



FAKULTAS TEKNOLOGI INDUSTRI
UNIVERSITAS ISLAM INDONESIA



PROSIDING

ISBN 978-979-96964-6-5

SEMINAR NASIONAL TEKNOIN 2009

Energi Alternatif:
SOLUSI TERHADAP KRISIS ENERGI
DI INDONESIA

JURUSAN TEKNIK ELEKTRO

Yogyakarta, 14 November 2009

TEKNOIN

JURNAL TEKNOLOGI INDUSTRI ISSN 1550-2100/1

 LG Innotek

**PROSIDING
SEMINAR NASIONAL TEKNOIN 2009**

**ENERGI ALTERNATIF
SOLUSI TERHADAP KRISIS ENERGI DI INDONESIA**

Yogyakarta, 14 November 2009

BIDANG TEKNIK ELEKTRO

Diselenggarakan oleh :

FAKULTAS TEKNOLOGI INDUSTRI
UNIVERSITAS ISLAM INDONESIA
YOGYAKARTA
2009

**ORGANISASI PENYELENGGARA
SEMINAR NASIONAL TEKNOIN 2009**

Penanggung Jawab	: Dekan Fakultas Teknologi Industri
Pengarah	: Wakil Dekan Direktur Pascasarjana MTI Ketua Jurusan Teknik Kimia Ketua Jurusan Teknik Industri Ketua Jurusan Teknik Informatika Ketua Jurusan Teknik Elektro Ketua Jurusan Teknik Mesin
Ketua Pelaksana	: Dr. Ir. Farham HM Saleh, MSIE.
Bendahara	: 1. Yustiasih Purwaningrum, ST., MT. 2. Erawati Lestari, A.Md.
Reviewer	: 1. Dr. Ir. Hari Purnomo, MT. 2. Dr. Ir. Faisal Rasyid Maddun, MSIE. 3. Winda Nur Cahyo, ST., MT. 4. Dr. Sri Kusumadewi, S.Si., MT. 5. Ir. Hj. Budi Astuti, MT. 6. Agung Nugroho Adi, ST., MT.
Sekretariat, Makalah & Prosiding:	1. Dwi Ana Ratna Wati, ST., M.Eng. 2. Medilla Kusriyanto, ST., M.Eng. 3. Pangesti Rahman, SE. 4. Tuti Umiyati, A.Md. 5. Agung Nugroho, A.Md. 6. M. Susilo Atmodjo
Acara:	1. Wahyudi Budi Pramono, ST., M.Eng 2. Arif Hidayat, ST., MT. 3. Suwati, S.Sos. 4. Mishbahul Munir, A.Md.
Bidang Umum:	1. Kasiyono, S.Kom 2. Supardiman 3. Hani'ah 4. Sarjudi
Pembantu	1. Tri Handana 2. Wiyono 3. Muhammad Henry Himawan
Sekretariat	Panitia Seminar Nasional Teknoin 2009 Fakultas Teknologi Industri Universitas Islam Indonesia Jl. Kaliurang km 14 Yogyakarta Telp. (0274) 895287 Fax. (0274) 895007 e-mail : seminarteknoin@yahoo.com web : www.fit.uui.ac.id

KATA PENGANTAR

Assalamu'alaikum warahmatullahi wabarakatuh

Puji syukur kami panjatkan kehadiran Allah SWT, yang telah melimpahkan Rahmat dan Hidayah-Nya sehingga Seminar Nasional Teknoin 2009 dapat terselenggara. Seminar ini merupakan acara tahunan yang diselenggarakan Fakultas Teknologi Industri, Universitas Islam Indonesia.

Seminar Nasional Teknoin 2009, merupakan kegiatan ilmiah yang bertujuan mensinergikan hasil penelitian dengan implementasi tentang energi alternatif pada bidang Teknik Tekstil, Teknik Kimia, Teknik Industri, Teknik Informatika, Teknik Elektro dan Teknik Mesin. Tema Seminar Nasional Teknoin 2009 adalah "Energi Alternatif : Solusi Hadapi Krisis Energi di Indonesia"

Pada Seminar Nasional Teknoin 2009, terdapat 174 abstrak yang masuk. Setelah direview oleh reviewer yang berkompeten, 134 abstrak dapat diterima dan 120 full paper yang masuk ke dalam Prosiding, yaitu 18 makalah bidang Teknik Kimia dan Tekstil, 23 makalah bidang Teknik Industri, 18 makalah bidang Teknik Informatika, 44 makalah bidang Teknik Elektro dan 17 makalah bidang teknik mesin.

Sebagai ketua panitia, saya mengucapkan terima kasih dan penghargaan yang setinggi-tingginya kepada pengarah, tim reviewer dan panitia pelaksana yang telah bekerja maksimal untuk mensukseskan seminar ini.

Ucapan terima kasih juga kami sampaikan kepada, Dr. Ir. Widi Setiawan, dan Ir. Kiap M.A. Wicaksono sebagai keynote speaker. Terima kasih juga kami sampaikan kepada seluruh pemakalah dan peserta seminar.

Semoga seminar ini dapat lebih membuka wacana dan ide-ide baru untuk pengembangan energi alternatif. Akhir kata, selamat berseminar dan kami tunggu partisipasinya pada seminar nasional Teknoin 2010 tahun depan.

Wassalamu'alaikum warahmatullahi wabarakatuh

Yogyakarta, 14 November 2009
Ketua Panitia,

Dr. Ir. Farham HM. Saleh, MSIE

KATA PENGANTAR

**SAMBUTAN DEKAN FAKULTAS TEKNOLOGI INDUSTRI
UNIVERSITAS ISLAM INDONESIA**

Peserta seminar yang kami hormati,

Assalamu'alaikum Warahmatullahi Wabarokatuh

Puji syukur kita haturkan kehadiran Allah SWT karena berkat rahmat dan karunia-Nya Seminar Nasional Teknoin 2009 dengan tema "**Energi Alternatif: Solusi terhadap Krisis Energi di Indonesia**". dapat diselenggarakan.

Seminar ini diharapkan sebagai media tukar informasi antar pihak perguruan tinggi, lembaga peneliti, pemerintah, dan pihak industri serta memberikan kontribusi bagi perkembangan teknologi di Indonesia.

Atas nama civitas akademika Fakultas Teknologi Industri, Universitas Islam Indonesia, saya menyampaikan terima kasih yang sebesar-besarnya kepada semua pihak yang telah berkontribusi atas terselenggaranya Seminar Nasional Teknoin 2009 ini. Seminar ini dapat berlangsung karena usaha terbaik dari panitia pelaksana.

Terima kasih secara khusus saya sampaikan kepada **Bapak Dr. Ir. Widi Setiawan** selaku Kepala Pusat Akselerator dan Proses Bahan, BATAN Yogyakarta, dan **Bapak Ir. Kiap M.A. Wicaksono** selaku Asisten Manajer Produksi PT. Geo Dipa Energi Unit Dieng, yang berkenan hadir sebagai keynote speaker pada seminar ini.

Akhir kata selamat berseminar, semoga seminar ini tidak hanya menjadi rutinitas presentasi tetapi ada tindak lanjut baik dari praktisi maupun dari akademisi.

Wassalamu'alaikum Warahmatullahi Wabarokatuh.

Yogyakarta, 14 November 2009
Dekan,

Fathul Wahid, ST, M.Sc.

DAFTAR ISI

Halaman Judul	i
Organisasi	ii
Kata Pengantar Ketua Panitia Pelaksana	iv
Sambutan Dekan Fakultas Teknologi Industri	v
Daftar Isi	vi

Bidang Teknik Elektro

A VISION-BASED SYSTEM FOR MONITORING DRIVER FATIGUE	1
Aryuanto, F. Yudi Limpraptono	
PENGEMBANGAN SISTEM SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION) PADA PEMBANGKIT LISTRIK TENAGA HIBRIDA	7
Aryuanto, Yusuf Ismail Nakhoda	
PENGARUH SUHU LEBIH TERHADAP KETAHANAN ISOLASI KABEL NYI DAN NYA	13
Agus Supardi	
APLIKASI TEKNIK SENTUH SEBAGAI PENGENDALI KECEPATAN MOTOR DC	19
Asofwan, Novizal	
PERANCANGAN PEMBANGKIT LISTRIK PIKOHIDRO BERPENGERAK AIR TENAGA GRAFITASI SEBAGAI PENGGERAK GENERATOR	25
Sofwan, PWS Putro	
ANALISA PERBANDINGAN KUALITATIF BERBASIS THERMOGRAPHY INFRA MERAH PADA PEMELIHARAAN PREDIKTIF ANTARA TRANFORMATOR 250KVA DAN 1,250 MVA	33
Muhammad Andang Novianta	
APLIKASI NEURAL NETWORK HIERARCHICAL PROCESSING (NNHP) DALAM SISTEM PENDUKUNG KEPUTUSAN DIAGNOSIS KECERDASAN EMOSIONAL	41
Alvin Syahroni, Dwi Ana Ratna Wati	
ALAT PENDETEKSI WARNA BERDASARKAN WARNA DASAR PENYUSUN RGB DENGAN SENSOR TCS230 COLOUR DETECTOR DEVICE BASED OF BASIC COMPOSER RGB BY TCS230 CENSOR	47
Muhammad Andang Novianta	
CHANGE AUTOMATIC POWER LINE (CAPL) DENGAN PENGENDALI AT89C2051 TERPANTAU SECARA MOBILE	51
Budi Nugroho, Rahmat	
DATA LOGGER ABSENSI DENGAN RFID (RADIO FREQUENCY IDENTIFICATION)	57
Budi Nugroho	
RANCANG BANGUN EXTENSOMETER UNTUK DETEKSI PERGESERAN TANAH	63
Bambang Widiyatmoko, Dwi Hanto, Wildan Panji Tresna dan Prabowo Puranto	
PERANCANGAN DAN IMPLEMENTASI POWER CONTROLLER SEBAGAI PENGONTROL SWITCH BEBAN LISTRIK TENAGA SURYA	67
Dedi Setiyawan, Jangkung Raharjo, Muhammad Ary Murti	
EKOSISTEM TELEKOMUNIKASI PEDESAAN BERBASIS INTERNET YANG MANDIRI DAN PRODUKTIF	73
Eko Didik Widiyanto	

ANALISA PENGARUH PERUBAHAN CUACA TERHADAP RUGI-RUGI KORONA PADA SUTT 150 kV (APLIKASI GI MANINJAU – GI PADANG LUAR).....	77
Erhaneli	
SIMULASI DETEKSI KESALAHAN DATA DENGAN METODA CRC MENGGUNAKAN PERANGKAT LUNAK VISUAL BASIC	83
Sindak Hutauruk, Darma Doni Putra	
APLIKASI PERANGKAT LUNAK UNTUK PENELUSURAN GANGGUAN PERANGKAT DIGITAL LOOP CARRIER BROADACCESS ADC TELEDATA DI PT TELKOM KANDATEL SURABAYA TIMUR	89
Nonot Wisnu Karyanto, Kunjung Wahyudi	
APLIKASI SISTEM PENDUKUNG KEPUTUSAN PEMILIHAN TANAMAN OBAT ALTERNATIF DENGAN METODE MCDM	97
Kunjung Wahyudi	
ANALISIS KINERJA SISTEM KOMUNIKASI SERAT OPTIK BERBASIS SOLITON YANG DIDASARKAN PADA BIT RATE, AMPLIFIER SPACING, INTERAKSI SOLITON, DAN TIMING JITTER	103
Yaye Hantian Pebrianti, Mamat Rokhmatl, Bambang Setya	
PERANCANGAN DAN OPTIMALISASI DISPERSION-SHIFTED FIBER (DSF) UNTUK MENINGKATKAN KINERJA SISTEM KOMUNIKASI OPTIK	111
Muhamad TomiHaetami, Mamat Rokhmat, Achmad Hambali	
RANCANG BANGUN PROTOTIPE PEMBANGKIT LISTRIK TENAGA AIR GELOMBANG LAUT (PLTA-GL)	119
Massus Subekti, Daryanto, Adi Purwanto	
DESAIN ALAT PENGUKUR KEKUATAN BENANG DENGAN TAMPILAN PADA LCD BERBASIS MIKROKONTROLLER AT89S52	129
M. Ibrahim Azhari	
ANALISA PENGARUH KETIDAK SEIMBANGAN BEBAN TERHADAP ARUS DAN TEGANGAN PADA TRANSFORMATOR DISTRIBUSI 20 KV	137
Sepannur Bandri	
MONITORING DAN PENGATURAN BEBAN LISTRIK PADA GEDUNG PERKANTORAN BERBASIS WEB	145
Slamet Winardi, Imam Turmudi	
KOMPRESI CITRA MENGGUNAKAN TRANSFORMASI WAVELET DENGAN ALGORITMA EMBEDDED ZEROTREE WAVELET (EZW)	149
Suhartati Agoes, Laehan	
SUPERCHANNEL SEBAGAI ALTERNATIF DALAM MENGATASI INTERFERENCE FREKUENSI 2,4 GHZ.....	157
Sutiyo Widya Atmadja	
OPTIMALISASI KUALITAS DAYA PADA TRANSFORMATOR DISTRIBUSI DENGAN SIMULASI ETAP	165
Suwarno , Mahrizal Masri, Pardamean Sinurat	
PENGGUNAAN ADAPTIVE CODED MODULATION (ACM) UNTUK MITIGASI PENGARUH REDAMAN HUJAN DAN INTERFERENSI PADA SISTEM LMDS DI SURABAYA	169
Syahfrizal Tahcfullloh, Suwadi, Gamantyo Hendrantoro	

RANCANG BANGUN MOTOR INDUKSI LINIER "SINGLE SIDED" TIGA PHASA DENGAN KECEPATAN RENDAH	175
Toto Tohir, Sasongko Pramono H, Sarjiya, Hamzah Berahim	
DESAIN MOTOR INDUKSI LINIER TIGA PHASA SINGLE SIDED (MILS).....	183
Toto Tohir, Sarjiya, Sasongko Pramono H, Hamzah Berahim2	
PERANGKAT LUNAK UNTUK KOMUNIKASI DATA MENGGUNAKAN TEKNOLOGI BLUETOOTH UNTUK E-COMMERCE SOLUTION TO PARKING SPACE OPTIMIZATION (ESPSO).....	191
R. W. Tri Hartono, Ilham Abdussalam, Hasan Surya	
REALISASI PERANGKAT LUNAK UNTUK DISTRIBUSI INFORMASI PADA E-COMMERCE SOLUTION TO PARKING SPACE OPTIMIZATION (ESPSO)	199
R. W. Tri Hartono, Gugum Gumilar, Hasan Surya	
APLIKASI HIGH SPEED MICROPROCESSOR AVR 32 UNTUK PEMROSESAN DATA RADAR SEKUNDER	207
Wahyu Widada dan Sri Kliwati	
RANCANGAN SENSOR STRAIN TANAH BERBASIS FIBER BRAGG GRATING UNTUK DETEKSI TANAH LONGSOR	211
Wildan Panji Tresna, Dwi Hanto, Prabowo Puranto, Bambang Widiyatmoko	
PEMBENTUKAN BUDAYA KESELAMATAN DALAM PEMANFAATAN TENAGA NUKLIR DI BIDANG INDUSTRI	215
Lilis Susanti Setyaningsih	
KARAKTERISTIK PROFIL VERTIKAL ENERGI PANAS LATEN KONDENSASI YANG DILEPASKAN DI ATMOSFER INDONESIA BERBASIS OBSERVASI SENSOR TMI SATELIT TRMM	219
Arief Suryantoro, Krismianto dan Martono	
ANALISIS PROFIL VERTIKAL KANDUNGAN AIR CAIR DAN PADAT DALAM AWAN DAN KAITANNYA DENGAN ENERGI PANAS LATEN KONDENSASI YANG DILEPASKAN DI ATMOSFER YOGYAKARTA.....	227
Arief Suryantoro dan Krismianto	
ANALISA PENGARUH PERUBAHAN CUACA TERHADAP RUGI-RUGI KORONA PADA SUTT 150 KV (APLIKASI GI MANINJAU – GI PADANG LUAR)	235
Erhaneli	
EKSPLORASI KORELASI ANTARA SPEKTRUM CITRA DENGAN KOMPOSISI KIMIAWI HASIL PENYARINGAN MINYAK GORENG BEKAS DI INDUSTRI EMPING	241
Drs. Hadi Mulya, MT.	
ENERGI NUKLIR SEBAGAI ENERGI BERSIH DITINJAU DARI ASPEK REGULASI NASIONAL	247
Moekhamad Alfian, Yus Rusdian Akhmad	
IDENTIFIKASI SISTEM NONLINIER BERBASIS METODE SLIDING MODE OBSERVER DAN JARINGAN SARAF TIRUAN REKUREN	253
Rully Soelaiman, Erico Rachmat Firmanto	
PENGARUH PERUBAHAN PENGETANAHAN SISTEM DISTRIBUSI TENAGA LISTRIK TERHADAP KOORDINASI PENGAMAN GANGGUAN TANAH	261
Warindi, Supriyatna	

PEMANFAATAN SAMPAH ORGANIK HIJAU DAUN MENJADI ARANG BRIKET UNTUK BAHAN BAKAR ALTERNATIF PEMBANGKIT TENAGA LISTRIK.....267
Titiek Suheta, Bambang Riyanto

OPTIMALISASI DAYA REAKTIF PADA SISTEM TENAGA LISTRIK, MENGGUNAKAN METODE ALGORITMA GENETIK DENGAN SIMULASI ETAP..... 271
Mahrizal Masri, Suwarno, Pardamean Sinurat

PENGEMBANGAN LASER MAMPU TALA PADA DAERAH C-BAND TEROTOMASI PC.....277
Prabowo Puranto, Bambang Widyatmoko, Hendra Adinanta

A VISION-BASED SYSTEM FOR MONITORING DRIVER FATIGUE

Aryunto¹⁾

F. Yudi Limpraptono²⁾

^{1,2} Department of Electrical Engineering, Institut Teknologi Nasional (ITN) Malang
Jalan Raya Karanglo Km. 2 Malang

¹ aryunto@gmail.com, ² fyudil@yahoo.com

Abstract

This paper presents a vision-based system for monitoring driver fatigue. The system is divided into three stages: face detection, eye detection, and fatigue detection. Face detection based on the skin color segmentation is used to localize face image from a whole image. To overcome the illumination changes in the driver's cockpit, the skin color segmentation technique based on a normalized RGB chromaticity diagram is adopted. After face is localized, eye is detected by projection technique of the gradient image and by extracting white color of eye's sclera. Then a PERCLOS (percentage of eye closure over time) is calculated and used to detect a fatigue condition.

Keywords : *Driver fatigue, machine vision, face detection, eye detecton, fatigue detection.*

Introduction

Driver fatigue is one of the main causes of traffic accidents. Statistics show that 20% of the fatal traffic accidents is caused by the driver fatigue [1]. In trucking industry, 57% of fatal truck accidents are due to driver fatigue [2]. A system that could monitor driver fatigue and give a warning to the driver is needed to avoid or reduce such problem [3],[4]. Many methods have been developed to detect driver fatigue such as using EEG (Electroencephalographic) signal [5], or by detecting the driver's grip force due to fatigue or loosing alertnes [6]. The drawback of those methods is the inconvenience of installing sensors on driver's body.

To overcome such inconvenient, the methods based-on machine vision are proposed by [2],[7],[8],[9],[10],[11],[12]. The main advantages of those approaches are no need sensors installation on driver's body, and could be implemented in real time. It only uses a video camera system installed on the car's dashboard for capturing image of the driver, usually the face. However, the approach facing the common problem in the image processing field, i.e. the problem of illumination changes.

Most of existing methods utilize eye feature to detect the fatigue state. Usually they detect the opening/closing of the eye, and calculating the time of eye's closing, or the frequency of eye's closing/opening. Other methods utilize mouth's features are proposed by [13],[14],[15].

In this research, we propose a vison-based system for monitoring driver fatigue using eye's feature. To cope with the illumination problem, a color segmentation method based on normalized RGB chromaticity diagram is employed to detect a face. Further, the white color of eye's sclera and the projection of gradient image are used as the clue to detect the opening of eye.

The paper is organized as follows. Overview of the existing driver fatigue monitoring system is described in the next section. Then our proposed method is presented, followed by the experimental results. Finally, conclusion is given in the last section.

Overview of Existing Methods

A typical driver fatigue detection system is illustrated in figure 1[11]. It detects eye to determine the driver fatigue. Since position and illumination condition around the driver is changing during driving, to improve the speed and accuracy of the eye detection, eye should be localized and detected in the first video frame. To detect eye, firstly face detection is performed, then the searching area of eye could be limited in the area near/inside face region.

The common method for detecting face is by applying skin color segmentation to extract skin or face skin from a whole image. To cope with the illumination changes, several techniques are adopted, such as using

HSI color model [9], [16], mixed skin color model based on YUV and YIQ space [11].

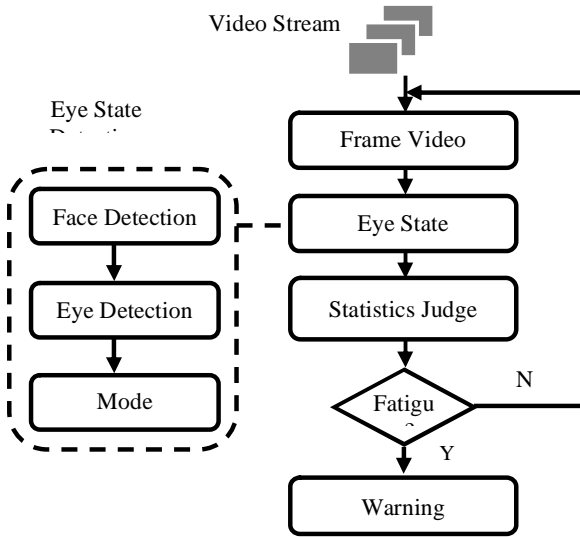


Figure 1. Flow diagram of driver fatigue detection system [11].

After face is detected, eye is searched in the region inside face. There are several techniques for detecting eye, such as template matching [9], Support Vector Machine (SVM) classifier [2], Hough Transform [12]. Other techniques using IR-illuminator are employed in [8],[10], which is based on the observation that by illuminating the eye with IR-LED, a dark and a bright pupil image could be obtained. Thus pupil or eye could be localized easily.

The general approach to detect driver fatigue is by measuring eyelid movement. Two parameters are used [2] : PERCLOS (Percentage of eye closure over time) and AECS (Average eye-closure speed). The degree of eye's opening is determined from the pupil's shape. If eye is closed, then pupil will be closed by eyelid and the shape becomes ellips. Thus the ratio of ellips's axes could be used to define the degree of eye's openness.

PERCLOS is calculated using the following formula [11]:

$$PERCLOS = \frac{Num_CloseFrame}{Num_SumFrame} \times 100\% \quad (1)$$

where $Num_CloseFrame$ is the number of frames when the eye is close, $Num_SumFrame$ is the total number of frames observed. Based on P80 criteria, then a state is defined as fatigue if PERCLOS is greater than 20%.

Proposed Driver Fatigue Monitoring

In this research, we use the general framework for detecting driver fatigue, which is composed of three stages : face detection, eye detection, and fatigue

detection. In the face detection stage, we employ our previous research on the skin color segmentation for face detection [17]. The approach is based on normalized RGB chromaticity diagram to extract skin color from image.

In the eye detection stage, we extend our previous method [17] to extract the white color of eye's sclera, and combining it with the projection of gradient image technique to find the position of eye.

Face Detection

To detect a face, first the skin color is extracted using the coarse and fine skin region, followed by an ellipse detection [17]. The coarse skin region is defined using fixed boundaries, where skin and skin-like colors (colors close to skin color) are extracted. To separate skin color from skin-like colors, the fine skin region with variable boundaries is employed.

The boundaries of the coarse skin region is defined by four lines as shown in figure 2. The *line-G*, *line-R*, *line-B*, and *line-up* are given as:

$$- \text{line-G} : g = r \quad (2)$$

$$- \text{line-R} : g = r - 0.4 \quad (3)$$

$$- \text{line-B} : g = -r + 0.6 \quad (4)$$

$$- \text{line-up} : g = 0.4 \quad (5)$$

where

$$r = \frac{R}{R+G+B} \quad (6)$$

$$g = \frac{G}{R+G+B} \quad (7)$$

In addition to those four lines, a circle (*line-c* in figure 2) is used to exclude the white pixels, which is given as

$$\text{line-c} : (g - 0.33)^2 + (r - 0.33)^2 = 0.0004 \quad (8)$$

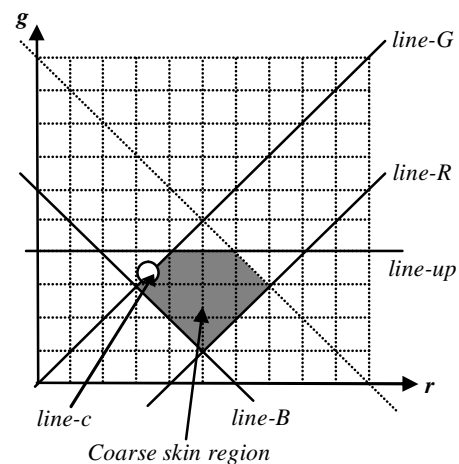


Figure 2. The coarse skin region [17].

The boundaries of the fine skin region are selected automatically by analyzing two developed histograms called g_pos and g_neg . g_pos histogram is created by

counting pixels with the value obtained by subtracting r value from g value. g_neg histogram is created by counting pixels with the value obtained by adding g value and r value.

The left and right valleys of two highest peaks of g_pos histogram called as $PTL1$, $PTR1$, $PTL2$, $PTR2$, and those from g_neg histogram called as $NTL1$, $NTR1$, $NTL2$, $NTR2$ are used as the parameter for defining the fine skin region using the following rules:

- Region-1:

$$\text{IF } (PTL1 \leq Pos \leq PTR1) \text{ AND } (NTL1 \leq Neg \leq NTR1), \quad (9)$$

- Region-2:

$$\text{IF } (PTL1 \leq Pos \leq PTR1) \text{ AND } (NTL2 \leq Neg \leq NTR2), \quad (10)$$

- Region-3:

$$\text{IF } (PTL2 \leq Pos \leq PTR2) \text{ AND } (NTL1 \leq Neg \leq NTR1), \quad (11)$$

- Region-4:

$$\text{IF } (PTL2 \leq Pos \leq PTR2) \text{ AND } (NTL2 \leq Neg \leq NTR2), \quad (12)$$

- Region-5:

$$\text{Region-5} = (\text{Region-1}) \cup (\text{Region-2}) \quad (13)$$

- Region-6:

$$\text{Region-6} = (\text{Region-3}) \cup (\text{Region-4}) \quad (14)$$

- Region-7:

$$\text{Region-7} = (\text{Region-1}) \cup (\text{Region-3}) \quad (15)$$

- Region-8:

$$\text{Region-8} = (\text{Region-2}) \cup (\text{Region-4}) \quad (16)$$

- Region-9:

$$\text{IF } g \leq 0.34 \quad (17)$$

- Region-10:

$$\text{IF } (R + G + B)/3 \geq 0.33 \quad (18)$$

where

$$Pos = g - r \text{ and } Neg = g + r \quad (19)$$

Eye Detection

After face is detected, eye is searched in the area inside face. If we perform the horizontal projection of the gradient image inside face, then the peaks represent the vertical location of eyebrow, eye, and mouth. However the two highest peaks are the ones of eyebrow and eye. Thus we could utilize both two peaks to define the upper and lower position of eye.

To detect the opening of eye, a method similar to the coarse skin region is adopted. Hence the boundaries are limited to the white color, since the aim is to extract white sclera of eye. When eye is open then white color (sclera) is extracted, otherwise no white color is detected. Thus the number of white pixels could be used to decide whether the eye is close or open. The method works fine if there are no white objects near to the eye.

Experimental Results

We tested our method using MATLAB running on PC. A Webcam is used to collect the video data of a person during normal state (opening the eye) and fatigue state

(closing the eye). Frame rate of the video is 30 frame per second. Apparently we conduct the off-line experiment, that is firstly video is recorded, then we extract each frame of the video as the input to the algorithm.

Figure 3 shows the result of face detection stage, where figure 3(a) is the original image, while the detected face is shown with ellipse drawn in figure 3(b). Gradient image of the detected face is shown in figure 4. From the figure, we might see that the dark colors dominate the eyebrow, eye, and mouth areas. Thus horizontal projection of the image will have peaks on those areas as shown in figure 5.



(a)



(b)

Figure 3. Result of face detection.

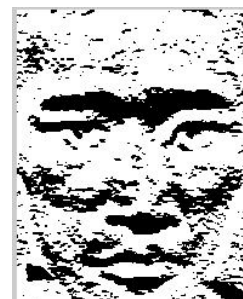


Figure 4. Gradient image.

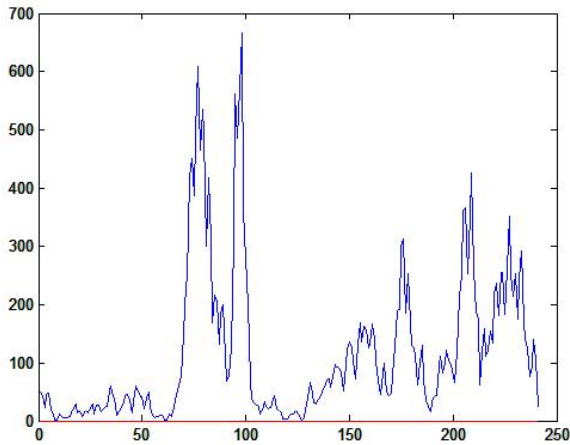


Figure 5. Horizontal projection of the gradient image.

Figure 6 shows the result of white color extraction using our proposed method as described in previous section. White color in the figure indicates the white objects extracted, i.e. eye's sclera.



Figure 6. Eye's sclera extracted.

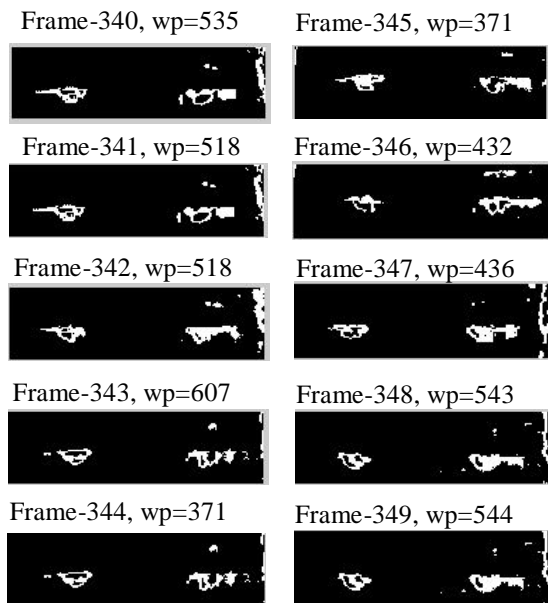


Figure 7. Eye's sclera extracted from frame-340 to frame-349 (wp =the number of white pixels).

Figure 7 dan figure 8 show the results of eye's sclera extraction of the video images, where from frame-340 to frame-349 (when eye is open) are shown in figure 7, while from frame-490 to frame-499 (when eye is close) are shown in figure 8. The number of white pixels

denoted by wp is indicated in each figure. From the figures, we could see that the number of white pixels in figure 7 are larger compared to the ones in figure 8. Therefore we could detect the opening or closing of the eye by introducing a threshold to the number of white pixels.

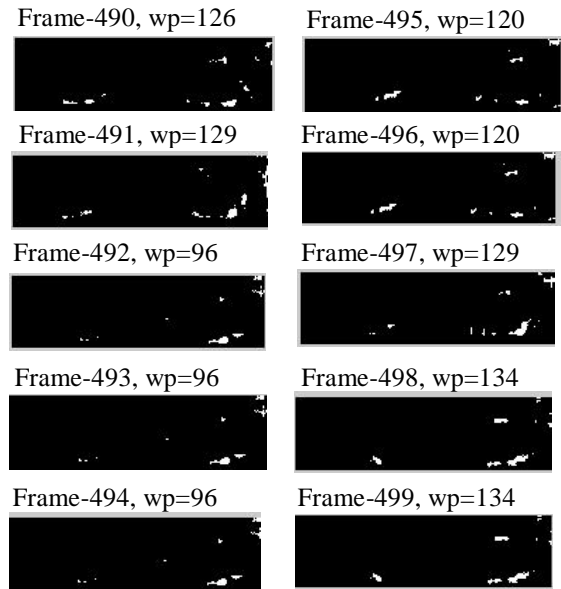


Figure 8. Eye's sclera extracted from frame-490 to frame-499 (wp =the number of white pixels).

Conclusion

In the paper, a vision system to detect driver fatigue is presented. The method employs a face detection technique to localize eye. The opening/closing of eye is detected by extracting white color of sclera in the eye's candidate area obtained by projection of the gradient image. Then, the fatigue state is determined by calculating the number of frames of the eye closing.

For future work, we will conduct the real experiments on the driver's cockpit. Further the real implementation will be considered.

References

- [1] A. Williamson, T. Chamberlain. (2005). Review of on-road driver fatigue monitoring devices. *Technical Report, NSW Injury Risk Management Research Centre, University of New South Wales.*
- [2] Q. Ji, Z. Zhu, P. Lan. (2004). Real-time nonintrusive monitoring and prediction of driver fatigue. *IEEE transactions on vehicular technology*, Vol. 53, No. 4, pp. 1052-1068.

- [3] T.Yoshida, H. Kuroda, T. Nishigaito. (2004). Adaptive driver-assistance system. *Hitachi Review*, Vol. 53, No. 4. pp. 212- 216.
- [4] L. Fletcher, G. Loy, N. Barnes, A. Zelinsky. (2005). Correlating driver gaze with the road scene for driver assistance systems. *Robotics and Autonomous Systems*, Vol. 52, pp. 71-84
- [5] S.K.L. Lal, A. Craig, P. Boord, L. Kirkup, H. Nguyen. (2003). Development of an algorithm for an EEG-based driver fatigue countermeasure. *Journal of Safety Research*, 34, pp. 321-328.
- [6] T.C. Chieh, M.M Mustafa, A. Hussain, E. Zahedi, Burhanuddin. (2003). Driver Fatigue detection using steering grip force. *Proceedings of SCORed*, Malaysia.
- [7] H. Veeraraghavan, N. Papanikolopoulos. (2001). Detecting Driver Fatigue Through the Use of Advanced Face Monitoring Techniques. *Final report of the Center for Transportation Studies*, University of Minnesota, USA.
- [8] L.M. Bergasa, J. Nuevo, M.A. Sotelo, M. Vazquez. (2004). Real-Time System for Monitoring Driver Vigilance. *Proceedings of 2004 IEEE Intelligent Vehicles Symposium*, Parma, Italy.
- [9] W.B. Horng, C.Y. Chen, Y. Chang. (2004). Driver fatigue detection based on eye tracking and dynamic template matching. *Proceedings of IEEE Intl. Conference on Networking, Sensing and Control*, Taipei, Taiwan.
- [10] L. Bretzner, M. Krantz. (2005). Towards low-cost systems for measuring visual cues of driver fatigue and inattention in automotive applications. *Proceedings of IEEE International Conference on Vehicular Electronics and Safety*, Xian, Shaanxi, China.
- [11] T. Hu, G. Liu, J. Lin. (2006). Driver's Fatigue States Detection Based on Video. *Proceedings of the 2006 International Symposium on Safety Science and Technology*, China.
- [12] T. D'Orazio, M. Leo, C. Guaragnella, A. Distanto. (2007). A visual approach for driver inattention detection. *Pattern Recognition* 40, pp. 2341 – 2355.
- [13] C. Jiangwei, J. Lisheng, T. Bingliang, S. Shuming, W. Rongben. (2004). A monitoring method of driver mouth behaviour based on machine vision. *Proceedings of IEEE Intelligent Vehicles Symposium*, Parma, Italy.
- [14] T. Wang, P. Shi. (2005). Yawning detection for determining driver drowsiness. *Proceedings of IEEE Intl. Workshop VLSI Design and Video Technology*, China.
- [15] M. Saradadevi, P. Bajaj. (2008). Driver Fatigue Detection Using Mouth and Yawning Analysis. *International Journal of Computer Science and Network Security*, Vol. 8, No. 6, pp 183-188.
- [16] D.T. Lin, C.M. Yang. (2004). Real-time Eye Detection Using Face Circle Fitting and Dark-pixel Filtering. *Proceedings of International Conference on Multimedia and Expo (ICME)*.
- [17] A. Soetedjo, K. Yamada. (2008). Skin color segmentation using coarse-to-fine region on normalized RGB chromaticity diagram for face detection. *IEICE Trans. on Information and Systems*, Vol. E91-D, No. 10, pp. 2493-2502.