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From the President

It is our great pleasure to publish new issue of international journal, "International Journal of Electronics, Mechanical and Mechatronics Engineering" (IJEMME) of Istanbul Aydin University. Our sustainable strategy is to demonstrate new trends in science and technology subject to high quality standards by ensuring a stringent peer review process.

The scope of the International Journal of Electronics, Mechanical and Mechatronics Engineering (IJEMME) covers the novel scientific papers about Electronics, Image Processing, Information Theory, Electrical Systems, Power Electronics, Control Theory, Embedded Systems, Robotics, Motion Control, Stochastic Modeling, System Design, Multidisciplinary Engineering, Computer Engineering, Optical Engineering, Design Optimization, Material Science, Metamaterials, Heat and Mass Transfer, Kinematics, Dynamics, Thermo-Dynamics, Energy and Applications, Renewable Energy, Environmental Impacts, Structural Analysis, Fluid Dynamics and related topics of the above subjects.

Manuscripts reporting original theoretical and/or experimental work and tutorial expositions of permanent reference value are highly welcome.

I sincerely wish to thank the editor in chief, members of the editorial board, and authors of the seventh issue who have generously contributed their time and knowledge to the work and the mission of the journal.

Dr. Mustafa AYDIN
President

From Editor

In this issue of "International Journal of Electronics, Mechanical and Mechatronics Engineering (IJEMME)", we have especially selected the scientific areas which will cover future prospective Engineering titles such as Robotics, Mechanics, Electronics, Telecommunications, Control systems, System Engineering, Biomedical, and renewable Energy Sources.

We have selected only a few of the manuscripts to be published after a peer review process of many submitted studies. Accepted papers are as follows:

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Editor in Chief

CPW FED UWB Monopole With Double Band Notch Antenna With Compact Size

Behnaz MOJAVERNAJAF[1], Yashar ZEHFOROOSH[1]

ABSTRACT

In this paper the new antenna structures firstly a modified band-notched compact printed half-elliptical monopole antenna is proposed for ultra-wideband (UWB) applications. Wider impedance bandwidth can be achieved by carving two sectors on top-side of the semi-ellipse-shaped patch. Two connected arc-shaped slots with a variable angle between them are inserted in the patch to act as a filter structure. The proposed antenna is etched on a FR4 substrate with the size of 25 × 25 × 1.6 mm3 and optimized to operate over the frequency band between 2.5 and 15GHz for VSWR<2, omitting the undesired frequency band

Keyword: *Ultra Wide Band, CPN, Microstrip, Antenna*

1. INTRODUCTION

Ultra-wideband antennas have attracted great attention in the recent years [1-6]. However, over the designated UWB frequency range, there are existing narrow bands used by worldwide interoperability for microwave access (WiMAX) operation in the 3.3{3.7 GHz band and wireless local area network (WLAN) in the 5.15{5.825 GHz band. Therefore, it is desired to design the UWB antenna with dual- notched bands in 3.3-3.7 GHz and 5-6 GHz to minimize the potential interference. Recently, a number of UWB antennas with band-notched characteristics have been discussed [7-{14] and various methods have been used to achieve band notched function, such as embedding a slot of different shapes in the radiating patch [7-10], using parasitic patches [11, 12], embedding a slit in the feeding strip [13], or etching split ring resonator (SRR) coupled to the feed-line [14]. However, each approach above only creates one single altering frequency and is not able to provide satisfactory skirt characteristics and a sufficient rejection bandwidth. In addition, all of the antennas mentioned above have concerned no more than two notched bands and most of them only have one notched band, which cannot fulfill dual or multi-rejected band function. A few dual or multi-rejected band UWB antennas were presented [15, 16]. However, the band-notched characteristics of these antennas are not desirable to avoid the interference problem within the UWB operating band. Obtaining high effective band-notched characteristics is a challenging issue. The main problem of the band rejected function design is the difficulty

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of controlling bandwidth of the notched band, and few band-notched UWB antennas with controllable rejected bandwidth have been presented. In this paper as shown in follow section the new UWB antenna with dual band notch is presented.

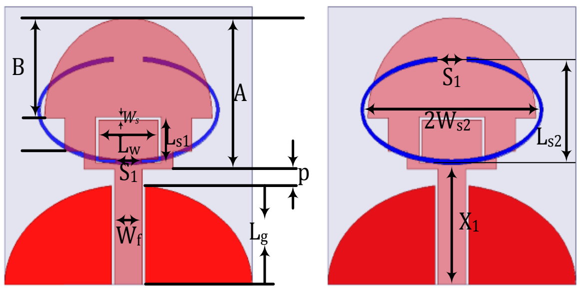


Fig.1. *antenna configuration*

Table 1. *Antenna dimensions*

A	13.6mm	Ls1	4.1mm	Ls2	9.7mm
B	9mm	Lw	6.6mm	Ws2	9mm
p	1.48mm	Wf	3mm	Ws	0.3mm
S1	2.6mm	Lg	9mm	X1	10.8mm

2. ANTENNA CONFIGURATION AND DISCUSSION

Figure 1 shows the structure and dimensions of the proposed antenna, whose conductor is fabricated on an inexpensive FR4 substrate with the dielectric constant of $\varepsilon r = 4.4$ and the substrate thickness of $h = 1.6$ mm. The antenna shape were modified using the Ansoft High Frequency Structure Simulator (HFSS). Then the optimal dimensions were determined from experimental adjustment. The dimensions of the designed antenna, including the substrate, is L × W = 25 × 25 mm2. A 50Ω CPW feedline with width of Wf = 3 mm with gap distance of 0.3mm and length of X1=9 mm, is used to feed. The antenna is symmetrical with respect to the longitudinal direction.

The basic antenna structure consists of a truncated ground plane with rectangular shape and a circular patch with. In this structure, the slot is added in the corner of radiating element, because provides a wideband behavior with a relatively good matching [5], also on the ground of the substrate, the ground changed to elliptical shape. The modified radiation patch is created two other rectangular shape slit as an impedance matching element to control the impedance bandwidth of a square monopole (at steps 3 and 4 of Fig.2) [6], because it helps matching the patch with the two-step feedline in a wide range of frequencies. This is because the truncation creates a capacitive load that neutralizes the inductive nature of the patch to produce nearly-pure resistive input impedance [1].

The dimensions of the notch (2Ls+2Lw-S1) embedded in the radiation patch plane are important parameters in determining the sensitivity of rejection band of 5.5GHz. The variation of Lw and S1 parameters is shown in Fig.4 (a, b). For creation band rejection of antenna in centered frequency of 3.5GHz, an elliptical shape is embedded in other side of patch.

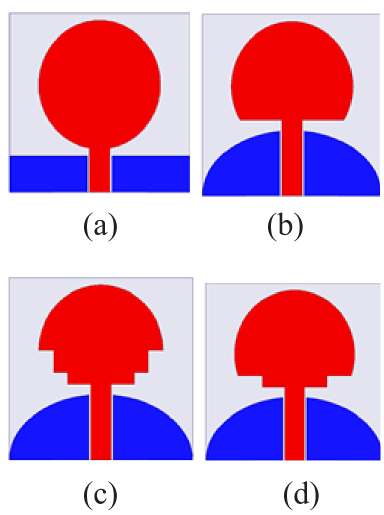


Fig 2. *Antenna steps for designing*

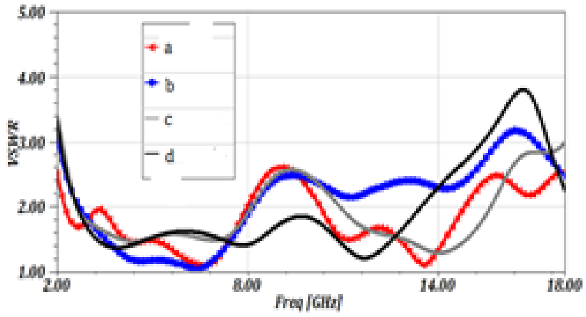
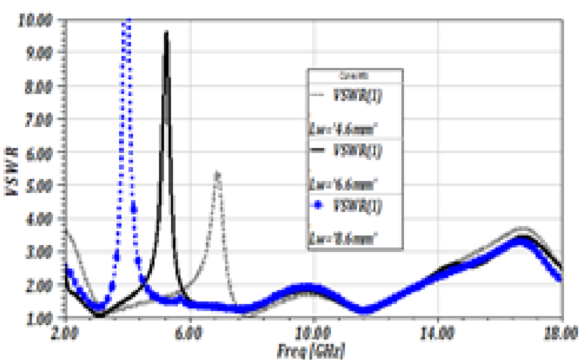


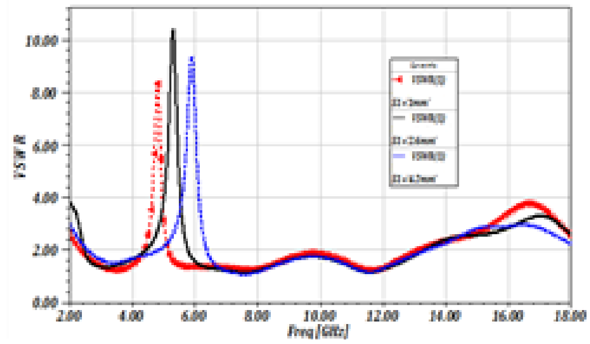
Fig.3 *VSWR variation of antenna designing steps in Fig 2*

3. RESULT AND DISCUSSION

Figure 5 illustrates the simulated and measured return loss curves of the proposed antenna against the frequency. A good agreement between the simulated and measured results has been observed. The measured results indicate that the -10 dB impedance bandwidth of the proposed antenna is in the frequency range from 2.5 to 15 GHz, which cover the bandwidth of the FCC definition for UWB indoor communication systems. It is also seen that the proposed antenna exhibits a notched band of 3.5 and 5.5GHz. The slight deviation of measured results from simulated one is mainly due to fabrication errors. The radiation characteristics of the proposed antenna are measured in a 5:5m × 5m × 3m anechoic chamber with an Agilent E8362C network analyzer along with far field measurement software.



(a)



(b)

Fig. 4 *The variation of Lw and S1 parameters*

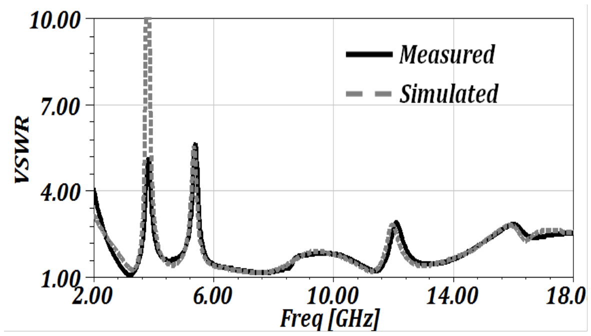


Fig.5 *comparison between simulated and measured VSWR*

It is observed from Figure 6 that at low frequency of 3 GHz both E-and H-plane radiation patterns are Omni-directional. As the frequency increases, both the planes become slightly directional due to higher order harmonic and nulls introduced in the patterns as expected. Despite of band notched structure, the proposed antenna with single band notch characteristics can exhibit stable radiation patterns and retains its Omni-directionality throughout the operating band. Figure 7 shows the measured peak gain of the proposed band notch antenna in the UWB frequency range. It is seen that the antenna achieved good gain throughout ultra-wide frequency band except at notched bands. The photograph of fabricated antenna is presented in Figure 8.

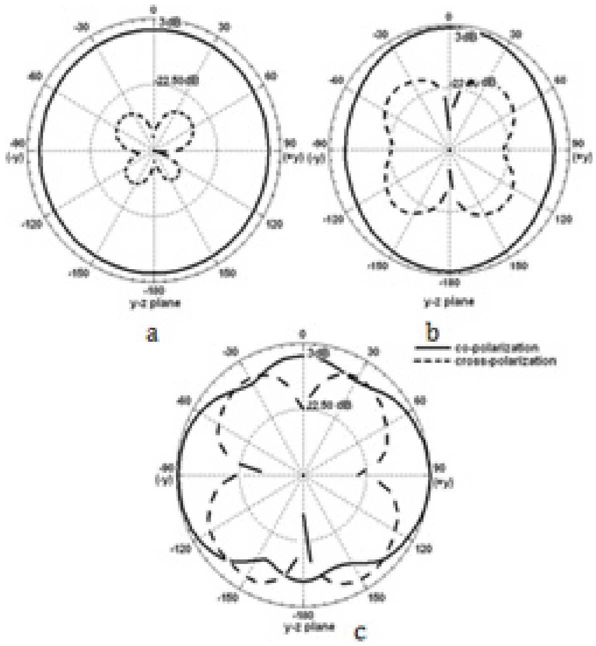


Fig. 6 *measured radiation patterns of the proposed antenna for two planes at (a) 3.0 GHz, (b) 6.0 GHz and (c) 8.0 GHz*

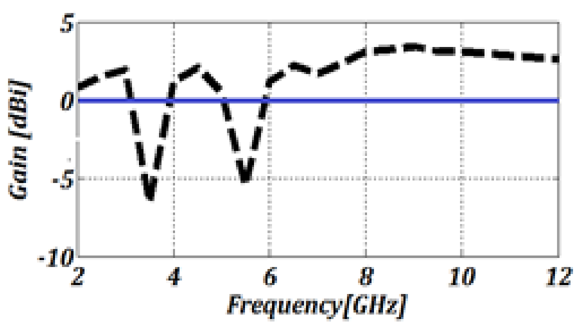


Fig. 7 *measured peak gain of the proposed band notch antenna*

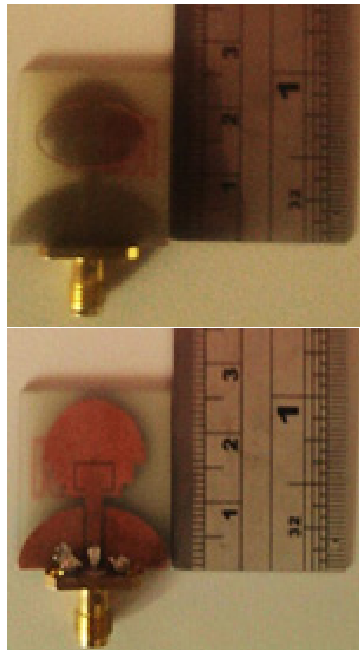


Fig. 8 *photograph of fabricated antenna*

4. CONCLUSION

A compact UWB monopole antenna with triple band-notched characteristics is presented and investigated. We have discussed that by etching C-shaped slot in the patch and placing an elliptical C shaped under patch of radiating patch, double band-notched characteristic is achieved. The radiation patterns in the H-plane are nearly omnidirectional over the entire UWB band. The gain is stable with a sharp decrease in the designed notched bands. Consequently, the proposed antennas are expected to be a good candidate in various portable UWB systems.

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Solar Tracking Systems and A Two-Axis Active Prototype With Stepwise Movement

Gökhan ORAL[1] , Osman N. UÇAN[1]

ABSTRACT

In this work, criteria for a two-axis solar tracking system that provides a higher voltage and power output than a fixed solar panel, are determined and a prototype is realized with stepwise movement. From that point on, to design a practical solar tracker, extensive research studies were conducted which resulted in determination of optimal techniques and components. As a result, by using a small scale solar panel, servo motors as drive elements, Arduino processor as the controller, and a wireless transmitter that transmits voltage feedback to the controller, a two-axis active solar tracker is developed which moves in pre-determined steps.

Keywords: *Solar Panel, Two-axis tracker, Active Solar Tracking System, Stepwise Adaptation*

1. INTRODUCTION

In the beginning, solar energy is used only in heating purposes and for getting hot water in both residential and industrial domains. However, in recent times, it became a fundamental source of electrical power as a result of rapidly developing technology of solar cells, namely photovoltaic cells, that basically convert sun light into electricity. Solar cells that are used for generating electrical power are called photovoltaic, that the term itself explains the obtainment of voltage from photons. Photovoltaic solar cells, can be employed flexibly, as in simple series and/or parallel connections and/or combinations, according to current and/or voltage requirement, therefore according to the power demand of consumers and to the specific purposes of many kind of appliances. Solar tracking can be achieved by single-axis or to increase susceptibility and efficiency by two-axis motion mechanisms. For solar trackers with two-axis mechanism, there exist two types of techniques. These techniques are known as, polar or ecuatoral tracking and elevation or inclination tracking, in the solar energy literature. From physics, it is a well-known fact that, highest energy can be obtained when the photons of solar radiation coincide with the converter, the solar panel, perpendicularly. Thus, solar tracking systems aim maximizing the energy output by adjusting the position of the cell in order to get the solar radiation in an optimal perpendicular angle. Although the optimal performence depends on the sharpness of the coinciding angle, high resolution in motion mechanism is not essential. As a matter of fact, experiments

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show that a 10 degrees of deviation from the optimal angle decreases the efficiency to a value of 98.5%.

Up to 2002, development of two-axis solar tracking systems was not taken seriously, thus, works and experiments were only conducted by academic researchers and hobbyists. In 2002, first patent was granted and commercial productions became the current issue. However, at this point, several difficulties of experience came up. For instance, control of second axis complicates the overall system. Besides, mechanical drawbacks emerge as the system gets more complicated.

Although, it is not necessary to incorporate solar tracker systems in all kinds of solar cell installations, to increase the efficiency and the performance in generation of electricity, it is a requirement. Solar tracking mechanisms have drawbacks such as, increase in cost, reliability, energy consumption of control circuitry, and need for maintenance, notwithstanding the aforementioned benefits, i.e. increase in efficiency and performance.

In common, solar tracking systems share characteristics listed below, partially and/or completely.

- Single column architecture or parallel, console like structure,
- One or more driving motor,
- Light sensing unit,
- Autonomous or auxiallry power supply,
- Light tracking or tracking based on a database,
- Continuous or stepwise discrete movement mechanism,
- Adjustment of inclination and/or declination angle.

There are several solar tracking methods proposed in the present literature for practices like solar cells, solar radiation collectors, condensers and telescopes, where it is essential to get the solar radiation from a perpendicular angle. An ideally constructed solar tracking system ought to provide orientation of the photovoltaic solar cell directly to the direction of the radiation coming from sun. To accomplish this task, horizontal and vertical movement of the solar panel is needed. Solar tracking systems can be classified into two major categories accordingly. These classes are, passive tracking systems which employ mechanical and/or hydraulic driving mechanisms, and active tracking systems which incorporate electrically driven and, not necessarily, electronically controlled designs.

2. METHODS

In literature on solar radiation is, in general, assumed as spherical wavefronts coincide with a horizontal plane, in a similar manner with far field modeling approach. Based on this, solar cells or cell banks are positioned on horizontal plane with slope, to get the wavefronts with vertically perpendicular angles. As everyone knows, sun moves in the sky during the day.

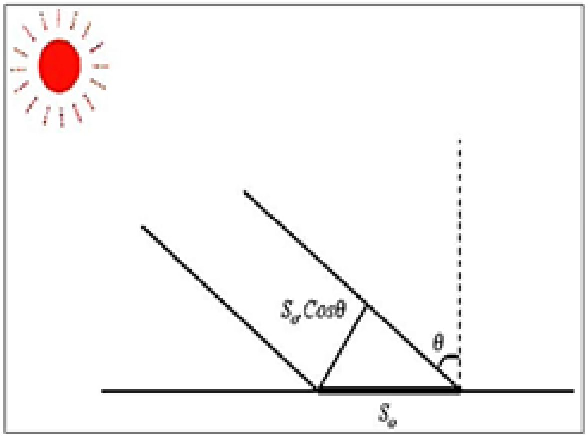

Figure 1. Inclination angle, θ, of solar radiation

For a fixed solar collectror and/or panel, as can be seen from Figure 1, projection of receptive field on the plane is determined by the cosine of the incoming light. As the angle of the incoming solar radiation, "θ", increase, power output of the solar cells decrease.

A. PASSIVE TRACKING

Principle of operation of a passive solar tracking system relies on thermal expansion of a material, usually Freon, or alloys that have form memory which remember its former shape.

In general, these type of tracking systems are made up of a couple of actuators that make inverse movements of each other. When both actuators are equally illuminated, they stay in equilibrium position. Illumination differences of these actuators result in an unbalance of forces. By this way, inclination of the tracking system can be accomplished. Consequently, actuators reach new equal lighting levels, and therefore tracking system comes up to a new equilibrium position.

Passive solar tracking systems have less complex structures than active solar tracking systems, if we compare, and they operate in a lower efficiency.

Besides, there exists the risk of not working in low temperatures or quitting operation. Existing experimental studies in the literature show that, passive mechanical systems are comparable with electrically controlled active systems in performance scores. Mostly passive solar tracking systems are not demanded much by the consumers yet, although they have less cost. This tendency would change accordingly to the developments in the mechanical fronts. From Figure 2, a passive solar tracker mechanism designed using computer aided methods can be seen. In this passive solar tracking system application, two pieces of double alloy metal rods of aluminum and steel are used. In this application, the principle of operation was that although the inclinations of the expanding metal rods are small, corresponding mechanical forces due to these inclinations are large.

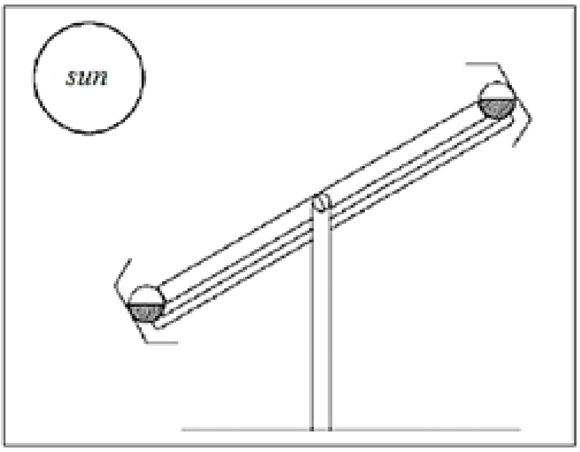

Figure 2. *Passive Solar Tracker*

These double alloy metal rods are positioned bilaterally on wooden frames. Their positions are symmetrical to the center of the horizontal axis. In addition, the passive solar tracking system is also equipped with a damping mechanism in order to prevent oscillations and/or slowdowns in motion. Finally, by the solar panel with passive solar tracking system, it is statedthat the efficiency can be increased by a ratio of 23%.

B. ACTIVE TRACKING

From a general perspective, active solar tracking systems can be classified in three categories as, microcontroller and electrical or optical sensor based, computer controlled, date and time based and using an auxillary two-sided solar cell. It is also possible to inlude a hybrid class where three categories listed above are combined.

Electrical or optical sensor based solar tracking systems are commonly include at least a couple of anti parallel connected photoresistors or photovoltaic solar cells. Both of the sensing elements reach an electrical equilibrium under equal light intensities. This is the main principle of operation of these solar tracking systems. Therefore, control signal that is required to operate the driving motor, is never used or used in a negligible ratio.

In solar tracking systems that involve auxillary double-sided solar cell, double-sided solar cell achieves sensing and driving task, that is serves for the system to track the desired position. In computer controlled, date and time based solar tracking systems, using databases as well, solar positions are calculated for daily and annually by algorithms and control signals are generated.

In general, microprocessor based solar tracking systems, need two motors as actuators and two solar cells. For a microcontroller based solar tracker, three distinct tracking algorithm can be listed as below.

- First algorithm moves the solar cell using global coordinates in a circular manner. Aim is defened as to determine the point that provides optimal voltage within this pre-defined circle. The circle is to be defined by the radius chosen by the user.

- In the second algorithm, solar panel is moved in a squre pattern. By this, solar tracking system tries to find the maximal voltage level.

- The third and the last algorithm involves the method in the second algorithm and determines the parameters for optimal days in a year, and hours in a day. These parameters are incorporated in predicting the next position of the sun, thus the solar tracking system.

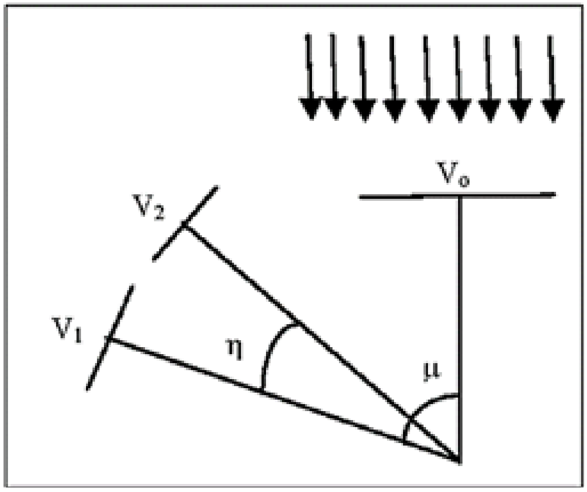

Figure 3. *Operation principle of a solar tracker*

A typical calculation of operation is shown in Figure 3 and described here. Assuming that there are two voltage values measured from solar panels, V1 and V2 present. These voltage levels and/or solar panels are being separated from each other by an angle of η. Besides, V0 and V1 voltages are also separated from each other by an angle of μ. Here, V0 voltage level stands for the possible voltage level that could be measured when solar panel is positioned perpendicularly according to the sun and/ or light source. If V1, V2 voltages and η angle is known, μ angle can be calculated as follows.

$$\mu = \arctan\left(\frac{V_2 - V_1 \cos \eta}{V1 \sin \eta}\right) \qquad (1)$$

This equation can also be written from Figure 3, as it is actually a geometrical interpretation. In the overall, developed algorithm is programmed and uploaded to the microcontroller, where driver circuits of actuators are also connected to the microcontroller, thus linking the code to sensing and driving elements. From sensors employed, highest resolution measured was 6°.

Under the light of obtained findings, 1° deviation from perpendicular angle results in measurement of 99,98 % of the maximal voltage level as well as 10° deviation from perpendicular angle results in measurement of 98,5 % of the maximal voltage level is concluded.

3. PROTOTYPE

Developed active solar tracking system in this work can be seen from Figure 4 with its final view. This tracker has not designde for a continuous-motion, thus for continuous controlling perspectives are not concerned. Step-wise movements, that are determined according to the measurements, yield adequate performance, therefore, it becomes more practical to implement the control mechanism and/or to decrease the installation costs.

Besides, terminal connections of the servo motor that is located beneath the lower plane do not contribute any problems to the rotational motion. However, rotating upper plane, which is controlled by a single servo motor, has connections with the fixed plane, thus inhibits infinite rotation. In order for these terminal connections not to block rotational motion, by eliminating recurrent positions that come up in several angle combinations, and by including all possible positions for lower and upper planes, rotational movement of the lower plane is limited 90° rotation of the lower plane provides all possible positions. Therefore it was adequate to limit rotation of the lower plane to 90°, and the design was realized accordingly. For also the upper plane,it was not necessary to have motions in large angles. For instance, it is useless to have a 180° rotation because the main purpose is to make perpendicular angles with the incoming solar radiation. As a result, rotational motion of the upper plane is limited between 30° angles.

Active solar tracking system developed in this work, employs voltage level that the solar cell bank produces as the feedback criterion. Therefore, obtainment of the optimal voltage value is the main purpose of the closed loop tracker system. Voltage information is being transferred to the controller unit via a wireless transmitter operating in 2.4 GHz radio frequency. Wireless transmitter card also include an analog-to-digital converter, where analoguously obtained voltage values are converted to digital data before wireless transmission.

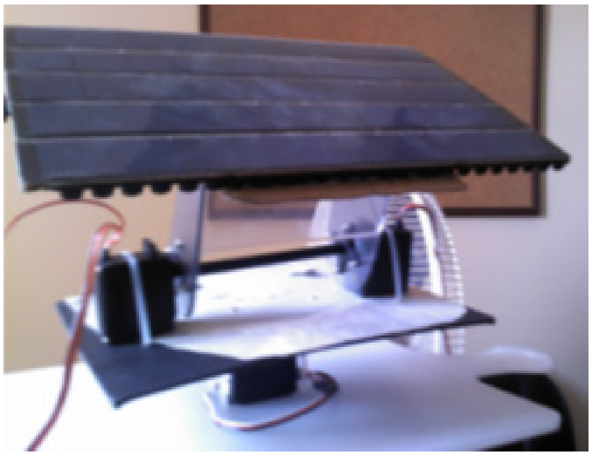

Figure 4. *Developed Solar Tracker*

In control unit, which is also checked by a Matlab code, feedback voltage information data are visualised. Digital voltage information data are made of numbers between 0 and 1023. These values correspond to voltage levels between 0 and 5 volts. A sample voltage recording can be seen from Figure 5. In this figure, recorded data are again converted to voltage levels between 0 and 5. Horizontal axis represents time in seconds and the sample recording shown here lasts approximately 6 minutes - 350 seconds. A fluctuation between 4.5 volts is observed during this sample recording. When investigated in detail, ripples can be seen better as shown in right bottom corner of the Figure 5. In short-term operations, these fluctuations result from passing birds or clouds, and can be interpreted as noise. These fluctuations, which one can assume them as system noise, have an average magnitude of 0.25 volts. Because of its low order of magnitude, it can be neglected, and it is not required to be overcame.

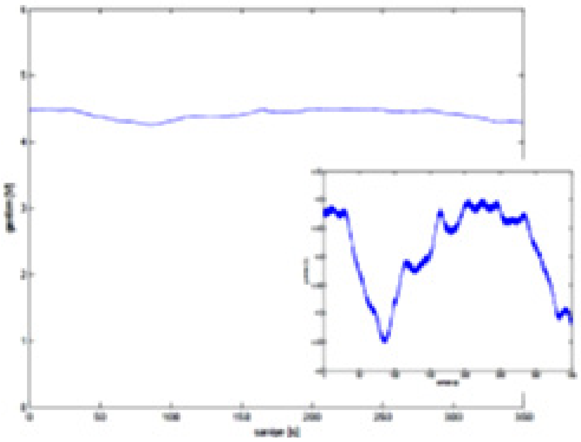

Figure 5. *Voltage level fluctuations*

In the active solar tracking system designed, instantaneous and/or short-term fluctuations are omitted and therefore, instead of a continuously controlled design, stepwise movements are appreciated as mentioned before. In the closed loop active tracker developed, three action plans were determined, and these action plansa re valid for noon, before-noon, after-noon. During the daytime, within time intervals for these action plans, measurements should be done and optimal position should be determined. These positions might be different from day to day and/or year to year. According to our stepwise design, our control system has 9 different pre-defined positions. These positions are determined by adding and subtracting 15 degreed angles of the solar panel in x and y axes. Therefore, for an action plan to be chosen, feedback from each of these nine positions are evaluated and maximal voltage value is chosen.

4. CONCLUSION

In this work, criteria for a two-axis solar tracking system that provides a higher voltage and power output than a fixed solar panel, are determined and a prototype is realized with stepwise movement. From that point on, to design a practical solar tracker, extensive research studies were conducted which resulted in determination of optimal techniques and components. As a result, by using a small scale solar panel, servo motors as drive elements, Arduino processor as the controller, and a wireless transmitter that transmits voltage feedback to the controller, a two-axis active solar tracker is developed which moves in pre-determined steps. Developed system is pretty original, when compared to the previous approaches in the literature. As a consequence of stepwise motion and control strategy comprising of pre-determined action plans, sensing, driving and control circuits of the overall system consume quite low quantities of power and energy.

Table 1. *Daily measurements*

before-noon 11:00		*horizontal*		
		-15^0	0^0	15^0
vertical	15^0	5,85	5,81	5,73
	0^0	5,78	5,70	5,59
	-15^0	5,66	5,61	5,47

(a)

noon 14:00		*horizontal*		
		-15^0	0^0	15^0
vertical	15^0	5,90	5,93	5,89
	0^0	5,82	5,89	5,84
	-15^0	5,79	5,81	5,78

(b)

after-noon 17:00		*horizontal*		
		-15^0	0^0	15^0
vertical	15^0	5,70	5,79	5,83
	0^0	5,59	5,68	5,74
	-15^0	5,48	5,57	5,62

(c)

(a) Before noon at 11:00 (b) Noon 14:00 (c) After noon 17:00

From Table 1, measurement data can be seen recorded in a sunny day in August. As it is mentioned before, there are three action strategies in a day that depends on solar positioning. Therefore, the first one is shown in table (a), where measurements that are conducted before noon (11:00 a.m.) included. Here, optimal position, namely the position that provides maximal voltage level is obtained by 15^o vertical and minus 15^o horizontal angles. In (b), best position is obtained by selecting 15^o vertical and 0^o horizontal angles. The last table, (c), shows measurement results at afternoon, and by 15^o vertical and 15^o horizontal angles maximal voltage level is obtained.

Active solar tracking system developed here, uses the selected position out of 9, and holds that until next day time and/or action plan. Therefore, neglectible voltage fluctuations during one action plan, i.e. afternoon, as measured and plotted in Figure 5, do not cause any negative effect.

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Healthy Sport Monitoring System

Parviz ABBASOV[1]

ABSTRACT

Every individual responses differently to physical activity. Working out more than body endures can cause serious health problems. Rapid developments in information and communication technologies affects the whole area of health. Recently developed wearable wireless non-invasive health sensors allow us to create healthcare application. This research aims to give an idea for implementation of healthcare systems in sports area. This system will improve healthy and social life and encourage people to engage more with sport activities.

Keywords: *E-Health, Sport Monitoring System, Biometric Sensors*

1. INTRODUCTION

Everybody does not get equal benefits from exercising. Regular, accurate and careful physical activity is important to protect and improve individual health status [1]. Continuous health control can help sport consultants to increase safety of physical activities and support motivation throughout individuals. It can help consultants to design appropriate training options for each individual. It will help to establish expectations between individuals and sport consultants. Individuals can evaluate their time during the sport and sport consultants can evaluate and improve the workout plans. Long-term and real-time monitoring of medical data informs about the emergency situations. In spite of using conventional methods nowadays technology can help us design the real time monitoring system. Wearable non-invasive sensors will give continuous and real-time vital data about body's work during physical activity. By using these portable sensors with 3G wireless communication technology it creates the real time sport monitoring system [2]. This system will prevent the time loss, reduce the costs and guarantee the safety of the physical activity. Aim of this project is to help sport and health consultants to use more conventional methods and become able to keep individuals health under control more accurately.

2. MISSING ASPECTS (PROPERTIES) WITHIN EXISTING SPORT SYSTEMS

There are various health monitoring systems currently existing. They offer different options to help people engage with sport while monitoring time, distance, steps, burned calories etc, based on target workout advices. Most of them are designed for users and are not suitable for sport and health consultants. These systems do not provide information

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that supports remote health control and consultant interventions. They are inadequate to guarantee health safety for individuals. Recently developed wireless biometric sensors can bring a solution to these problems. Vital signs are important part of individual's health. These non-invasive biometric sensors provide continuous control and monitoring of vital data. New designed non-invasive biometric systems are user friendly with being portable, wearable, light and reliable [3]. They can reduce the medical check-up costs, increase the usability of medical application. Using this system will encourage and motivate people to engage sport with health control.

3. ARDUINO PLATFORM

Arduino is a programmable an open-source electronic board. Arduino is using ATMel brand processors [4]. It is helps programmers to develop innovative projects with reduced costs. Arduino IDE editor is compiling our program and installing it to the card. In this project used Arduino Uno rev.3. It is the latest revision of the Arduino platform and e-health sensor platform v2.0 which has been designed by Libelium. Arduino Uno board is an electronic card with 14 digital and 6 analog inputs which are supported by the ATMega328 brand processor [4]. (Fig. 1)

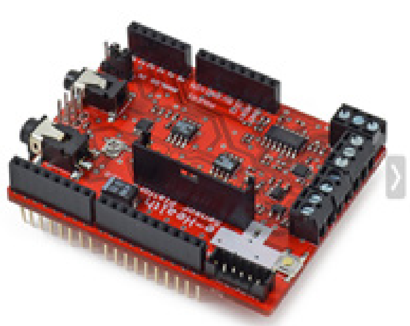

Figure 1. *E-Health v2.0 Platform.*

4. E-HEALTH PLATFORM AND BIOMETRIC SENSORS

E-Health v2.0 platform is providing information which allows to make biometric, medical and sport applications by using Arduino, Rasperry Pi and Intel electronic cards. Biometric data can be send to application by using 6 different wireless technologies: Wi-Fi, 3G, GPRS, Bluetooth, 802.15.4 and ZigBee which allows to do real time monitoring and analyze individual health status [5].

This platform is supporting 9 various biometric sensors: (Fig. 2)

- Pulse
- Airflow (Respiration)
- Body Temperature
- Electrocardiogram
- Glucometer
- Galvanic Skin Response
- Blood Pressure
- Patient Position
- Electromyography

Figure 2. *E-Health v2.0 Platform and Biometric Sensors*

5. DESIGNING OF THE MODEL FOR SPORT MONITORING SYSTEM

Application was developed in the .Net Framework 4.5 with using C# programming language. The database of system was developed in MS SQL Server. Data transactions between the application and database are operating with sql stored procedures. This system aims to help sport and health consultants. Therefore, only consultants have access to the system. Application consists following forms:

- Login
- Administrator
- User Information
- Vital Signs
- Vital Calculator
- Diagrams
- Report

6. USER INTERFACES

Login window is designed to access the system. (Fig. 3) This window requires the credentials of the users to secure the system. Unauthenticated users cannot access the system. These credentials belong only to health and sport consultants and are created through administrator form. (Fig. 4) User Information form allows consultants to add, delete and update the individual's information. (Fig. 5) Vital Signs form will be designed with continuous monitoring, controlling and analyzing of the vital signs during the physical activity. (Fig. 6)The Vital Calculator window calculates the amount of the daily calorie requirements, body mass index, body fat ratio and exercise heart rate zones. (Fig. 7) It gives feedback to consultants after comparing the results with target zones. In next form consultant can automatically make a report by selecting date ranges of recorded data of the individual. Diagrams form is designed to visually show the changes of vital signs. (Fig. 8)

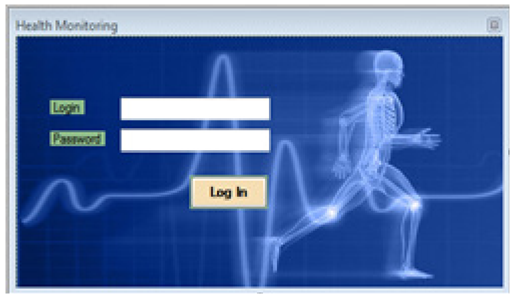

Figure 3. *Login Form*

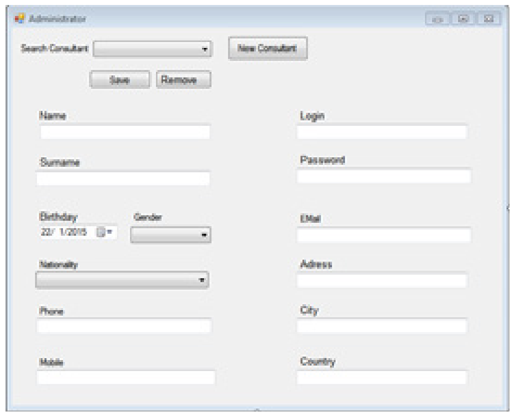

Figure 4. *Administrator Form*

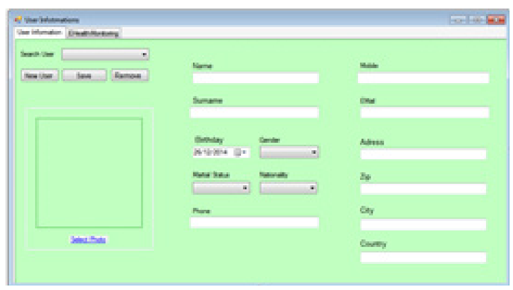

Figure 5. *User Information Form*

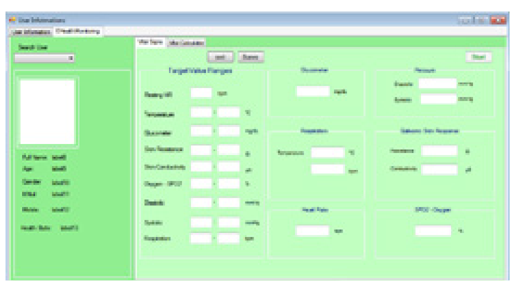

Figure 6. *Vital Signs Form*

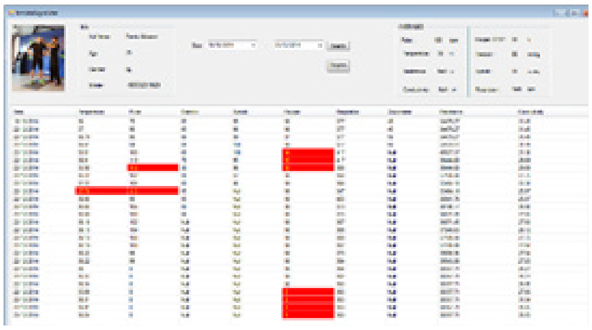

Figure 7. *Report Form*

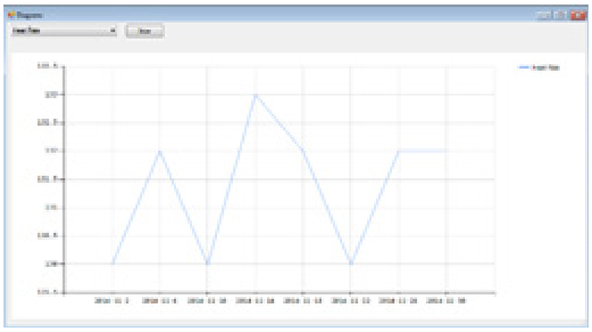

Figure 8. *Diagrams Form*

7. DATA CONTROL AND PROCESSING UNIT.

Data control and processing are main unit of the health monitoring system. This unit controls the health status changes during sport activity and display all data in Vital Signs form. (Fig.9)

Developed algorithm controls the vital signs according to predetermined health limits by sport doctors. It will automatically warn the consultant if it detects data which is not in predetermined limit ranges. The sample of this procedure is shown in Figure 9.

Figure 9. *System Warning Test.*

After all processes system records information to the database. These processes are performed according to the flowchart in Figure 10.

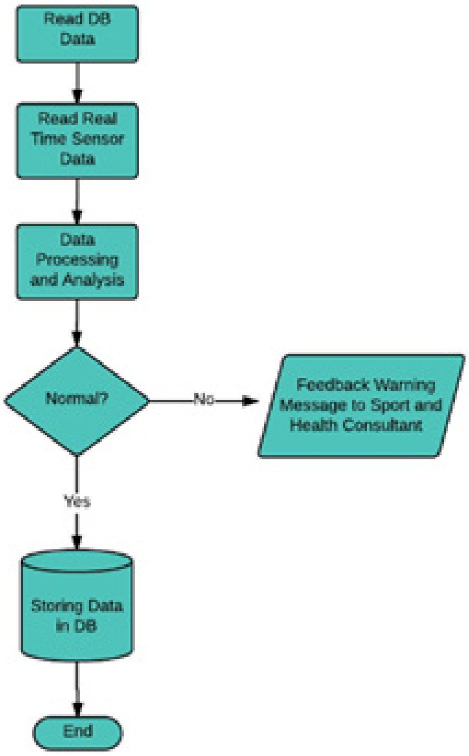

Figure 10. *Data control and Processing Flowchart*

8. WIRELESS COMMUNICATION UNIT.

In this module 3G internet platform is used to provide communication between sensor platform and application requires a high speed internet connection and communication with using WCDMA and HSPA cellular networks. This communication layer is designed according the flowchart in Figure 11.

9. CONCLUSION

This paper presents a technological solution for healthy sport life. It provides an easy way to health and sport consultants to keep control over individuals during sport activity. Sport monitoring system decreases the costs of check-up requirements after every sport day. By integrating this system as a sport consultant module to current sport applications, can make them more useful and safe for people.

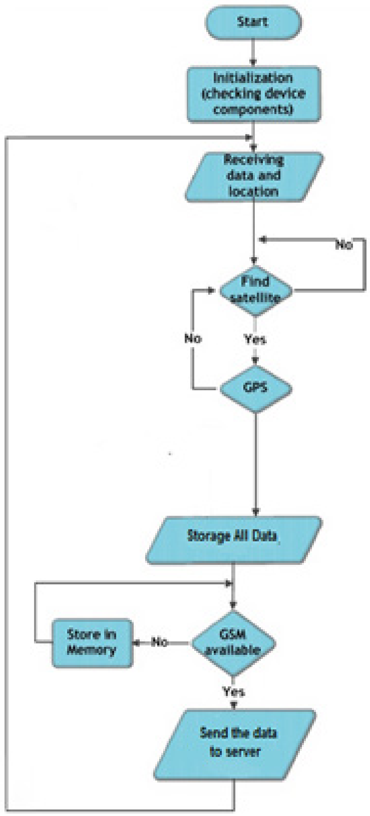

Figure 11. *3G Communication Flowchart*

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Camera Based Product Counting of Belt Conveyors

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ABSTRACT

This work involves the development of a vision-based system for counting the numberof products that pass on a conveyor belt. The system has applications in automatic control and optimization of industrial processes that involve belt conveyors and their related packaging operations. Determining automatically the number of products to be packaged without the need for additional hardware setup yields an important reducement in the initial cost of the complete installation. In this work, by introducing a vision based approach, thus with involvement of image and video processing techniques, counting of products passing on a belt conveyor system just using a camera is investigated.

Keywords: *Matlab, Conveyor Belt, Image Processing, Simuling, Image Processing Toolbox, Camera Based Product Counting On Belt Conveyors*

1. INTRODUCTION

The basis of this project is to apply computer vision techniques to develop a program which should recognize and count products passing on a conveyor belt image frames, and enumerate their value. That is to have a computer "watch" the image and then tell the user the total number of the products which are on the image, therefore to be packaged in the next step.

2. CONVEYOR BELT SYSTEMS:

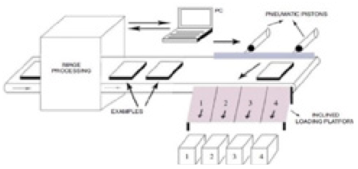

Figure 1.1 *A Generic Conveyor Belt system*

A conveyor belt is a mechanical system that is used to move products from one location to another. Conveyor belt is a continuous loop that is mostly used by almost all factories that make serial production.

As it is known, conveyor belt system is used for efficient transportation of products from one location to another. Therefore, transportation of product becomes faster, easier and safer. Therefore, it is important to decrease cost of production. Aim of conveyor belt that is used in the study is to transfer material from one location to another and also it is used to sort products according to height and shape products.

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3. IMAGE PROCESSING PART

Image processing techniques or in other words computer vision refers to the application of human vision techniques to a computer, teaching the computer to see. The subject itself has been around since the 1960s, but it is only recently that it has been possible to build useful computer systems using ideas from computer vision. This subject is driven by three main areas: computational geometry, artificial intelligence, and image processing (Forsyth 2003).

Computational geometry now is widely used in every corner of science and engineering, from design and manufacturing to astrophysics, molecular biology and fluid dynamics. To build 3D computer models, lots of problems can be solved in these areas.

In artificial intelligence field, people use computer vision technique as a tool to involve both the acquisition and processing of visual information. For instance, recently some companies and research groups focus on face recognition technique, which is widely used in virtual reality, national ID, security trading terminal, CCTV control and etc (Zhao 2003).

A computational vison – image processing system executes the following processes in the specified order:

- Image capture and enhancement
- Segmentation
- Feature extraction
- Matching features to models
- Exploitation of constraints and image cues to recover information lost during image processing,
- Application of domain knowledge to recognize objects in the scene and their attributes.

Image processing is the base of the other two areas. It refers to processing digital images by means of a digital computer. We know that 80% of the information that we get from outside world are captured by the vision, so it is not surprising that images play the single most important role in human perception. However, humans are limited to the visual band of the electromagnetic spectrum, such as ultrasound, electron microscopy. Therefore, we need the imaging machines which cover almost the entire electromagnetic spectrum, ranging from gamma to radio waves. They can operate on images generated by sources that human are not accustomed to associating with image. Thus, digital image processing is applied a wide and varied fields (Gonzalez 2002, p.1-2). For example, in medical imaging, it can be used to enhance imagery, or identify important phenomena or events.

Once the image is acquired in digital form, it is processed using digital image processing routines with the final goal of image segmentation. The initial processing is usually a filtering operation to reduce the noise which is introduced by the image formation process. This process is noisy due to sampling, quantization and random disturbances in the capture hardware.

Filtering has its own associated degradations such as blurring the edges of objects. At this point the filtered image is then segmented into disjoint regions using a possible combination of edge detectors, thresholding techniques, morphological operations and other image processing transforms. This form of processing can be classified as low-level processing where the objects of interest are revealed. There is no object recognition or feature-based classification of regions.

4. MATLAB AND SIMULINK

Introduction

MATLAB is a high-performance language for technical computing created by The MathWorks in 1984. It integrates computation, visualization, and programming in an easyto-use environment where problems and solutions are expressed in familiar mathematical notation.

Typical uses include:

- Mathematics and computation
- Algorithm development
- Data acquisition
- Modeling, simulation, and prototyping
- Data analysis, exploration, and visualization
- Scientific and engineering graphics
- Application development, including graphical user interface building

MATLAB has evolved over a period of years with input from many users. In university environments, it is the standard instructional tool for introductory and advanced courses in mathematics, engineering, and science. In industry, MATLAB is the tool of choice for high-productivity research, development, and analysis. [1]

4.1. HISTORY OF MATLAB

MATLAB was invented in the late 1970s by Cleve Moler, then chairman of the computer science department at the University of New Mexico. He designed it to give his student's access to LINPACK and EISPACK without having to learn Fortran. It soon spread to other universities and found a strong audience within the applied mathematics community.

Jack Little, an engineer, was exposed to it during a visit Moler made to Stanford University in 1983. Recognizing its commercial potential, he joined with Moler and Steve Bangert. They rewrote MATLAB in C and founded The MathWorks in 1984 to continue its development. These rewritten libraries were known as JACKPAC.

MATLAB was first adopted by control design engineers, Little's specialty, but quickly spread to many other domains. It is now also used in education, in particular the teaching of linear algebra and numerical analysis, and is popular amongst scientists involved with image processing.

4.2. What Is MATLAB

MATLAB is a numerical computing environment and programming language. It allows easy matrix manipulation, plotting of functions and data, implementation of algorithms, creation of user interfaces, and interfacing with programs in other languages. Although it specializes in numerical computing, an optional toolbox interfaces with the Maple symbolic engine, allows it to be part of a full computer algebra system. Besides dealing with explicit matrices in linear algebra, it can handle differential equations, polynomials, signal processing, and other applications. Results can be made available both numerically and as excellent graphics.

MATLAB solves many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non-interactive language such as C or Fortran. The name MATLAB stands for Matrix Laboratory. MATLAB was originally written to provide easy access to matrix software developed by the LINPACK and EISPACK projects. Today, MATLAB engines incorporate the LAPACK and BLAS libraries, embedding the state of the art in software for matrix computation.

MATLAB features a family of add-on application-specific solutions called Toolboxes. Toolboxes allow learning and applying specialized technology. Toolboxes are comprehensive collections of MATLAB functions (M-files) that extend the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many others.

As of 2004, MATLAB was reported to be used by more than one million people in industry and academia.

4.3. WHAT IS SIMULINK

Simulink is a software bundled with MATLAB for modeling, simulating, and analyzing dynamic systems. It supports linear and nonlinear systems, modeled in continuous time, sampled time, or a hybrid of the two. Systems can also be multi-rate, i.e., have different parts that are sampled or updated at different rates.

Simulink enables users to pose a question about a system, model it, and see what happens. With Simulink, models can be built easily from scratch, existing models can be taken and be added to it. Thousands of engineers around the world use Simulink to model and solve real problems in a variety of industries.

5. IMAGE PROCESSING TOOLBOX

Image processing is any form of signal processing, where the input is an image, such as a photograph or video frame; the output may be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional array and applying standard signal-processing techniques to it.

Application areas behind the interest in digital image processing methods are so varied and can be listed into two main categories (namely, improvement of pictorial information for human interpretation; and processing of image data for storage, transmission, and representation for machine vision.). Space applications, medical imaging, remote earth resources observations, and astronomy are examples of those applications, where improvement of pictorial information for human interpretation is apparent. Studying pollution patterns from aerial and satellite imagery, image enhancement and restoration procedures to process degraded images of unrecoverable objects are two further applications that can basically serve geographers and archeologists respectively. In machine vision applications, interest focuses on procedures for extracting information from an image in a form suitable for computer processing.

The digital image processing involves a number of fundamental steps (e.g. image acquisition, image enhancement and preprocessing, edge detection and segmentation, representation and description, and matching and recognition). The output of these steps is either an image or an image attribute.

An important characteristic in the design of systems is the level of testing and experimentation that is normally required before arriving at an acceptable solution and hence obtaining a feasible system implementation. This characteristic is applied to the field of digital image processing, where extensive experimental work involving software simulation and testing with large sets of sample images is generally required to offer solutions to problems.

6. FUNDAMENTAL STEPS IN IMAGE PROCESSING

The field of digital image processing is referring to processing digital images using a digital computer. Whereas, a digital image is composed of a finite number of elements, each of which has a particular location and value. These elements are referred to as picture elements, image elements, or pixels. Before going to processing an image, it is converted into a digital form. Among the many and variant possible processing and analysis steps performed on a digital image, we, in this paper, are more interested in image edge detection and segmentation, and image matching and recognition processes.

Image Enhancement: Processing an image so that the result is more suitable for a particular application. (sharpening or deblurring an out of focus image, highlighting edges, improving image contrast, or brightening an image, removing noise)

Image Restoration: This may be considered as reversing the damage done to an image by a known cause. (removing of blur caused by linear motion, removal of optical distortions)

Image Segmentation: This involves subdividing an image into constituent parts, or isolating certain aspects of an image. (finding lines, circles, or particular shapes in an image, in an aerial photograph, identifying cars, trees, buildings, or roads.

Edge Detection: Edge detection is a type of image segmentation techniques, whose main task is to determine the presence of an edge or a line in an image and outlines them in an appropriate way. Prewitt, Sobel, and Canny have developed other edge detector operators, whose mask operators for both x, and y axes are tabulated in Table I. The mask operators are [3x3] arrays (matrices).

Name of the operator	Mask for x-axis			Mask for y-axis		
Prewitt	-1	0	1	1	1	1
	-1	0	1	0	0	0
	-1	0	1	-1	-1	-1
Sobel	-1	0	1	-1	-2	-1
	-2	0	2	0	0	0
	-1	0	2	1	2	1
Canny	1	2	1	-1	0	1
	0	0	0	-2	0	2
	-1	-2	-1	-1	0	1

Mask operators for three edge detecting operators

Image Matching: The matching process is refereeing to finding a correspondence between various data sets. The data sets can represent images, photographs, maps or any other form of object model. Matching has always been a challenging problem in the area of image research and development. Some factors, which can pose problems in image matching includes, but not limited to; changes in the image content, plane rotation, change in scale, change in illumination, and differences caused by electronic noise.

The basic principle of matching is to search through all the pixels for the right area which is identical to a given template image. However, because images are normally having huge amount of pixels, it's not realistic from the performance point of view to apply a complete search in the image space. For this specific reason, proposed image matching algorithms are improved to reduce searching time and having an optimized performance. Another fact that need to be considered as well is existence of various number of image matching algorithms tailored to suit specific applications such that no general algorithm is available that is optimized for all variety of uses. Image matching algorithms are categorized as; area based, feature based, transformation model, direct methods, spatial domain methods, frequency domain methods, and image nature based methods. For the experimental and simulation purposes, in this paper, a relatively simple matching algorithm is proposed and adopted.

A condition is that both images are of the same dimensions. If all pixels are found identical then input images are considered matched. The algorithm however, may accept some differences between corresponding pixels and still consider a matching decision for input images, if the user fixes a threshold value for such acceptable differences

7. TYPES OF DIGITAL IMAGES

- **Binary:** Each pixel is just black or white. Since there are only two possible values for each pixel (0,1), we only need **one bit** per pixel.

- **Grayscale:** Each pixel is a shade of gray, normally from **0** (black) to **255** (white). This range means that each pixel can be represented by **eight bits**, or exactly **one byte**. Other greyscale ranges are used, but generally they are a power of **2**.

- **True Color**, or **RGB**: Each pixel has a particular color; that color is described by the amount of **red, green** and **blue** in it. If each of these components has a range 0–255, this gives a total of **2563** different possible colors. Such an image is a "stack" of **three matrices**; representing the **red, green** and **blue** values for each pixel. This means that for every pixel there correspond 3 values.

8. MATLAB AND DIGITAL IMAGE PROCESSING

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. The basic data element in MATLAB, which is an interactive system, is a matrix. This allows finding solutions to many technical computing problems, especially those involving matrix representations, in a relatively short time compared to the time required to write a program in a scalar non-interactive language such as C.

MATLAB is complemented by a family of application-specific solutions called toolboxes. The Image Processing Toolbox is a collection of MATLAB functions (called M-functions or M-files) that extend the capability of the MATLAB environment for the solution of digital image processing problems. The toolbox supports four types of images: (Grayscale, Binary, Indexed, and RGB images). The toolbox provides specific functions that perform converting images from one class to another.

Edges of an image are considered a type of crucial information that can be extracted by applying detectors with different techniques. The Image Processing Toolbox includes a group of edge detectors through its edge function. This functionality allows one to specify any of the derivative (gradient) filters discussed in the preceding section. The edge function accepts an intensity image and returns a MATLAB binary image, where pixel values of 1 indicate where the detector located an edge and 0 otherwise.

General Commands:

- **imread:** Read an image
- **figure:** creates a figure on the screen.
- **imshow(g):** which displays the matrix g as an image.
- **pixval on:** turns on the pixel values in our figure.
- **impixel(i,j):** the command returns the value of the pixel (i,j)
- **iminfo:** Information about the image.

Arithmetic Operations:

These operations act by applying a simple function y=f(x) to each gray value in the image.

- Simple functions include **adding** or **subtract** a constant value to each pixel: y = x±C
- (imadd, imsubtract)
- **Multiplying** each pixel by a constant: y = C•x (immultiply, imdivide)
- **Complement:** For a grayscale image is its photographic negative.

Histograms:

- Given a grayscale image, its histogram consists of the histogram of its gray levels; that is, a graph indicating the number of times each gray level occurs in the image.
- We can infer a great deal about the appearance of an image from its histogram.
- In a **dark** image, the gray levels would be clustered at the lower end
- In a **uniformly bright** image, the gray levels would be clustered at the upper end.
- In a **well contrasted** image, the gray levels would be well spread out over much of the range.
- **Problem:** Given a poorly contrasted image, we would like to enhance its contrast, by spreading out its histogram. There are two ways of doing this.

Thresholding:

- **Single thresholding:** A grayscale image is turned into a binary image by first choosing a gray level **T** in the original image, and then turning every pixel black or white according to whether its gray value is greater than or less than **T.**
- A pixel becomes white if its gray level is > **T**
- A pixel becomes black if its gray level is <= **T**
- Double thresholding: Here we choose two values T1 and T2 and apply a thresholding operation as:
- A pixel becomes white if its gray level between **T1** and **T2**
- A pixel becomes black if its gray level is otherwise

Color Images:

- A **color model** is a method for specifying colors in some standard way. It generally consists of a 3D coordinate system and a subspace of that system in which each color is represented by a single point.
- **RGB:** In this model, each color is represented as 3 values **R**, **G** and **B**, indicating the amounts of red, green and blue which make up the color.
- **HSV:**
- Hue: The “true color” attribute (red, green, blue, orange, yellow, and so on).
- Saturation: The amount by which the color as been diluted with white. The more white in the color, the lower the saturation.

Value: The degree of brightness: a well lit color has high intensity; a dark color has low intensity.

9. CONCLUSION

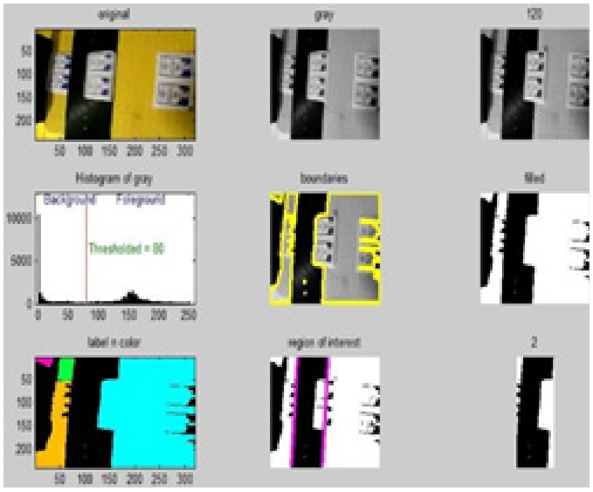

Figure 9.1 *Overall View of Analysis Window*

A complete view of the analysis and counting process visualization window is shown in Figure 9.1 where each item and its corresponding process will be given next. Here, both for simplicity and for paying the main attention on the image/video processing and counting algorithm a conveyor belt video prepared by www.4SmartMove.com where I have downloaded and used.

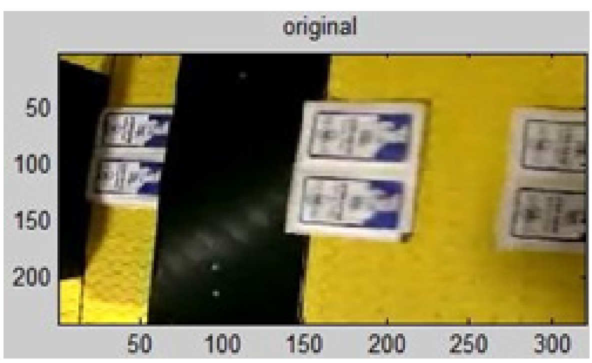

Figure 9.2 *Original Video*

There are several similar commercial videos prepared by the mentioned company and in detail a frame of the one of the incorporated videos can be seen in Figure 9.2. On a yellow background of the conveyor belt, products pass by. Resolution of the videos are 240x320 pixels, thus when I read the video in Matlab and separate it in frames, I obtain a 240x320x3 sized frame, thus it has RGB components.

Figure 9.3 *Gray Frames*

To apply processing easier and faster, RGB images (each one of the frames) are transformed to gray level images as can be seen in Figure 9.3. So to again for the computational concerns, a sampling process is conducted such that not using every frame but capturing one of each four frames to process further. Therefore image processing procedure becomes much more feasible for real-time applications in particular.

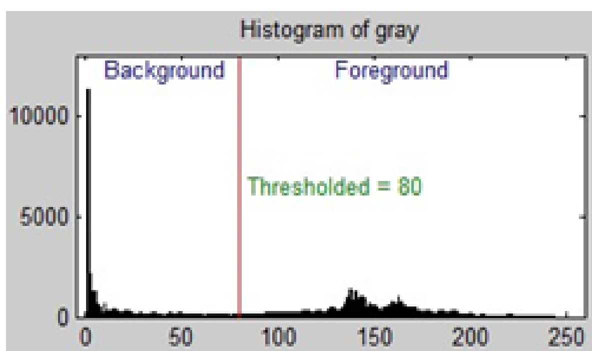

Figure 9.4 *Histogram of Gray-level Distributions*

After obtaining sampled gray-level images, a better way to simplify images is to transform them into binary valued images. In order to accomplish this transformation, here comes the histogram analysis part. By incorporating a histogram analysis, we can have information on the distribution of gray-levels in an image. For instance, in Figure 9.4 histogram values of a frame can be seen.

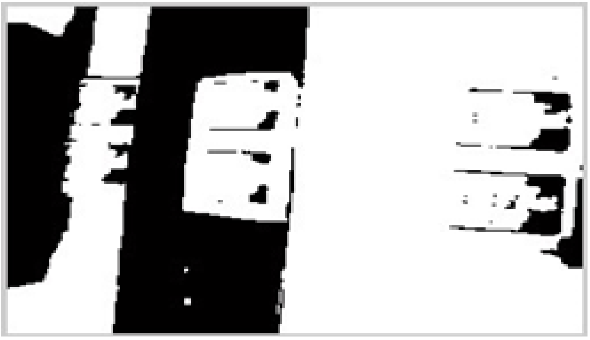

Figure 9.5 *Binary valued image*

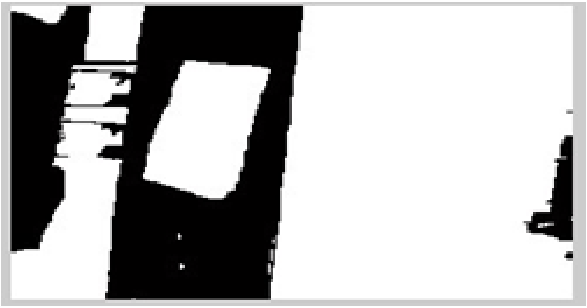

Figure 9.6 *Filled version of the image*

Viewing of the gray-level distributions of an image yields a better understanding for the determination of the threshold value and/or values for binary-valued version image. From Figure 9.5 thresholded, i.e. binary version of the image can be seen. Chosen level, 80, as threshold value gives best result which is determined by trial and error and justified by the histogram plot as mentioned above. Lower or higher values do not yield adequate results, especially when filling 22 To further advance image processing in order to provide a smoother ground for counting application, filling small but irrelevant parts in contrast with seemingly big and/or available parts, an image filling approach is done. As a result a satisfactory image for consequent steps has obtained. The filled image that comes after the binary valued version can be seen in Figure 9.6. Before beginning to count products one more step is added to processing in order to visualize better the process, which is the labeling of the structures, that can be seen by eye, in our final filled images.

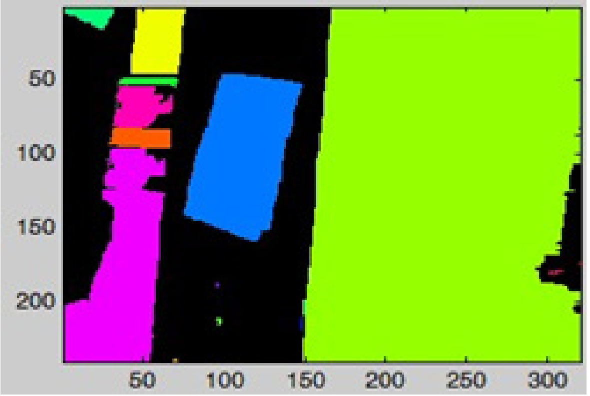

Figure 9.7 *Color-labeled image*

Before beginning to count products one more step is added to processing in order to visualize better the process, which is the labeling of the structures, that can be seen by eye, in our final filled images. Labeled image – parts then assigned random color codes as can be seen from Figure 9.7.

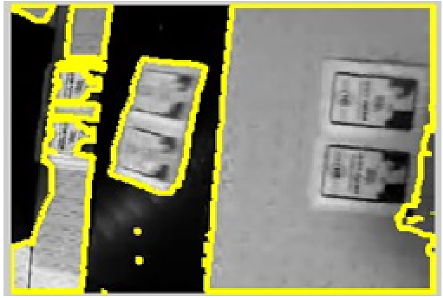

Figure 9.8 *Boundaries of Sub-structures*

A critique step comes here, which is the determination of boundaries in our image, which are the end lines of sub-structures. This step yielded a good determination of products on the conveyor belt, and an example frame for this step can be seen in Figure 9.8 where boundaries are plotted yellow onto the gray-level image.

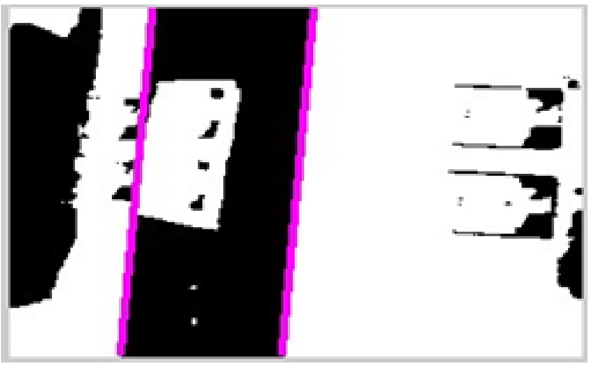

Figure 9.9 *Region of Interest*

Utilizing these boundaries, we can determine a 'region of interest' in order to apply counting process effectively. From Figure 9.9 it can be seen that the best possible region is selected, as it is shown in marble lines on the binary valued image.

Figure 9.10 *Target Area for Counting*

Finally, cutting this region gives us enough information for starting counting process. This novel part of the image can be seen from Figure 9.10. Resting part is a bit more straightforward, thus we have an almost black ground, where white 'products' pass on that surface.

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