CCE535 Graduation Project (1)

“ Radar System Design”

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Advanced Computer Networks

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SUMMARY

This project covers aspects of .....

ACKNOWLEDGMENT

First of all, countless thanks to ALLAH the almighty

I would like to thank .....

Project Team Members

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NOMENCLATURE

b_f	The motor friction coefficient.
e_a, e_b and e_c	The trapezoidal induced emfs.
$\frac{d}{dt}$	The derivative operator.

ABBREVIATIONS

AMB	Active Magnetic Bearing.
$BLDC$	Brushless Direct Current.
$CATIA$	Computer Aided Three-dimensional Interactive Application

Chapter 1

INTRODUCTION

This project encompasses aspects of .....Radar System design can control the rotor position with an accuracy of a micrometer [1].

1.1 Project idea

We are considering providing a complete radar system that will help to reduce the number of accidents on the highways by implementing a system that is used for car speed detecting and fast recognizing the detail of the plate of the car. This system is considered to be better than the existing road radars and provide new features that will lead to high accuracy, fast detecting, plate recognition and plate's details extraction at every radar unit then send the details to the responsible authority to take the necessary action with the car driver. This System will meet our specifications in a simple way with a simple radar circuit that provide the signal for detecting the cars in an electromagnetic wave, then make a simple hardware circuit that provide the speed of the detected car by calibration to give an order to the camera to picture the over speed cars. After that the license plate of the car will be extracted from the car picture and then extract the ARABIC letters and numbers from the plate, and then send these contents to the responsible authority by an automatic E-mail. In addition to that the old system is considered to be expensive (approx 10,000$) and this system is considered to be maximum 2000$ and this value is rising according to road type.

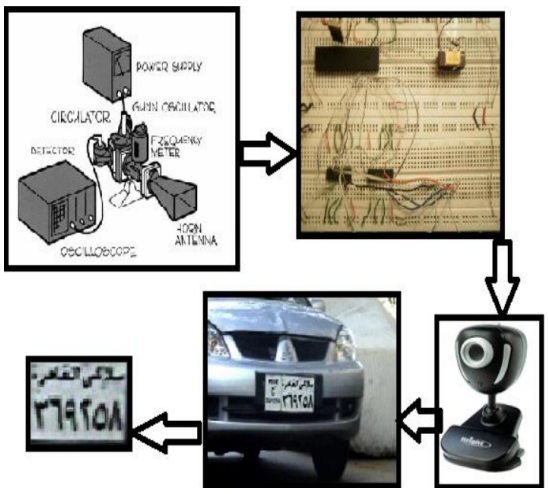
1.1.1 Main Description:

When the car moves in front of the radar circuit, the radar calculates the car's speed by using the main characteristics of Doppler frequencies. The output of the radar is voltage varying from 0 to 50 m volt. Get the output voltage of the radar and turn it into the ADC circuit to convert it from analogue dc volt form to digital output, where the computer can deal with it. The output of the interface will be 8-bits, and then it will vary from 0 to 255.So we need to do our calibration for determining the car's speed with specific software. After detecting the car speed, we have to give an order to the camera to capture this car if it moving over speed and if it's not moving over speed just determines the speed of it. After taking the photo for the car we have to does some processing on it to get recognize the license plate. After recognizing the plates, we extract the information of the plate and report it.

Project Description

The radar system is consists of 4 phases:

- Radar circuit.
- Analogue to digital interface.
- Software's programming for reading the digital input, calibration for the car speed, give an order to the camera to capture the car.
- Finally the image processing software to recognize the plate of the car.



1.1.2 Project requirements:

- Information about Radar system.
- Radar wave generator circuit.
- Analogue to digital interface.
- Software for reading from the parallel port.
- Software for speed calibration.
- Software for image processing and determining the plate's contents.

1.2 Methodology

The main goal of this project is to minimize the number of accidents per years, which occurs all over the roads, by punishing the drivers that cross the speed limits. So we can achieve this goal by following some steps to get this idea.We use the radar to detect a moving car along the road which the radar will be located. After that by the output of the radar circuit, we get the output voltage and convert it to digital form that will be used for measuring the car's speed. Then the next phase is to order the camera by the input value of the speed of the car to Taking a photo for the car if it moving over speed. After saving the image of the car, we make a number of operations that will be helpful for analyzing the image, and detect the plate contents to report it. The last part of the system is to take details of the car's plate after extract the contents of the plate and sending the car details to the responsible authority.

1.3 Project objectives

1.3.1 HARDWARE & NETWORK PLATFORMS:

We will use for converting from analogue to digital a specific hardware elements that will help and make it more simple for implementing the hardware. We will use a microcontroller for converting from analogue to digital.

1.3.2 Programming Languages:

- We will use micro C for the program of the microcontroler which will be used for analogue to digital converter(ADC).
- Proteus for circuit simulation.
- Csharp and Matlab for inetrface.
- Matlab for calibration and license plate recognetion(LPR).

1.3.3 KEY PROJECT BENEFITS:

1. Detect the speeding cars automatically.
2. Using radar to measure speed of the car to avoid accident.
3. Reduce human element which reduce errors.
4. Easy handling and low cost.
5. Make the road safer.

Now we will speak about each one of the system componentsto describe every operation in each part and how it will be connected wih the other phase. Chapter 2 will be about the radar circuit,its components and the doppler shift which is the main idea of the radar operation In chapter 3, chapter 4 we will mention in it how to design the hardware interface and how it will operate to convert the output analogue signal from the radar circuit to digital form to can be easly recognized by the computer by attached the parallel cable with the interface and the computer. Chapter 5 will be about when the camera will picture the moving cars, recognizing informationof the plate of the car and send these information automaticaly by e-mail to responsible authority. At chapter 6 , software engineering is about the flow chart of the system, constraints and the duration and tasks implementation.

Chapter 2

Radar

This chapter presents ...

2.1 SD

.....

2.2 SYD

The proposed system is designed using the procedure given in .....

STEP 1: Arm and .....:

For payload and arm with the specifications given in Table **??**, the maximum load Torque, T_{Lmax}, when the arm is horizontal, is calculated from the following equation:

$$T_{Lmax} = (0.15\ m_p + 0.075\ m_a)\ g \tag{2.1}$$

Hence, the maximum load torque is equal 0.71 Nm.

STEP 2: .....: ..... See Appendix A.

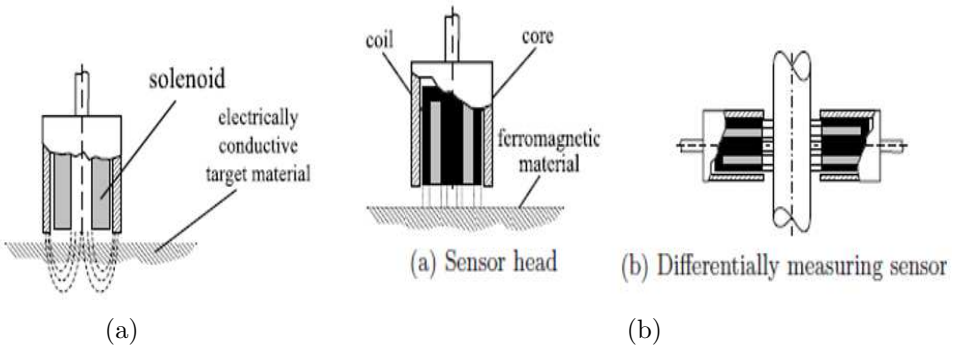
2.3 MS

In this system..... Nevertheless, ...

The second type ..... The most common sensor for this function is ..... shown in Fig. **??**.

Table 2.1: Arm and payload parameters

	Payload	**Arm**
Dimension (mm)	40x40x20	150x40x10
Mass (kg)	$m_p = 0.25$	$m_a = 0.47$
C.G. Location (m)	0.15	0.075



(a) (b)

Figure 2.1: Air gap measuring sensors (a) Eddy current displacement sensor, (b) Inductive displacement sensor.

2.4 ABC

.....

2.4.1 SUB1-ABC

.....

2.4.2 SUB2-ABC

.....

Chapter 3

SYSTEM DYNAMIC MODEL

This chapter presents .....

3.1 B

The .....:

$$\begin{bmatrix} v_a \\ v_b \\ v_c \end{bmatrix} = \begin{bmatrix} R & 0 & 0 \\ 0 & R & 0 \\ 0 & 0 & R \end{bmatrix} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} L_s - L_m & 0 & 0 \\ 0 & L_s - L_m & 0 \\ 0 & 0 & L_s - L_m \end{bmatrix} \frac{d}{dt} \begin{bmatrix} i_a \\ i_b \\ i_c \end{bmatrix} + \begin{bmatrix} e_a \\ e_b \\ e_c \end{bmatrix} \tag{3.1}$$

.....with a maximum magnitude of $\pm$ 1.

3.2 AMBM

3.2.1 Model.

.....

3.3 MPA

.....

$$ {}^{1}H_{2} = \left[\begin{array}{ccc|c} 1 & 0 & 0 & {}^{1}x_{2} \\ 0 & 1 & 0 & {}^{1}y_{2} \\ 0 & 0 & 1 & {}^{1}z_{2} \\ \hline 0 & 0 & 0 & 1 \end{array}\right] \tag{3.2} $$

where, ${}^{1}x_{2}$, ${}^{1}y_{2}$ and ${}^{1}z_{2}$ are constants lengths.

Chapter 4

CONTROLLER DESIGN

This Chapter.....

4.1 Angle

A .....

$$U_\phi = \ddot{\phi}_d + K_p\ e + K_d\ \dot{e} + K_i \int_0^t e\ dt \tag{4.1}$$

.....

4.2 Control

with respect to the cost function

$$J = \int_0^\infty \begin{bmatrix} x(t) \\ u(t) \end{bmatrix}^T \begin{bmatrix} q & s \\ s^T & r \end{bmatrix} \begin{bmatrix} x(t) \\ u(t) \end{bmatrix} \tag{4.2}$$

Chapter 5

Results and Discussion

This chapter .....

Chapter 6

CONCLUSIONS

6.1 Conclusions

Now, we are capable of detecting the moving cars and capture the over speeding cars to recognize the license plate of the car to send it to the related authority. Another feature has been added to the system, is to extract the Arabic numbers to send the license plate contents to the related authority by sending an e-mail with an attached text file which contains the Arabic numbers. This feature will reduce the size of the attached file which will be sent to make it easier and faster to be received by the related authority.

6.2 Future work:

6.2.1 Professional cameras:

1. **Professional cameras for face detection:**

   Nowadays people are aware of the need of vehicle security due to the fact that they are various cases of car robbery. Therefore it is incumbent upon us to increase the level of securities. To make the system more secure, the system is recommended to integrate with face detection. This is means instead of identifying driver with their plate, it also important to identify by her or his face.

   We can do this by using a professional camera that contain a face detect applications, nowadays there are growing number of digital cameras now include a Face Recognition mode. The camera detects faces in a scene and then automatically focuses (AF) and optimizes exposure (AE).

2. **- Professional camera to upgrade the image quality:** We want to use more professional cameras to improve the image quality to be easier to recognize the plate numbers.

Color-ccd-digital camera

3. **- Hard and waterproof cameras:**

   We can use hard cameras to avoid damages because they are located in the streets so they can be damaged by any one, but if we use hard material or it can be put in hard box it will be safer to avoid damage. Also, we want to use waterproof cameras because it is located in the open air, so maybe it will be rained.

4. **Location of the camera:**

   The camera to vehicle distance around 40 feet. This system is able to detect license plate area for all the vehicles. We want to put the camera in the middle of the road to be able to detect any vehicles.

6.2.2 Identification of segmented character:

Save the segmented characters and numbers in one text file which may be by comparing the segmented image with an already saved one or compare it to a matrix of images in order to be ready for database.

1. **-Recognition System of Arabic Characters**

   At this stage, a recognition system of Arabic characters is presented, using a structural method based on the extraction of primitives (holes, concavities, characters form, existence of points, position of point, and number of connected components). This stage is performed in two steps; Characters classification and identification.

a) Characters classification:

The character classification takes as criteria the concavities in different directions, and the holes, which represent the main characteristics (morphological ones). The choice of these characteristics enables the system to work with multi-sized characters without having to perform an eventual normalization.

The inner details of characters such as the presence of holes and concavities are obtained to produce some unique features for some Arabic characters. The holes feature is used to identify some characters or resolve any ambiguity in the recognition phase. The presence or absence of the hole, concavities direction, and dots are powerful features for enhancing the implemented Arabic recognition system.

L: concavities to the left,

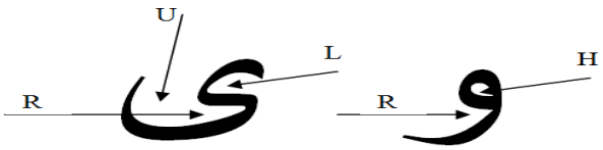
R: concavities to the right,

U: to the top,

H: character containing hole

We can compute each character's class using this formula:

$$class = 2^0 H + 2^1 U + 2^2 R + 2^3 L$$



We must study the intensity of top and down parts, if the character has the intensity of top part is smaller or greater than the intensity of the down part.

Intensity of top part >down part	م	ص	س
Intensity of top part < down part	د	ط	ل

b)Characters identification:

-Egyptian new license plates use only 17 characters from 28.

(أ – ب – ج – د – ر – س –ص – ط – ع – ف – ق – ل

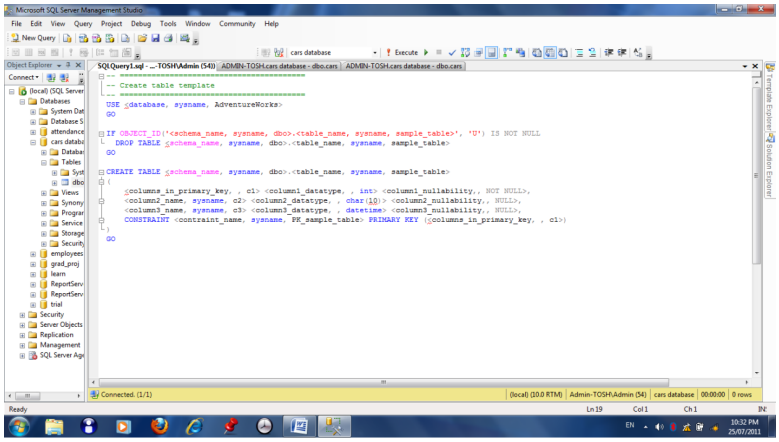
– م – ن – هـ - و- ى)

char / Feature	ر	د	م	ص	ط	ع	ل	س	هـ	و	ى
Curve left		1	1							1	1
Hole				1	1				1	1	
Curve right						1					1
Curve up				1	1		1	1			1
(Top/down) Intensity											
Thin											
Down dot location											

After that we can identify any Arabic plate character.

6.2.3 Creating a database of the system:

We use to create a data base for all the cars plate numbers and their owner identity .We use SQL to create a database for the car plate number and the name of the owner and his penalty.



6.2.4 Sending SMS

After building the database system and detecting the license plate numbers, we will use these numbers to compare it with the data base elements to extract the car owner's telephone number. After that we will use a software program to send an automatic SMS to the car owner to inform him that he has been crossed the limit speed. This program

will be designed by C# and the main function of the operation will be:

```
sms = "You've received a speeding ticket!\nSpeed: " + 150 + "\nPlace: Alexandrai ST
@ 100 KM\nTime: " + DateTime.Now + "\nBill: " + 500 + " LE";
sendSMS("COM19", "0105471662", sms);
```

We have first to attach the mobile phone to the COM port, and defining it by task manager. Then the SMS will be sent to the required number via the attached mobile phone.

6.2.5 Moving and non moving cars

Use the LPR (license Plate Recognition) in monitoring roads and detect moving parts by using video segmentation this system is used in south Africa where we can catch stolen cars by automatically recognize the car plate and search it in a database, if the passing car is identical with one of those in the black list it sends the location to the authorized persons. Detection of moving vehicles simplifies the processing on subsequent analysis steps. Due to dynamic changes in natural scenes such as sudden illumination and weather changes, repetitive motions that cause clutter (tree leaves moving in blowing wind), motion detection is a difficult problem to process reliably. Frequently used techniques for moving vehicle detection are background subtraction, statistical methods, temporal differencing and optical flow. In case we used the Background subtraction which is particularly a commonly used technique for motion segmentation in static scenes, it attempts to detect moving regions by subtracting the current image pixel-bypixel from a reference background image that is created by averaging images over time in an initialization period, The pixels where the difference is above a threshold are classified as foreground. After creating a foreground pixel map, some morphological post processing operations such as erosion, dilation and closing are performed to reduce the effects of noise and enhance the detected regions. The reference background is updated with new images over time to adapt to dynamic scene changes. While in case we used Statistical Methods which is more advanced methods that make use of the statistical characteristics of individual pixels have been developed to overcome the shortcomings of basic background subtraction methods. These statistical methods are mainly inspired by the background subtraction methods in terms of keeping and dynamically updating statistics of the pixels that belong to the background image process. Foreground pixels are

identified by comparing each pixel's statistics with that of the background model. This approach is becoming more popular due to its reliability in scenes that contain noise, illumination changes and shadow Finally both methods can detect the moving vehicle we can use one of them to reach our target and distinguish between the moving cars and the non-moving ones for any following purposes.

REFERENCES

[1] T. Higuchi, K. Oka, and H. Sugawara, "Clean room robot with non-contact joints using magnetic bearings," Advanced Robotics, vol. 7, no. 2, pp. 105–119, 1993.

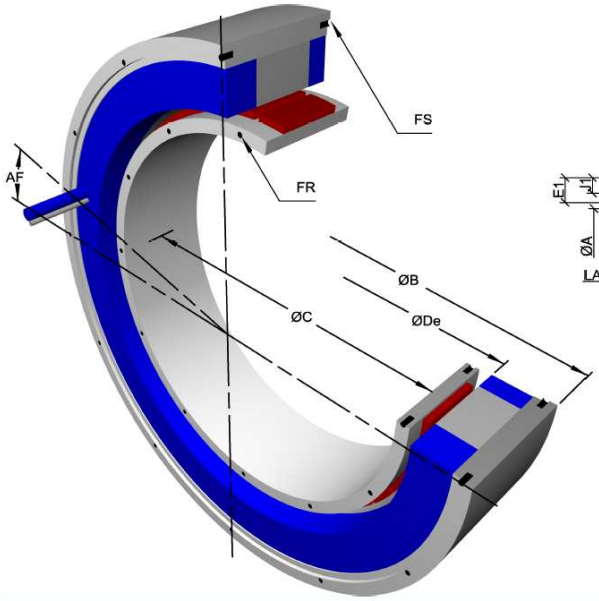
[2] T. Grochmal and U. of Alberta (Canada)., Modeling and Control of Magnetically-levitated Rotating Shafts with Active Magnetic Bearings and Self-bearing Motors, ser. Canadian theses. University of Alberta (Canada), 2008. [Online]. Available: https://books.google.com.eg/books?id=Sa6hHJfElUkC

Appendix A

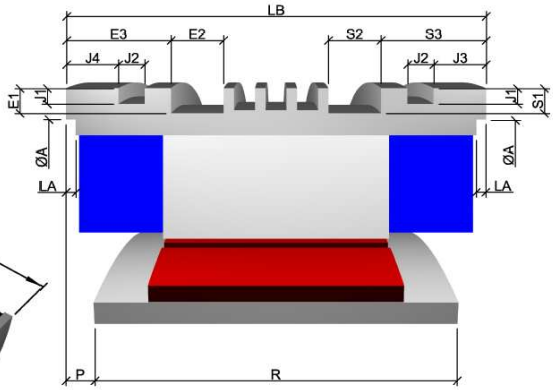
Brushless DC Motor

MOTORS 145 STK

Natural convection



Fluid cooling



DIMENSIONS FOR ALL 145 STK		
Housing internal centering diameter	A H8	130
Angle wire output / tapped holes	AF	22°30'
Housing external centering diameter (fluid cooling)	B f8	153
Housing external centering diameter (natural convection)	B f8	145
Rotoric internal centering diameter	C H7	56
Housing internal diameter	De	78.5
Depth of fluid front input / output groove	E1	4
Width of fluid front input / output groove	E2	13.35
Position of fluid front I/O groove	E3	16.3
Rotoric fixation holes	FR	8xM5 sur Ø63
Housing fixation holes	FS	8xM5 sur Ø136
O-ring groove depth	J1	2.3
O-ring groove width	J2	4
Position of rear o-ring groove	J3	3
Position of front o-ring groove	J4	10.8
Depth of housing internal centering diameter	LA	2
Alignment rotor / housing	P ± 0.1	20.5
Maximum rotoric contact diameter	Pmax	75
Depth of fluid rear I/O groove	S1	4
Width of fluid rear I/O groove	S2	13.35
Position of fluid rear I/O groove	S3	8.5

DIMENSIONS ACCORDING TO SIZE		145STK1M	145STK2M	145STK3M	145STK4M	145STK5M	145STK6M	145STK7M	145STK8M
Housing length	LB±0.15	92	119	146	173	200	227	254	281
Rotor length	R +0.15	59	86	113	140	167	194	221	248

INTEGRATION:

- ✓ The cables are made of PU, class 6, foreseen for cable-bearing chains, 2 mt standard length, copper square section according rated current.
- ✓ Rotor / housing alignment (P) has to be executed within +/- 0.1 mm. Optionally, we can supply a mounting tool for achieving that alignment in case of assembly without possibility of accurate alignment.
- ✓ Thermal devices cable consists of 2 shielded pairs 2x2x0.25mm² section, 7 mm max external diameter.
- ✓ (De) represents: 1- The maximum diameter passing inside the housing.
  2- The minimum diameter necessary for rotor assembly.
- ✓ (Pmax) diameter for pieces in contact with the rotor must never be exceeded.
- ✓ Tapped holes on each side of rotor and housing are angularly aligned.
- ✓ Cable positioning (AF) is theoretical. Leave a free room with a +/- 10 arc degrees tolerance around that position, on a 50 mm height from the housing side, for avoiding to stress the cables at the motor output.
  Do not tighten, twist or bend the power cable on the first 50 mm from motor side. Clamp the cable after those 50 mm.
- ✓ When designing the assembly, take care to insure a perfect contact between housing and user's bore for avoiding thermal problems.
- ✓ For housing mounting, use either external centering diameter (B) or internal centering diameters (A).
- ✓ For execution tolerances (perpendicularity, concentricity...), please consult us.
- ✓ Fluid input and output pipes have to be placed at the opposite of wire outputs on the same axial plane.
- ✓ O-ring grooves designed for 3 mm diameter o-rings.

A full integration handbook can be supplied to our customers upon request
For further information or specific request about our motors, feel free to contact us.

Figure A.1: BLDC motor data sheet page 1 of 3.