate the gap in the previously created datasets. The MTSD includes a variety of TS scenes to be used in TS detection and images contain only TS to assist in the recognition of TS.**

***Index Terms*—Traffic Sign Detection and Recognition; Traffic Sign Dataset; German TSDR Benchmark; Synthetic Digital Images.**

I. INTRODUCTION

Traffic Sign Detection & Recognition (TSDR) is part of the on-road applications in computer vision [1]. It can be used in driver-assistance systems, highway maintenance, sign inventories and intelligent autonomous vehicles.

Similar to other computer vision applications, TSDR systems possess many problems, including lighting conditions, motion blur, vehicle speed, signs within the same category that are similar to each other, weather affecting the visibility of signs, signs that may be bent or that may not be perpendicular to the vision system, and, in the case of the urban or open roads, other objects that may appear to be traffic signs. TSDR systems have been an important issue in the area of computer vision since the first paper was introduced in Japan in 1984 [2].

In order to have a rapid progress in TS detection and recognition techniques eight standard datasets had been introduced:

1. German TSDR Benchmark (GTSDRB) [3-5]
2. KUL Belgium Traffic Signs Dataset (KULD) [6]
3. Swedish Traffic Signs Dataset (STSD) [7]
4. The Netherlands RUG Traffic Signs Database (RUGD) [8]
5. France Stereopolis Database [9]
6. United States LISA Dataset (LISAD) [1]
7. United Kingdom Online Dataset (UKOD) [10, 11]
8. Russian Traffic Sign Dataset (RTSD) [12]

GTSDRB is the widely used dataset is the GTSDRB, was created to the "The German Traffic Sign Recognition Benchmark" competition. It contains a large TS dataset suitable for detection and recognition of TS found in Germany which comply with the Vienna Convention [13]. The GTSDRB is mainly created for the classification task as each image contains only one TS with a small view of the background. Recently they attached 900 new images contains scenes from the roads of Germany can be used in the detection task. Presented in "German Traffic Sign Detection Benchmark" competition [5] but the main problem for this dataset is the lack of video data which can be used to make the detection task more robust.

The KULD includes four videos that can be used in evaluating the performance of the TSDR system also it has more classes than the GTSDRD but the tradeoff is the limited number of images. STSD has only seven classes but the images are actually extracted from the video sequence while LISAD is the most recent database that is created because of the lack of TS databases in the US. It complies with the Manual on Uniform Traffic Control Devices (MUTCD) And Standard Highway Signs and Markings (SHSM) [14, 15]. Also, it includes at least a video track for each class in the dataset.

Unlike the previously mentioned datasets, which uses offline images taken from the real world, the UKOD and RTSD use an online TS database [16, 17] and then applies many distortion techniques such as geometric distortion, blurring, and illumination variations, in trying to imitate the real world problems. This technique allows the recognition task to be done over all the TS types and avoids the process of labeling the database [11].

The previously mentioned datasets are not widely used yet except the GTSDRB. Recently synthetic images has been tested in [10, 11, 18] for the recognition task but comparing the results with the one obtained from the standard dataset is not satisfactory [12, 19]. The need for a general dataset that can be used around the world is enormously increasing.

Traffic Signs have two main standards in the world and they are the Vienna Convention and the MUTCD. Mainly across Europe, they use the Vienna Convention and U.S uses the MUTCD. Most other countries use standards that are close to one of them, or a combination of the two [20, 21].

Table 1 illustrates the information regarding the number of classes, number images, and the sizes for the images etc.

In this paper, a Malaysian Traffic Sign Dataset (MTSD) is created. Malaysian TSs are mostly similar to the TS found in the USA, the design of TSs in Malaysia must follow "ARAHAN TEKNIK (JALAN) 2A/85" found in [22]. Warning signs are diamond shaped and are yellow and black in color. Regulatory signs are round with white backgrounds, red

borders, and black pictograms. Mandatory instruction signs are round with blue backgrounds and white pictogram. The exceptions are the stop sign and the give way sign.

The MTSD is distinct from the other datasets by many unique factors that will make it discriminatory used under many conditions:

1. There is no large dataset for Malaysia previously collected.
2. The dataset is collected with different sources using Mobile, camera, and google maps.
3. There is no dataset collected while raining or at night which is a challenge to the TSDR techniques.

The Malaysian Traffic Sign Dataset (MTSD), is publicly available the following six links:

- http://vcari.net/cairo/downloads/MTSD.part1.rar
- http://vcari.net/cairo/downloads/MTSD.part2.rar
- http://vcari.net/cairo/downloads/MTSD.part3.rar
- http://vcari.net/cairo/downloads/MTSD.part4.rar
- http://vcari.net/cairo/downloads/MTSD.part5.rar
- http://vcari.net/cairo/downloads/MTSD.part6.rar

Table 1
Public Available Traffic Sign Databases

	GTSDRB (2012 & 2013)	KULD (2009)	STSD (2011)	RUGD (2003)	Stereo-plis (2010)	LISAD (2012)	UKOD (2012)	RTSD (2013)
Number of classes	43	100+	7	3	10	49	100+	140
Number of TS scenes	9000	9006	20000	48	847	6610	43509	N/A
Number of TS	39,209 training, 12,630 testing	13444	3488	48	251	7855	1200 Synthetic	80000+ Synthetic
Sign sizes	15x15 to 250x250 px	100x100 to 1628x1236 px	3x5 to 263x248 px	N/A	25x25 to 204x159 px	6x6 to 167x168 px	24x24 px	30x30 px
Image sizes	1360x800 px	1628x1236 px	1280x960 px	360x270 px	1920x1080 px	640x480 to 1024x522 px	648x480 px	1280×720 px
Include videos	No	Yes, 4 tracks	No	No	No	Yes, for all annota-tions	No	No
Country of origin	Germ-any	Belgium	Sweden	The Neth-erlands	France	United States	United Kingdom	Russia

II. DATASET COLLECTION

The dataset is composed of two different categories, the detection dataset consists of one thousand images in which the traffic signs is detected from the captured traffic sign scene. Figure 1 shows a various captured scenes and the recognition dataset which is extracted from the TS scenes to produce more than two thousand traffic signs some of them are illustrated in Figure 2.

The detection dataset is collected under different circumstances at morning and night, foggy, raining and clear weather to offspring a diversified dataset that satisfy challenging new conditions. The traffic sign scenes are ranging from having no TS to fifteen TS per scene. The collected process is done from several sources using google maps, digital camera and two different mobile cameras resulting in a pixel range from 1920x977 px (FHD) to 4592x3448 px (UHD+) which is considered to be very high. While the recognition dataset which is consists of only traffic signs extracted from the scenes is resized to a standard 32x32 px.

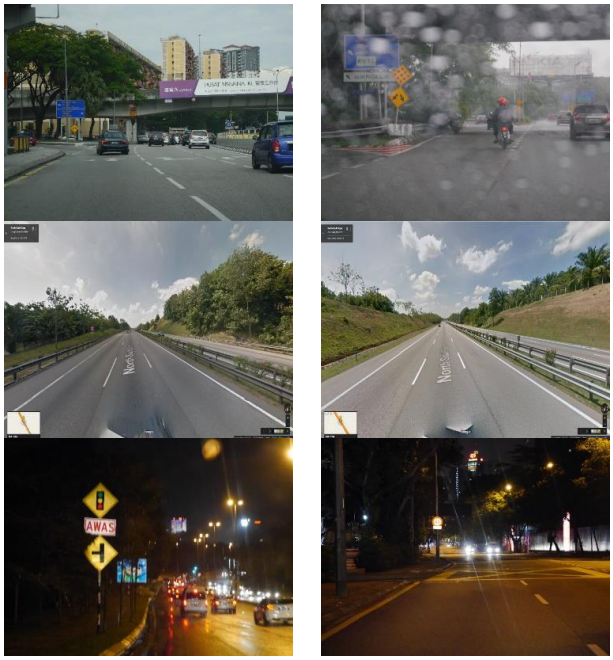


Figure 1: Various captured scenes during different conditions (daylight, raining and night) captured using a digital camera and google street maps.

Figure 2: Various traffic signs such as speed limit, road work, pedestrian crossing, traffic sign ahead and no entry.

III. DATASET STATISTICS

The detection dataset consist of one thousand scenes is explicated in Figure 3. 797 photos are taken using a digital camera to output 583 images during daylight, 139 images at night and 95 images while raining. Another 162 images are taken from google street maps during daylight and 41 images are captured by two different mobile cameras also during daylight. The resolution is recorded in Table 2.

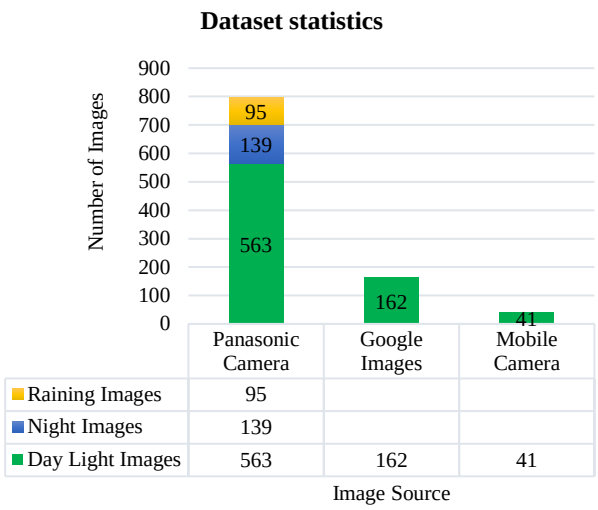


Figure 3: The number of captured scenes taken via different camera's sources under different lighting conditions.

Table 2
The captured scene's resolution

Image size	Image Source
1920x977 px (FHD)	Google Street Maps
3840x2160 px (4K UHD)	Mobile Camera
4592x3448 px (UHD+)	Digital Camera

While in the recognition dataset, TS is divided into five groups, as stated in the Malaysian TS standard, which are Warning Danger "WD", Regulatory Prohibitive "RP", Regulatory Mandatory "RM", Guide Information "GI" and Temporary "T". The TS group distribution among the one thousand images is clarified in Figure 4. Each group of TS consists of a different TS signs showed in the hierarchy in

Figure 7.

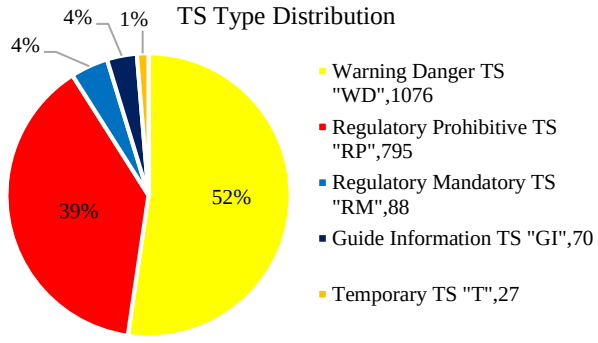


Figure 4: The TS distribution among the captured scenes.

IV. DATASET GROUND TRUTH

Ground truth by detention is the actual data (desired output) for any classification problem. It used to test the accuracy of the supervised learning techniques by comparing its classification output with the ground truth. In this dataset, the ground truth is split into two different categories one for the detection part and the other one for the recognition part.

In order to elucidate the information in the ground truth, four files are created to clarify all the information needed to describe the dataset. The "Statistics_GT.txt" shows the number of TS in each scene in addition to the weather condition and the camera source. Part of this file is shown in Figure 5. The first line shows the header name attributes, which are the File Name, Lightning, Image Source, and Number of TS

```
File Name;Lightning;Image Source;Number of TS
'1.jpg';'Day Light';'Google Street View';2
'10.jpg';'Day Light';'Google Street View';2
'100.jpg';'Day Light';'Google Street View';2
'101.jpg';'Day Light';'Google Street View';1
'102.jpg';'Day Light';'Google Street View';1
'103.jpg';'Day Light';'Google Street View';3
'104.jpg';'Day Light';'Google Street View';1
'105.jpg';'Day Light';'Google Street View';1
'106.jpg';'Day Light';'Google Street View';1
'107.jpg';'Day Light';'Google Street View';4
```

Figure 5: Sample data from the ground truth file "Statistics_GT.txt".

The second ground truth file is created to depict the TS scene which can be used in testing the detection part or detection techniques. In this file a lot of information such as the TS location, color and shape are required. All the information needed to accurately examine the detection technique is in the ground truth file "GT_Detection.txt" which a part of it is shown in Figure 6. It includes the attributes File Name, X (position), Y (position), Width, Height, TS Color, Shape, Class ID, Lightning, and Image Source.

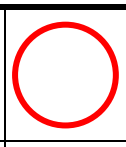
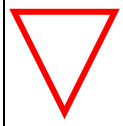
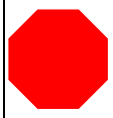
```
File Name;X;Y;Width;Height;TS Color;Shape;Class ID;Lightning;Image Source
'1.jpg';581;490;19;17;Red;'Red Circle';1;'Day Light';'Google Street View'
'1.jpg';886;483;14;14;Red;'Red Circle';1;'Day Light';'Google Street View'
'10.jpg';801;493;21;21;Red;'Directive No';2;'Day Light';'Google Street View'
'10.jpg';1157;477;23;22;Red;'Directive No';2;'Day Light';'Google Street View'
'100.jpg';638;421;38;37;Yellow;'Diamond';3;'Day Light';'Google Street View'
'100.jpg';760;415;15;14;Red;'Red Circle';1;'Day Light';'Google Street View'
'101.jpg';356;350;52;53;Red;'Red Circle';1;'Day Light';'Google Street View'
'102.jpg';633;390;32;30;Yellow;'Diamond';3;'Day Light';'Google Street View'
'103.jpg';1026;369;42;46;Yellow;'Diamond';3;'Day Light';'Google Street View'
```

Figure 6: Sample data from the ground truth file "GT_Detection.txt".

In order to understand the attributes in "GT_Detection.txt", Table 3 shows all the TS classes found in the Dataset in addition to its ID, shape and color and these are the attributes that can be found is this ground truth file.

Figure 7: Standard TS hierarchy illustrates the class, class ID, name, and amount of each traffic sign.

Table 3
The TS class ID, shape, and color

TS					
Class ID	1	2	3	4	5
TS Shape	Red Circle	Directive No	Diamond	Rectangle	Blue Circle
TS Color	Red	Red	Yellow or Orange	Blue	Blue
TS					
Class ID	6	7	8	9	10
TS Shape	Flip Triangle	Regulatory No	No Entry	Pentagon	Octagon
TS Color	Red	Red	Red	Yellow	Red

In the recognition part, any supervised learning algorithms must know the actual output or class in order to train the model. The information required to train or test the recognition technique is in the ground truth file named "GT_Recognition.txt" which includes the attributes File Name, Sign Type, Sign Group, Sign Class, TS Class, Class ID, Lightning, and Image Source, part of it is shown in Figure 8.

```
File Name;Sign Type;Sign Group;Sign Class;TS Class;Class ID;Lightning;Image Source
'1_1.jpg';'RP';7;60;'RP',7,60;22;'Day Light';'Google Street View'
'1_2.jpg';'RP';7;60;'RP',7,60;22;'Day Light';'Google Street View'
'10_1.jpg';'RP';8;3;'RP',8,3;28;'Day Light';'Google Street View'
'10_2.jpg';'RP';8;3;'RP',8,3;28;'Day Light';'Google Street View'
'100_1.jpg';'WD';16;1;'WD',16,1;46;'Day Light';'Google Street View'
'100_2.jpg';'RP';7;60;'RP',7,60;22;'Day Light';'Google Street View'
'101_1.jpg';'RP';7;60;'RP',7,60;22;'Day Light';'Google Street View'
'102_1.jpg';'T';1;1;'T',1,1;34;'Day Light';'Google Street View'
'103_1.jpg';'WD';23;1;'WD',23,1;49;'Day Light';'Google Street View'
'103_2.jpg';'WD';36;1;'WD',36,1;62;'Day Light';'Google Street View'
'103_3.jpg';'RP';7;50;'RP',7,50;21;'Day Light';'Google Street View'
'104_1.jpg';'GI';9;1;'GI',9,1;1;'Day Light';'Google Street View'
'105_1.jpg';'GI';9;1;'GI',9,1;1;'Day Light';'Google Street View'
```

Figure 8: Sample data from the ground truth file "GT_Recognition.txt".

To realize the information in "GT_Recognition.txt", Table 4 shows all the sixty-six TS classes in the Dataset with its class and ID number. The TS class is actually a combination of three attributes which are Sign Type, Sign Group, and Sign Class as stated in [22]. Sign type is one of these categories Warning Danger "WD", Regulatory Prohibitive "RP", Regulatory Mandatory "RM", Guide Information "GI" and Temporary "T". Each sign type may have more than one group for example, "RM" sign type has only one sign group while the "RP" ten different sign groups. Also, the sign group may have more than one sign class. As in speed limits "RP,7" the number of sign classes are nine sign classes one for each speed limit sign and in "GI,9" is only one sign class.

All the previously mentioned ground truth files was created using a developed GUI tool using Matlab R2015a to automatically insert all the required information found in the TS scene (Figure 9). The developed GUI shows the TS scene to the right allowing the user to "Select the ROI" by click on the button. Then, a drag-able rectangle is visible to select the TS. The position of the rectangle (TS) is known by the left upper point ("X" and "Y") and the "Width" and "Height" of the drag-able rectangle. In the field of "Class ID", the user must enter the full ID that includes Sign Type, Sign Group and Sign Class separated by a semicolon. Finally, the "Time of the Day" and "Camera Type" must be adjustable to meet the scene conditions. By click "Save ROI" the information is stored in the main ground truth file "GT.txt" and the "ROI Count" incremented by one. If there is another TS in the same scene the same process must be done until all the TS information is correctly stored in the file. Moving to the next scene is done by clicking the "Next Image" button.

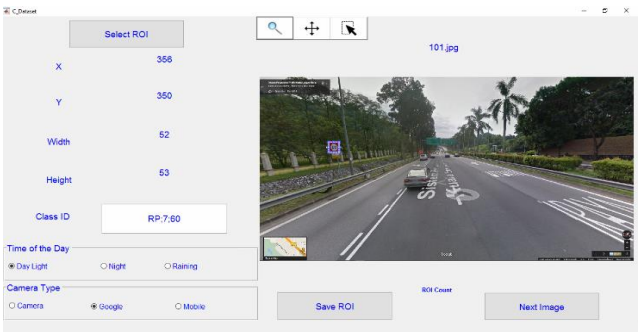


Figure 9: Screenshot capturing the developed GUI.

The main ground truth file "GT.txt" combining all the data related to the detection and the recognition parts. This file can be used when the user or developer wants to deal with that dataset as one part starting from the scene and ending up with the TS location and its category. This file has many attributes as shown in Figure 10.

V. CONCLUSIONS

In this paper, a new MTSD is presented which introduces new circumstances to be added the existing TS datasets. The proposed MTSD is the first TS dataset to include a TS scenes which are taken at night and during the rainy weather. Also, the MTSD has a variety of different resolutions ranging from the Full High Detention (UHD) to more than Ultra High Detention (UHD). It has a total of 1000 TS scenes which can be used to evaluate any detection technique and a total of 2056 TS images used in the evaluation of any recognition technique. All the ground truth data is reported in separate files which allow the automatic performance calculation of any detection or recognition technique

Future work should focus on applying the proposed MTSD to detection and recognition technique to compute and analyze the performance. Also, apply distortion techniques such as geometric distortion, blurring, and illumination variations to the

recognition dataset in order to expand the amount of TS images in the dataset.

Table 4
The TS class and TS ID

TS								
TS Name	U-turn	Keep right	Keep left	Pass either side	Compulsory motor-cycles track	Stop	No Left Turn	No right turn
TS Class	'GI',9,1	'RM',1,5	'RM',1,6	'RM',1,7	'RM',2,3	'RP',1,1	'RP',2,1	'RP',2,2
TS ID	1	2	3	4	5	6	7	8
TS								
TS Name	No U-turn	No entry	Weight limit sign 5T	Weight limit sign 30T	Height limit sign 2.-m	Height limit sign 3.-m	Height limit sign 4.-m	Height limit sign 5.-m
TS Class	'RP',3,1	'RP',4,1	'RP',5,5	'RP',5,30	'RP',6,2	'RP',6,3	'RP',6,4	'RP',6,5
TS ID	9	10	11	12	13	14	15	16
TS								
TS Name	Height limit sign 6.-m	Speed Limit 20	Speed Limit 30	Speed Limit 40	Speed Limit 50	Speed Limit 60	Speed Limit 70	Speed Limit 80
TS Class	'RP',6,6	'RP',7,20	'RP',7,30	'RP',7,40	'RP',7,50	'RP',7,60	'RP',7,70	'RP',7,80
TS ID	17	18	19	20	21	22	23	24
TS								
TS Name	Speed Limit 90	Speed Limit 110	No Entry for Vehicles Exceeding 5T, Trucks etc.	Heavy vehicles, no driving on right lane	No Parking	No Stopping	Give way	Wide limit 3.5m
TS Class	'RP',7,90	'RP',7,110	'RP',8,1	'RP',8,3	'RP',10,1	'RP',11,1	'RP',13,1	'RP',14,3
TS ID	25	26	27	28	29	30	31	32
TS								
TS Name	No overtaking	Road Work	Camera operation zone	Crosswind area	Caution! Hump	Hump ahead	Towing zone	Left bend
TS Class	'RP',17,1	'T',1,1	'WD',5,1	'WD',6,1	'WD',7,1	'WD',7,2	'WD',8,1	'WD',10,2
TS ID	33	34	35	36	37	38	39	40
TS								
TS Name	Slippery road	Pedestrian crossing opt1	Pedestrian crossing opt2	School children crossing opt1	School children crossing opt2	Caution	Narrow roads on the left	Traffic lights ahead
TS Class	'WD',13,1	'WD',14,1	'WD',14,2	'WD',15,1	'WD',15,2	'WD',16,1	'WD',21,1	'WD',22,1
TS ID	41	42	43	44	45	46	47	48
TS								
TS Name	Obstacles ahead	Staggered junctions	Crossroads T-junction	Crossroads to the right	Crossroads to the left	Exit to the left	Crossroads	Minor road on right
TS Class	'WD',23,1	'WD',25,1	'WD',27,1	'WD',27,2	'WD',27,3	'WD',27,5	'WD',27,6	'WD',28,1
TS ID	49	50	51	52	53	54	55	56
TS								
TS Name	Minor road on left	Minor road on left opt2	Cattle crossing	Roundabout ahead	Narrow bridge	Split way	Two way road	Divided road ending
TS Class	'WD',28,2	'WD',28,3	'WD',30,1	'WD',31,1	'WD',35,1	'WD',36,1	'WD',37,1	'WD',38,1
TS ID	57	58	59	60	61	62	63	64
TS								
TS Name	Curve on the left	Crossroads Y-junction						
TS Class	'WD',38,3	'WD',42,1						
TS ID	65	66						

```
File Name;X;Y;Width;Height;Sign Type;Sign Group;Sign Class;TS Class;Class ID;TS Color;Shape;Shape ID;Lightning;Image Source
'1.jpg';581;490;19;17;'RP';7;60;'RP',7,60;22;Red;'Red Circle';1;'Day Light';'Google Street View'
'1.jpg';886;483;14;14;'RP';7;60;'RP',7,60;22;Red;'Red Circle';1;'Day Light';'Google Street View'
'10.jpg';801;493;21;21;'RP';8;3;'RP',8,3;28;Red;'Directive No';2;'Day Light';'Google Street View'
'10.jpg';1157;477;23;22;'RP';8;3;'RP',8,3;28;Red;'Directive No';2;'Day Light';'Google Street View'
'100.jpg';638;421;38;37;'WD';16;1;'WD',16,1;46;Yellow;'Diamond';3;'Day Light';'Google Street View'
'100.jpg';760;415;15;14;'RP';7;60;'RP',7,60;22;Red;'Red Circle';1;'Day Light';'Google Street View'
'101.jpg';356;350;52;53;'RP';7;60;'RP',7,60;22;Red;'Red Circle';1;'Day Light';'Google Street View'
'102.jpg';633;390;32;30;'T';1;1;'T',1,1;34;Yellow;'Diamond';3;'Day Light';'Google Street View'
'103.jpg';1026;369;42;46;'WD';23;1;'WD',23,1;49;Yellow;'Diamond';3;'Day Light';'Google Street View'
'103.jpg';1025;420;42;46;'WD';36;1;'WD',36,1;62;Yellow;'Diamond';3;'Day Light';'Google Street View'
'103.jpg';721;439;20;19;'RP';7;50;'RP',7,50;21;Red;'Red Circle';1;'Day Light';'Google Street View'
'104.jpg';660;409;17;24;'GI';9;1;'GI',9,1;1;Blue;'Rectangle';4;'Day Light';'Google Street View'
'105.jpg';272;392;55;64;'GI';9;1;'GI',9,1;1;Blue;'Rectangle';4;'Day Light';'Google Street View'
```

Figure 10: Sample data from the main ground truth file "GT.txt".

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