Over-height Vehicle Detection System in Egypt

M. A. Massoud

***Abstract*— This paper presented a new technique of over-height vehicle detection. This technique was advanced driver assistance system to reduce collisions between motorists and overhead structures. The proposed technique was design by three different methods; mechanical, optical, and image processing method. The technique achieved at a real-time operation. This technique consisted of three stages; overhight detection, driver alert, and traffic administration unit. License plate recognition (LPR) was used at traffic administration unit. The system was robust, and had accurate performance.**

***Index Terms*— Overhight vehicle, License plate recognition, Camera calibration, Driver alert, traffic administration unit.**

I. INTRODUCTION

Accidents are the results of human errors such as; high speed, careless drive, overweight trunk, overhight trunk, and errors of the infrastructure road design.

Overhight trunks cause less control drive or collisions with bridges and tunnels which cause structures and vehicles damage. Therefore overhight vehicle is one of the most important reasons which cause accidents.

The proposed system is used to over-height trunk detection. The technique uses sign and sound message to alert over-height trunks before bridges. The system had ability to recognize the license plate of over-height trunk. Moreover, the system transmits license plate numbers of over-height trunk to traffic administration.

There are many studies of overhight vehicle collisions [1-6]. The objective of these studies is to assess the magnitude of overweight vehicle collisions with highway bridges which caused structural damage, and injuries. By statistics on over-height collisions in these studies, the importance to apply this technique is illustrated.

License plate recognition and application is attracted field to develop systems. Therefore, several techniques have been used to implement that by using template matching theorem [7, 8], artificial neural network [9-12], threshold techniques [13], and fuzzy logic system [14]. The vision sensors and computer vision algorithms are used in researches [15-17] to calculate traffic parameters.

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II.METHODLOGY

The proposed technique consists of three stages; overhight detection, driver alert, and traffic administration unit. Figure (1) shows the block diagram of the proposed technique.

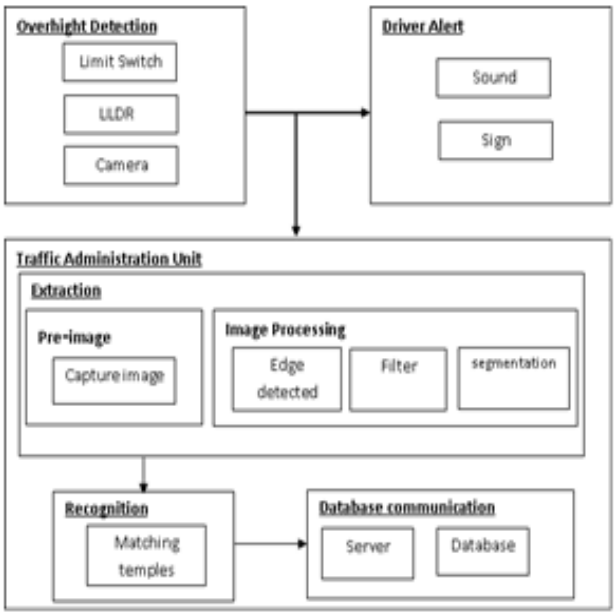

Fig1. The block diagram of the proposed technique.

2-1 Overhight detection:

The aim of this stage is to detect the overhight vehicles. The proposed technique uses three methods to demonstrate which a suitable method to recommend applying in Egypt is.

Overhight detection methods are depending on types of sensors which are used. Limit switch (LS), laser& light dependence resistor (LLDR), and camera are sensors which are used. LS and LLDR are mechanical and optical sensors for sensing and detecting vehicles at specific height, but camera (image processing method) can determine the height of a trunk that is higher than a bridge.

Camera Calibration and Height Estimation

To determine the vehicles height a camera is calibrated. The camera can be modeled as a projective pinhole [18] to map world points $P([x_w\ y_w\ z_w]^T)$ of a 3D point position in World coordinates to image points p $([u\ v\ 1]^T)$ of a 2D point

ISBN: 978-988-19252-8-2
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

position in Pixel coordinates according to the following relationship:

$$p = MP \quad ---------- (1)$$

Where M is projection matrix. Projection matrix has intrinsic and extrinsic parameters of a camera. The camera's location and orientation in the world can be represented by extrinsic parameters(C), but intrinsic parameters (A) are the relationships between pixel coordinates and camera coordinates.

$$p = A[C]P \quad --------(2)$$

$C = [R\ T]$

R Rotation

T Translation

$$z_c \begin{bmatrix} u \\ v \\ 1 \end{bmatrix} = A \begin{bmatrix} R & T \end{bmatrix} \begin{bmatrix} x_w \\ y_w \\ z_w \\ 1 \end{bmatrix} \text{------(3)}$$

The matrix M essentially captures the relationship between image and scene points, and allows one to extract metric information from image coordinates. Each point in the image corresponds with a world line passing through the camera center.

After calibrated camera, the vehicle high can be calculated using the following simplified formula.

$$\text{Real height (mm)} = \frac{\text{distance to object (mm)} \times \text{object height (pixels)} \times \text{sensor height (mm)}}{\text{focal length (mm)} \times \text{image height (pixels)}} \quad (4)$$

In this system, another camera is used to recognize the license plate for overhight vehicles. Figure (2) shows the system flowchart.

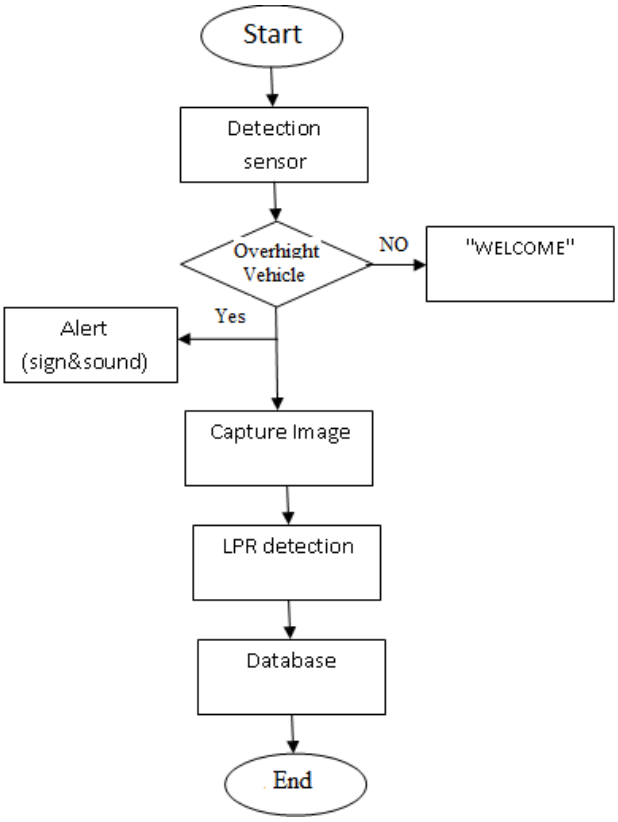

Fig 2. The system flowchart.

2-2 Driver Alert:

When an overhight vehicle tries to pass from the bridge the accident will occur. To prevent the vehicle from accident, the system has ability to announce drivers by sign and voice alerts. By using these alerts the drivers can take corrective action. There are two types of sign alert; traffic arrow sign, and LCD board. If the vehicle is overhight, LCD will appear "Turn". If the vehicle can pass from the bridge, LCD board will appear "Welcome". Traffic arrow sign is a light arrow sign which guides the driver to turn. Figure (3) shows the sign alerts of the proposed technique.

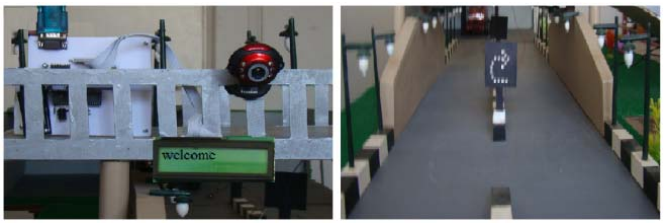

Fig 3. The sign alerts of the proposed technique.

ISBN: 978-988-19252-8-2
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

Voice alert is an important to declare the driver at overhight vehicle by sound. The sound message told him that he must be turn. Figure (4) illustrates the hardware circuit diagram of the technique.

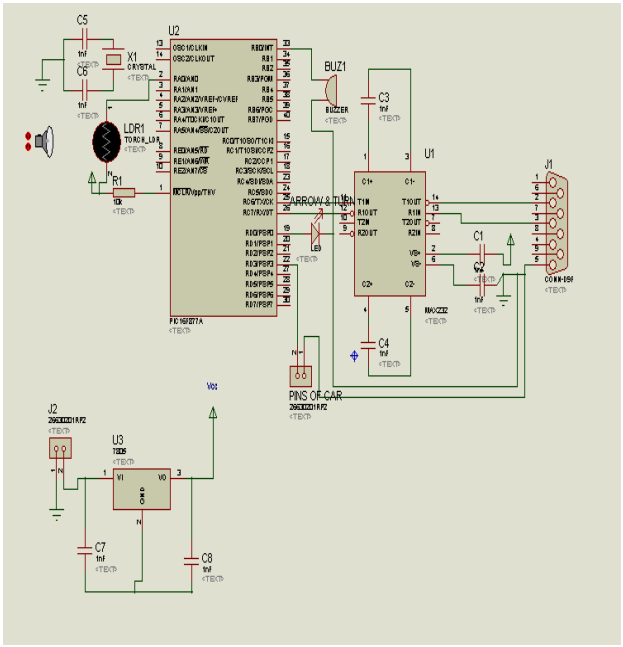

Fig 4. The hardware circuit diagram.

2-3 Traffic Administration Unit:

When the overhight vehicle is detected by sensor, the sensor will send a signal throw two directions. The first direction goes to driver alert unit, and the second goes to traffic administration unit. In traffic administration unit the second camera will work to capture the image of overhight vehicle. This stage is the same as algorithm [19]. It consists of two substages; LPR, and database communication.

2-3-1 LPR:

LPR consists of extraction and recognition steps. In extraction the camera captures the image of overhight vehicle and processing this image using the following algorithm;

- Edge detection:
  The Sobel edge detector is used to find rectangle of plate using dilation and erosion.
- 2D filter :
  2D median filter mask 5×5 is used to filter and smooth the eroded image.
- Segmentation:
  It is applied to separate and cut the characters and numbers of Egyptian plate with fixed size. Figure (5) shows Egyptian plate before and after segmentation.

Fig 5: Egyptian plate before and after segmentation.

- Recognition:
  In this step the database of characters and numbers were saved and correlated with characters and numbers of vehicle to find LPR of this vehicle.

2-3-2 Database Communication:

Database communication uses server and database. The User Datagram Protocol (UDP) is used to send and receive data through wireless network among the servers of the cities. Database can record the faults of overhight vehicles. Database is built by using Microsoft access database.

III RESULTS

The objective technique has been tested for a wide variety of situations and operational conditions. Table I shows the experimental results of the technique.

Table I
The experimental results of the technique.

Number of vehicles		Detected Vehicles by Mechanical Method	Detected Vehicles by Optical Method	Detected Vehicles by Camera Method
Overhight vehicles	6	6	6	6
Vehicles (can path from bridge)	3	0	0	3

The system is design to detect over-height vehicles, so that the performance of the three methods has been proven to be excellent results. The warning systems (sound and sign) work for all methods, but camera method is the best of them. The camera method has ability to estimate height of the vehicles.

IV. CONCULSIONS

The proposed technique was design by three different methods. The technique achieved at a real-time operation. Moreover, it was not sophisticated and simple. The results

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ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

proved the efficiency of the system and its applicability to the field of advanced driver assistance. The technique had many advantages; it could detect overweight vehicles, warn drivers to take corrective action, reduce exposure to costs associated with incidents or accidents, and warn traffic administration to overweight vehicles.

The camera method was the best method. In Egypt, LLDR method was recommended to be used because of lower cost and maintenance than the camera method.

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ISBN: 978-988-19252-8-2
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)