**CHAPTER 1**

**INTRODUCTION**

Cancer is the leading cause of death in Taiwan for years. Half of the cancer patients need radiation therapy (RT) in the whole treatment course. According to Health Promotion Administration Annual Report, 99 143 Taiwanese people were newly diagnosed with cancer in 2013. The goal of RT is to deliver a high dose radiation to the tumour while minimizing damages surrounding healthy tissue. During radiation treatment, patients are required to stay alone in the treatment room to protect others from radiation exposure. Therefore, the evaluation of patient’s immobilization and vital conditions has become essential in the clinical setting.

Uveal melanoma is a rare disease but is the most common primary ocular malignancy. The primary treatment is to control tumour by stereotactic radio surgery (SRS), which is an alternative option to enucleation and could achieve good outcomes. Also, in the course of SRS, immobilization is a key issue for patients to avoid other healthy tissue from damage. The current method to assess patient’s immobilization and vital signs in a treatment room is to place a surveillance camera in front of the head frame and multiple closed-circuit television cameras to monitor patient’s movements, as well as a separate wire-based pulse oximeter.Therapists can only obtain patient’s eye movements by observing the video in the control room. Such a primitive way can be just qualitative, unreliable, and ineffective, especially for a prolonged treatment process.

Among the common vital parameters of heart rate, blood pressure, and respiratory rhythm, heart rate has been the fastest and the most accessible one to be monitored during radiation treatment. For a 1-hour-long radiotherapy to uveal melanoma targeting on the eye, heart rate remains the least disturbing data to be obtained as compared to blood pressure and respiratory rhythm. The traditional wire-based setup for monitoring vital signs may occupy some space of radiation beam paths and interfere with radiation delivery. There are four common methods to measure eyeball movement .

* Video-Based Eye Tracker: In 2012, Fassi et aln proposed to use stereo cameras (two webcams) to reconstruct the tri dimensional position of pupil and cornea centers for automatic patient setup, with which an estimated error of 0.5° was achieved.
* Scleral Search Coil: An invasive method required a modified contact lens or annulus embedded with small coils of wire to be placed into the eye. The eye movements can be quantified by measuring the induced electromotive force .
* Electro-Oculography: Small voltages varying at different eye positions can be detected by using the sensor attached to the region around the eyes
* Infrared Oculography: This technique captures the amount of reflected infrared (IR) light that varies with the eye’s position by using a fixed light source (IR) and an IR detector. This principle has been utilized.Personal use is permitted, but.

It has been accepted for inclusion in a future issue of this journal. Content is final as presented, with the exception of pagination commercially such as EyeTech Digital Systems and EyeMax System . So far, no efficient and standard procedure can be used to detect the eye movement easily, considering the equipment and cost of the existing treatment environment. The videobased method seems to be the most suitable way for a long treatment measurement. Vital signs include many important features to indicate the status of the body’s life-sustaining functions, such as body temperature, heart rate, respiratory rhythm, blood pressure, and blood oxygenation. Nowadays, the most widespread techniques to assess these vital signs basically rely on contact measurement, such as finger monitors and blood pressure cuffs .

These methods require direct contact with human skin to sense the physiological signals. The induced discomforts increase over time with these attached sensors. Among these techniques, photoplethysmography (PPG) is a simple optical measurement to sense the cardiovascular pulse signal [blood volume pulse (BVP)] through variations in transmitted or reflected light . By use of signal processing via PPG, multiple studies have demonstrated remote PPG (rPPG) signals detection from facial videos without body contact or invasive procedures .Poh et al. proposed to apply independent component analysis (ICA) on recovering the BVP waveform from the recorded RGB videos.

The results were limited to stationary measurement which was pointed out in . In 2014, Monkaresi et al. introduced a machining learning method, namely, k-nearest neighbor (k-NN) classifier to improve the detection accuracy. The provided root-meansquare error (RMSE) can be significantly reduced to 3.64 bpm for indoor exercise. But the method also pointed out that could not be used in illumination fluctuation environment. Lately, rPPG has also been reported with the feasibility to detect blood oxygen saturation by measuring the relative pulsatility at two different wavelengths and blood pressure by calculating the delay in pulse transit time from the forehead to the palm .

Although contact-free measurement has served as a widespread topic in recent years, there is a lack of clinical experiments to prove the feasibility and system practicality for on-site applications, especially in radiation treatment room. a framework to monitor the pulse rate variation and track the eyeball movement of patients with primary ocular malignancy based on contactless technique.The use of a consumer-level web camera to simultaneously track the eyeball movement and monitor physiological signals remotely during radiotherapy. The measured pulse rates have been verified with the finite difference approximations (FDA) approved medical equipment. Compared with the current method to surveil the vital signs and eye movement with qualitative observation, the proposed methods are able to feedback the vital conditions and gaze position of patients more precisely and quantitatively during treatment delivery

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**CHAPTER 2**

**SYSTEM ARCHITECTURE**

To monitor eyeball movement and physiological signals, an adjustable camera fixation system was designed, An LED was placed right above the treated eye to guide the patient vision focusing on the dedicate position during RT. A commercial USB color camera (C920 HD Pro Webcam, Logitech Int., Hsinchu, Taiwan) was fixed above the untreated eye for unblocking the beam paths at a distance of 6–7 cm from the thermoplastic mask to record the video of the treated eye and an adjacent 3 cm × 3 cm skin area. The recorded videos were further analyzed with the proposed framework, which was majorly divided into three subsections to introduce eyeball detection and tracking, pulse rate measurement, and environmental lighting assessment.

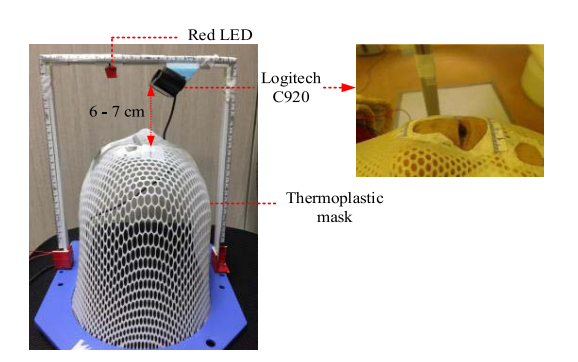


Fig. 1. Camera was fixed above the thermoplastic mask to capture the video during entire radiosurgery to uveal melan

The data workflow of each subsection and the relevant details are illustrated as follows. The proposed framework was constructed with MATLAB software and all video dataset was analyzed in a real-time process using the desktop with an Intel Core i7 3.10-GHz processor and 8-GB RAM demonstrates the designed graphical user interface (GUI). The provided information including eyeball motion trace, the pulse signal obtained by analyzing the video frame and its spectrum, corresponding pulse rate, and environmental lighting condition (RGBY).

A. Eyeball Detection and Tracking To assist the therapists in securing the immobilization in RT developed a real-time eyeball detection and tracking algorithm to survey patient’s eyeball movement and to test the data with the videos captured by the setup camera,illustrates the data workflow of the proposed eyeball tracking methodology. We first manually selected a candidate region of interest to exclude the background objects in the image.

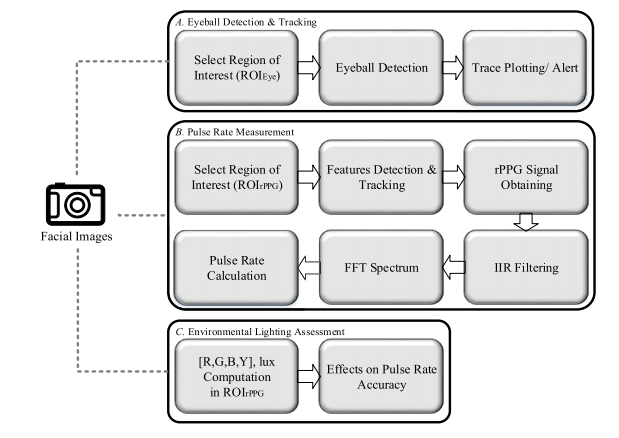


Fig. 2. Data workflow of each divided subsection of the proposed framework.

Second, image processing algorithms were applied in the selected ROIEye based on the procedure of RGB to gray image conversion using by forming a weighted sum of the R, G, and B components. Then, the morphological opening (erosion followed by dilation) was implemented first to remove the small objects (noise) from the foreground (the bright pixels). Afterward, the closing operation (dilation followed by erosion) was used to recover the boundaries of the foreground region in the image. The erosion and dilation operations are shown in the pixels are replaced with value 1, and all other pixels are replaced with value 0. Thresh\_level is adaptive to the histogram of the ROIEye data, ranges from 0 to 1,with all patients.

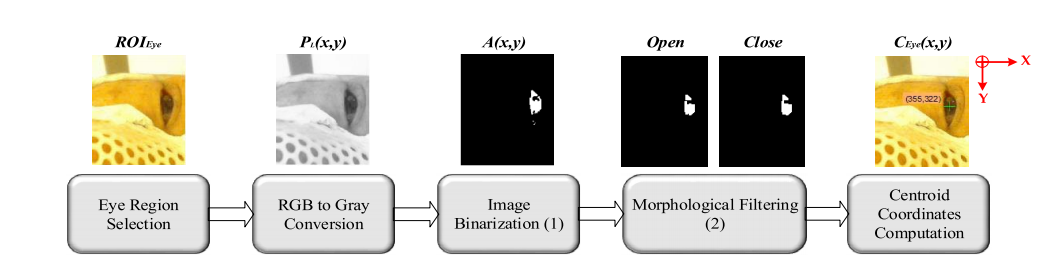


Fig. 3. Image processing procedure of the proposed eyeball detection method

Select Region of Interest (ROIrPPG): For rPPG measurement, determining the optimal ROI has a strong relation to the rPPG signal quality. Inappropriate ROI selection affects the performance, thereby decreases the detection accuracy. A previous study indicated that the forehead and both sides of cheeks served as potential candidates to provide the highest signal-tonoise ratio and computationally efficient ROI. Thus, we removed a portion of the thermoplastic mask to expose sufficient cheek area for rPPG signal acquisition. An ROIrPPG was formed as 120 pixels 60 pixels (width height) rectangle and manually selected from the exposed cheek region. It is of note that rPPG signal is susceptible to motion artifacts, which can be caused by the blink of an eye and subject’s movement. The ROIrPPG is required to avoid the eye region for reducing unnecessary disturbance.

Feature Detection and Tracking: Since the rPPG signal is susceptible to subject’s movement (e.g., breathing and unconscious motion), we further performed feature detection and tracking to reduce the motion artifacts of the rPPG signal. The reliable features are returned by examining the corner points within the selected ROIrPPG in the first image frame through computing the the minimum eigenvalue metric in order to determine the corner locations, as the blue crosses marked . Afterward, the feature points can be tracked by detecting the optical flow using Kanade–Lucas–Tomasi feature tracker algorithm across each image. For each feature in the previous frame, the point tracker attempts to find the corresponding point in the current frame by using point tracker object in MATLAB. An affine transformation matrix is designed to depict the motion between two consecutive images in plan coordinate system to cover wider parameters of displacement including translation, rotation, shear, and scaling. Therefore, the location of ROIrPPG was updated and maintained in the same covered skin area even with subject’s movements.

Obtain rPPG Signal: As published [24], the rPPG signal registered in green channel features stronger pulsatile component than R and B channels in ambient light for an RGB format video. Thus, obtained the spatial mean value of the green channel of all pixels in the determined ROIrPPG as the rPPG raw signal by the following equation: p (t) = (x,y∈ROIrPPG) G(x, y,t) |ROIrPPG| where G(x, y,t) denotes the green pixel value located in (x, y) at time t, |ROIrPPG| refers to the area of ROIrPPG in pixel. p(t) is the raw signal of rPPG at time t.

Infinite Impulse Response (IIR) Filtering the raw signal captured from the green channel was enriched of noise and the baseline drift varied severely. The baseline drift was caused because of a low-frequency disturbance originated by motion-induced specular variations. To reduce the effect of noise and baseline wander, a temporal normalization and an infinite impulse response (IIR) bandpass filter were employed to minimize the undesirable distortion. In this paper, we designed a fourth-order Butterworth bandpass filter with cutoff frequencies at 0.8 and 3 Hz.

Fast Fourier Transform(FFT) Spectrum: The fast Fourier transform (FFT) is a common calculation approach of pulse rate by transforming time series to frequency spectrum which is defined . The filtered signal is segmented by the N-length sliding window, where N is usually assigned at least twice of the maximum pulse rate for adequate resolution and is set to 1024 in the proposed method. The sampling frequency is 30 based on the camera capturing rate (30 frames/s)

**CHAPTER 3**

**TECHNOLOGY USED**

**Artificial intelligence**

Artificial intelligence (AI) is the simulation of human intelligence processes by machines, especially computer systems. These processes include learning (the acquisition of information and rules for using the information), reasoning (using rules to reach approximate or definite conclusions) and self-correction. Particular applications of AI include [expert systems](https://searchenterpriseai.techtarget.com/definition/expert-system), [speech recognition](https://searchcrm.techtarget.com/definition/voice-recognition) and [machine vision](https://searchenterpriseai.techtarget.com/definition/machine-vision-computer-vision). AI can be categorized as either [weak](https://searchenterpriseai.techtarget.com/definition/narrow-AI-weak-AI) or [strong](https://searchenterpriseai.techtarget.com/definition/artificial-general-intelligence-AGI). Weak AI, also known as narrow AI, is an AI system that is designed and trained for a particular task. Virtual personal assistants, such as Apple's Siri, are a form of weak AI. Strong AI, also known as artificial general intelligence, is an AI system with generalized human cognitive abilities. When presented with an unfamiliar task, a strong AI system is able to find a solution without human intervention.

Because hardware, software and staffing costs for AI can be expensive, many vendors are including AI components in their standard offerings, as well as access to Artificial Intelligence as a Service ([AIaaS](https://searchenterpriseai.techtarget.com/definition/Artificial-Intelligence-as-a-Service-AIaaS)) platforms. AI as a Service allows individuals and companies to experiment with AI for various business purposes and sample multiple platforms before making a commitment.

While AI tools present a range of new functionality for businesses ,the use of artificial intelligence raises ethical questions. This is because deep learning algorithms, which underpin many of the most advanced AI tools, are only as smart as the data they are given in training. Because a human selects what data should be used for training an AI program, the potential for human bias is inherent and must be monitored closely.

Some industry experts believe that the term artificial intelligence is too closely linked to popular culture, causing the general public to have unrealistic fears about artificial intelligence and improbable expectations about how it will change the workplace and life in general. Researchers and marketers hope the label [augmented intelligence](https://whatis.techtarget.com/definition/augmented-intelligence), which has a more neutral connotation, will help people understand that AI will simply improve products and services, not replace the humans that use them.

**Types of artificial intelligence**

* Type 1: Reactive machines. An example is Deep Blue, the IBM chess program that beat Garry Kasparov in the 1990s. Deep Blue can identify pieces on the chess board and make predictions, but it has no memory and cannot use past experiences to inform future ones. It analyzes possible moves -- its own and its opponent -- and chooses the most strategic move. Deep Blue and Google's AlphaGO were designed for narrow purposes and cannot easily be applied to another situation.
* Type 2: Limited memory**.** These AI systems can use past experiences to inform future decisions. Some of the decision-making functions in self-driving cars are designed this way. Observations inform actions happening in the not-so-distant future, such as a car changing lanes. These observations are not stored permanently.
* Type 3: Theory of mind. This psychology term refers to the understanding that others have their own beliefs, desires and intentions that impact the decisions they make. This kind of AI does not yet exist.
* Type 4: Self-awareness. In this category, AI systems have a sense of self, have consciousness. Machines with self-awareness understand their current state and can use the information to infer what others are feeling. This type of AI does not yet exist .

**Image Processing**

Image processing is a method to convert an image into digital form and perform some operations on it, in order to get an enhanced image or to extract some useful information from it. It is a type of signal dispensation in which input is image, like video frame or photograph and output may be image or characteristics associated with that image. Usually Image Processing system includes treating images as two dimensional signals while applying already set signal processing methods to them.

The two types of methods used for Image Processing are Analog and Digital Image Processing. Analog or visual techniques of image processing can be used for the hard copies like printouts and photographs. Image analysts use various fundamentals of interpretation while using these visual techniques. The image processing is not just confined to area that has to be studied but on knowledge of analyst. Association is another important tool in image processing through visual techniques. So analysts apply a combination of personal knowledge and collateral data to image processing.

  Digital Processing techniques help in manipulation of the digital images by using computers. As raw data from imaging sensors from satellite platform contains deficiencies. To get over such flaws and to get originality of information, it has to undergo various phases of processing. The three general phases that all types of data have to undergo while using digital technique are Pre- processing, enhancement and display, information extraction.

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**CHAPTER 4**

**IMLEMENTATION**

**Evaluating the Accuracy of Tracking Eyeball Movement**

Since it is hard to confirm the real eye positions on treatment videos without reliable quantification tools, adopted a database to validate the accuracy of the proposed eye detection method. The gaze interaction for everybody (Gi4E) is a standard database that has been commonly used to validate the iris center localization accuracy . It contains 1236 color images with a resolution of 800 × 600 pixels from 103 subjects. Each subject is asked to gaze at 12 different points on the monitor. All the image sequences are taken at indoor under various illuminations. The ground truth coordinates of both left and right irises are provided along with the database.Processed the images from the database with the proposed eyeball detection and tracking framework.

For eyeball detection, the 1236 images were taken for testing. The normalized error for worse eye characteristics defined was exploited as the metric for comparison with related works. Among the movement sequences of subject staring at 12 different points, we chose to analyze three of them— sequences 7–9, gazing at center right, front, and left points. Subjects with glasses and hair interference were excluded because glasses are not allowed during radiation treatment, there were 89 subjects, three images per person, and a total of 267 images were taken for the testing of eyeball movement. eWEC = max(dl, dr) w (9) where dl and dr are the Euclidean distances between the detected centroid and the ground truth iris center (in pixels) of the left and right eyes, respectively, and w is the true distance between both eyes in pixels.

**Clinical Trials**

Experimental Setup patients with uveal melanoma and recorded their facial videos of daily SRS. Each treatment with 10 Gy (Gy, a derived unit of ionizing radiation dose in the International System of Units) taking an hour, and there were five consecutive daily treatments for each patient For SRS, a dedicated stereotactic linear accelerator was used (CyberKnife, Accuray Inc., Sunnyvale, CA, USA)and informed consent was obtained from each patient. Fig. 7 shows the actual experimental setup of RT, where a thermoplastic mask was used to immobilize the patient’s head and a plastic frame was adopted to secure the camera. The RGB uncompressed video of each patient therapy was recorded at the speed of 30 frames/s and resolution of 640 × 480. The signals including eyeball movements, pulse signals, and environmental lighting conditions were collected and analyzed from the obtained videos.

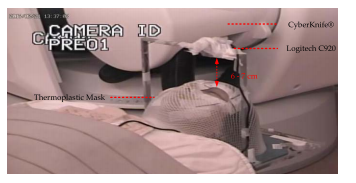


Fig. 4. Experimental setup for clinical trials.

Evaluation Metrics for Eyeball Immobilization the computation speed is sufficient to analyze the video instantly with the camera capturing speed of 30 frames. The system is able to analyze the video and plot the variation in the y-axis along with the eyeball movement instantly.

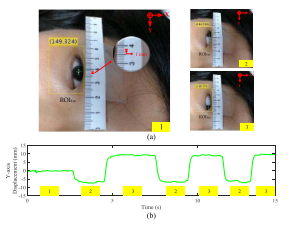


Fig. 5. Eyeball movement estimation and calibration. (a) As the example here, 1 mm is approximately equal to 5 pixels. (b) Instant eyeball movement track.

To evaluate the eyeball immobilization, the eyeball movement of each patient was traced from the recorded videos. The transverse movement (y-axis) because the longitudinal variation can be affected by eye blinking which cannot totally contribute to eyeball movement. To convert the estimated movement (in pixel) into millimetres (mm), first determined the number of pixels corresponding to 1-mm distance from the obtained image, the movements in distance (mm) can be derived based on the following equation: D(t) = k(Eye(y,t) − Ref(y)) where k is the calibration coefficient obtained by mapping 1-mm distance of the scalar to number of pixels (mm/pixels). Eye(y,t) is the detected eyeball location in the y-axis at time t, and Ref(y) is the referenced location where the eyeball should maintain at. If the detected movement |D(t)| exceeds criteria , an alert signal is displayed on the designed user interface.

To verify the calibration method, we conducted an experiment to compute the error of mapping the scaler from 2-D image to metric system. A healthy, age 25, female subject was requested to move her eyeball from left to right, and repeat 3 times. The average error was 0.96 ± 0.66 mm (mean ± SD). The overall immobilization performance of each patient’s in daily treatment can be scored by the following equation: Immobilization(%) = 1 − LengthD>Thresh Lengthvideo × 100% where LengthD>Thresh is the duration of measured distance |D(t)| exceeding the tolerated range (Thresh), Lengthvideo refers to the duration of the measured video.

Evaluation Metrics for Remote Pulse Rate Detection: The reference pulse rate was synchronized with the video frames and was also collected with FDA approved pulse oximeter (506DXN, Criticare Tech. Inc., North Kingstown, RI, USA). In this paper, we selected three metrics to analyze the error and accuracy of contactless pulse rate detection. To evaluate the error for remote pulse rate measurement, mean absolute error (MAE) and root-mean-square error (RMSE) are the most commonly used metrics to demonstrate the error between two measurements.

The remote pulse rate (PRi) obtained from the maximum peak in the frequency spectrum is compared with the pulse rate value (REFi) from the contact pulse oximeter every second. Where PRi denotes the pulse rate value obtained from the rPPG signal, REFi is the synchronized reference pulse rate measured the clinical approved pulse oximeter device, and N is the number of samples in each video. Each video is analyzed in a real-time mode and pulse rate values are compared in every second thorough whole video. Since the discrepancy of the measurements is obtained, the relative accuracy can be further derived based on the following equation: Acc(%) = 1 N N i=1 1 − |PRi − REFi| REFi × 100% (14) Fig. 9. Illustration of ac value obtained from the filtered version of the rPPG signal.

**Light Source Evaluation**

Besides, the amplitude of light absorption and reflectance from the skin tissue is relatively small compared with the average remittance. According to relevant works, the relationship between light intensity and given pixel in an image registered by the camera can be modeled as , which mainly involves dc and ac components . The model infers that the amplitude of both stationary part of the reflection coefficient ρcdc and the induced pulsatile component ρcac are proportional to the intensity of the given light source IC insufficient illuminance can directly reduce the magnitude of heartbeat induced color variation further computed the ac variation (peak-to-trough amplitude) under various lighting intensities, to provide with a future indicator for evaluating whether the current environmental lighting is suitable for conducting rPPG measurement. C = IC(ρcdc + ρcac), C ∈ {R, G, B} where IC is the intensity of the light source for the color channel C, ρcdc belongs to the static part of the reflection coefficient of the skin in color C, and ρcac indicates the zero-mean, time-varying reflectance fraction induced by the pulsation underneath the skin.

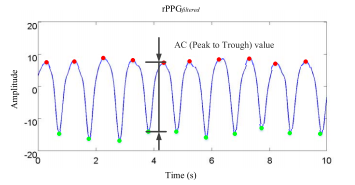


Fig. 6. Illustration of ac value obtained from the filtered version of the rPPG signal.

For each intensity benchmark, the ac variation of the rPPG signal can be obtained by computing the peak-totrough amplitude of each heartbeat and averaging over time thorough the entire video . We adopted Philips Hue to generate eight levels of intensity and recorded a 3-min video for each. The default lighting setup was 100% as (RGBY: 151, 104, 18, and 108), to simulate the radiation room lighting. Afterward, we gradually reduced the intensity from 100%, 85%, 65%, 50%, 30%, 15%, and 5% to 0%, to evaluate the eyeball tracking performance and the ac component induced by the blood volume variation of each video. The corresponding exposure values were measured with an illuminance spectrometer (SRI-2000, Optimum Optoelectronics Co., Ltd., Hsinchu, Taiwan) by aiming the detector sensor to the light source.

**CHAPTER 5**

**APPLICATIONS**

Radiation therapy is a treatment used for cancer and, less commonly, thyroid disease, blood disorders, and noncancerous growths. In the era of automation, an automatic and non-invasive tool is required for day-to-day health monitoring. Cardiac pulse being one of the vital physiological parameters has drawn attention of researchers for its measurement.An approach for automatic cardiac pulse measurement. Digital image processing, as a computer-based technology, carries out automatic processing, manipulation and interpretation of such visual information, and it plays an increasingly important role in many aspects of our daily life, as well as in a wide variety of disciplines and fields in science and technology, with applications such as television, photography, robotics, remote sensing, medical diagnosis and industrial inspection.

* Intelligent Transportation Systems – This technique can be used in Automatic number plate recognition and Traffic sign recognition.
* Remote Sensing – For this application, sensors capture the pictures of the earth’s surface in remote sensing satellites or multi – spectral scanner which is mounted on an aircraft. These pictures are processed by transmitting it to the Earth station. Techniques used to interpret the objects and regions are used in flood control, city planning, resource mobilization, agricultural production monitoring, etc.
* Moving object tracking – This application enables to measure motion parameters and acquire visual record of the moving object. The different types of approach to track an object are:Motion based tracking,Recognition based tracking

* Defense surveillance– Aerial surveillance methods are used to continuously keep an eye on the land and oceans. This application is also used to locate the types and formation of naval vessels of the ocean surface. The important duty is to divide the various objects present in the water body part of the image. The different parameters such as length, breadth, area, perimeter, compactness are set up to classify each of divided objects. It is important to recognize the distribution of these objects in different directions that are east, west, north, south, northeast, northwest, southeast and south west to explain all possible formations of the vessels.It can interpret the entire oceanic scenario from the spatial distribution of these objects.
* Biomedical Imaging techniques – For medical diagnosis, different types of imaging tools such as X- ray, Ultrasound, computer aided tomography (CT) etc are used. The diagrams of X- ray, MRI, and computer aided tomography (CT) are given below.

Artificial Intelligence is a system where machine, in particular computer systems are triggered to process like human intelligence, i.e., machines are substituting humans. The various AI processes include reasoning, learning and self-correction.

* SmartPhones

While the taught that AI is at least a few years away from causing any considerable effects on our lives, the fact remains that it is already having an enormous impact on the world. Artificial intelligence is affecting the decisions and the lifestyles every day.

* Smart Cars and drones

Talking about the AI, there is no better and more prominent display of this technology than what smart car and drone manufacturers are doing with it. Just a few years back, using a fully automatic car was a dream, however, now companies like Tesla have made so much progress that we already have a fleet of semi-automatic cars on the road.

* Music and Media Streaming Services

Another great example of how AI impacts our lives are the music and media streaming services that are using on a daily basis. It might feel that it is in total control but you are not. And as it is with everything, sometimes it’s good and sometimes it bad. For exampleI love the Discover Weekly playlist on Spotify as it has introduced to several new artists which wouldn’t have been introduced to if not for the AI gods at Spotify.

**CHAPTER 6**

**FUTURE SCOPE**

The eyeball tracking and rPPG signal quality under multiple levels of light luminance. The adopted eye tracking and rPPG measurement approaches were constructed based on image processing, with strong demand on the satisfactory light source. The theory of rPPG measurement is to detect the reflectance of lighting from the skin surface. Unstable or insufficient luminance can reduce the variation of the reflectance (ac magnitude), thereby affecting the signal quality significantly. To maintain high detection rate, the preferable environmental lighting condition was analyzed by evaluating the eye tracking feasibility and the accuracy of pulse rate detection. Demonstrating the eye tracking feasibility under different levels of illumination. The results show that the illuminance below 2223.92 lx is inadequate for tracking the eyeball from the captured images accurately. Also, the performance of rPPG pulse rate detection degraded with insufficient illuminance. The illuminance should be larger than 1454.59 lx to sustain satisfactory rPPG pulse rate detection accuracy.

Radiation Oncology is one of the pillars of multidisciplinary care of the patient with cancer. In the past 50 years, and especially the last 20, Radiation Oncology has experienced dramatic technological innovations, leading to image-based complex three-dimensional treatment planning and delivery of radiation therapy, using 3D-Conformal or Intensity Modulated Radiation therapy (IMRT), with increased precision in dose delivered to the target volume(s), while sparing adjacent normal structures (Organs at Risk, OAR).The dose-rate effect of external beam radiation therapy with conventional linear accelerators is governed by the overall beam-on-time. With the advent of flattening-filter-free accelerators and hypofractionation (high dose per fraction) radiation therapy schemas, biological effects of external beam dose rate will need further investigation.

**CONCLUSION**

Contactless impedance detection has already become a standard part of sensor and detector science. The theoretical background is reasonably well understood, even if modeling and prediction of the cell behavior is satisfactory only for the shapes of dependences and trends, whereas the absolute signal values can be predicted only with difficulties. The newest applications demonstrate that the use of impedance detection extends beyond the area of separation techniques. A simple disposable polydimethylsiloxane chip has been developed for contactless impedance flow-through cytometry.

A camera-based measurement method was proposed to simultaneously monitor patient’s eyeball movement and pulse rates during daily SRS to uveal melanoma. The proposed method may improve the current clinical application and assist medical staffs on monitoring patient’s vital parameters more efficiently and quantitatively. Three patients with primary ocular malignancy (uveal melanoma) were recruited to participate this study. The experimental results demonstrated the average error of 0.96 ± 0.66 mm (mean ± SD) for eyeball movement and the average accuracy of 96.67% for pulse rate detection. In addition, insufficient illuminance of ambient light can also affect the accuracy of eyeball and pulse rate detection. The systems for more vital parameters such as respiratory rhythm, oxygen saturation, and blood pressure are expected to be developed with the camera-based system in the near future to expand the scope and applications of contactless measurement.

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