We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

172,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

Artificial Intelligence Tool and Electronic Systems Used to Develop Optical Applications

Margarita Tecpoyotl-Torres¹, Alberto Ochoa²,
Jesús Escobedo-Alatorre¹, Miguel Basurto-Pensado¹,
Arturo García-Arias¹ and Jessica Morales-Valladares¹,
¹*Research Center for Engineering and Applied Sciences (CIICAp),
Autonomous University of Morelos,*
²*University of Juarez City
México*

1. Introduction

As we know, the computer science and electronics have a very big incidence in several research areas; optics and photonics are not the exception. For our group, the utilization of computers; and electronic systems and devices has permitted to develop several projects to control processes. Some of them will be described in this chapter.

In section 1, the development of irradiance meters based on electronic automation are shown. The design details and the results produced by the analysis of illumination sources in visible range are discussed. In the second section of this chapter, a description of the computer tool called Micro Engraved with Laser (MGL) to characterize materials is realized. The Reasoning Based on Cases (RBC) and its implementation in the software using Java are presented. In order to guaranty the lithography precision, a control system based on a microcontroller was developed and coupled to the mechanical system. On the other hand, in section 3, an alternative of engraving, considering the use of a Personal Digital Assistant (PDA), instead of a Personal Computer (PC) is described. In this case, C language is used for programming. With RBC, the application has the capacity to keep information in the cases library. Its use optimizes the materials characterization, recovering information of materials previously characterized. The communication between the PDA and the displacement table is achieved by means of a system based on a micro-controller DSPIC. The developed computers tool permits us to obtain lithography with channels narrower than an optical fiber, of approximately 145 μm , with minimum equipment. In section 4, perspectives of micro drilling are also analyzed. Micro drilling with smaller channel diameters is a challenge, with a complete analysis of mechanical material properties. The benefits of Laser-induced plasma machining technique are mentioned. Finally, in section 5 our conclusions are provided.

2. Applications of electronics systems to irradiance meters

The light detection constitutes a wide field of analysis in optics. As we know, the light can be detected by the eye, but it has several disadvantages, compared with electronic devices

Source: Advances in Lasers and Electro Optics, Book edited by: Nelson Costa and Adolfo Cartaxo,
ISBN 978-953-307-088-9, pp. 838, April 2010, INTECH, Croatia, downloaded from SCIYO.COM

designed to this purpose, such as a very slow response, a not adequate sensitivity to low-level signals, and it is not easy connected to electronic receiver for amplification, or other signal processing (Palais, 1984). The selection of the appropriate detector is very important in the irradiance meter design. It must be considered the costs, spectral responsivity, noise levels, and the type of meter where it will be inserted.

On the other hand, the type of meter can be determined in accordance to the objective that could be the determination of the total irradiance or the distribution produced by an illumination source. For the first case it is well known the Ulbrich Sphere, is generally used to determine the lamps performance and the energy emitted in visible, infrared, and ultraviolet radiation. For the second case, different types of meters have been developed in order to provide an empirical base of information for specific characteristics, such as: photometer and portable intensity light meters. The use of electronics and programming tools has been determinant in the development of these devices. For example, some of the portable meters use microprocessors to increase the accuracy and to give them special characteristics. Other ones are equipped with memory or datalogger for the data recording. In both cases, the addition of these characteristics represent a considerable increase in the cost.

Basic concepts

A high interest in illumination intensity measurement has been shown in several fields, for example in architecture design and public illumination (Westinhouse, 2000), where the selection of the appropriate sources is fundamental and constitutes one of the biggest reasons for the realized studies. Another area of interest is generated by the necessity of manufactures of illumination sources to provide complete information for users, making necessary the characterization of the irradiance profiles. In research activities, the interest in the energy propagation produced by an illumination source has lead to widest studies in the total irradiance and the corresponding distribution.

The power of optic beam is proportional to the light intensity (defined as the square of the electric field). Intensity is proportional to *irradiance*, the power density; its units are watts per square meter.

2.1 Semi-spherical irradiance meter

Among the current projects on this area, at first, we developed a semi-spherical irradiance meter prototype (Roman G., et al, 2006), figure 1, based on Light Emitting Diodes (LEDs) detectors array, distributed in order to produce an uniform covered area (figure 2).

The selection of the optical detector was realized in this case considering basically the costs, because its number in the static array is considerably big.

The optic power generated by a LED is linearly proportional to the forward driving current (Palais, 1984). The linear relationship can be understood by the following argument: The current I is the injected charge per second is then $N=i/e$, where e is the magnitude of the charge on each electron. If η is the fraction of these charges that will recombine and produce photons, the optic power output will be:

$$P = \eta N W_g = \frac{\eta W_g}{e} i \quad (1)$$

For emission, the diode is forward biased, and charges injected into the junction recombine to produce photons. For detection, the process is reversed: the inversed biased and incoming photons generate electron-hole pairs, producing electrical current.

Fig. 1. (a) Complete irradiance meter, based on a detectors array. (b) Photograph.

Fig. 2. Detectors distribution.

Fig. 3. Spectral responsivity of LED E5/AMB-C.

The largest response proving LEDs of different colors, as detectors was given by an amber LED used as detector, so, it was chosen to form part of the semi-spherical arrangement, in order to analyze white illumination sources profiles.

As the LEDs are commonly acquired without a data sheet, it is necessary to characterize them, this action can be realized by means of a monochromator, in this case, the ACTON 300. The spectral responsivity of this detector (E5/AMB-C) is shown in figure 3, from 350 up to 900 nm. The setup designed to characterize the detectors (LEDs) is shown in figure 4(a) and (b). As the response to illumination on a semiconductor junction, is a very small current, we use the amplification circuit shown in figure 4(b), with an amplification factor determined by the back-feed resistance (Horowitz, 2001). The capacitor was implemented to establish the analyzed signals. The linearity of the circuit can be appreciated in figure 4c, which was kept until the saturation region that means, approximately until 4.15 μ A. The maximal response was obtained at 570 nm (figure 3). The linear relation between the irradiance and the voltage is considered due to the linearity of the detection circuit.

Fig. 4. Linear response of I-V converter circuit.

A multiplexing stage was necessary due to the number of detectors (61), which is bigger than the number of the analogical inputs (16) of the used acquisition card (PCI-MIO-16E-1 de National Instruments). The data collection rate was of 1.25/16 MS/s, using a dual

(74HC4052) multiplexer. Each of the 8 conditioner cards is formed by the amplification and the multiplexing circuits (figure 5). The 8 conditioner cards were placed on the meter base (figure 1).

Fig. 5. Signal conditioner circuit.

Data visualization

The flowchart shown in figure 6 was used in the development of the collection and average data program. The data collection is realized by the acquisition data card and displayed using a program realized in LABVIEW, the data are storage, and this process is repeated 4 times, completed this cycle all is repeated again. When 100 data are collected in each detector, the corresponding average is calculated, which forms part of the useful data. After, the process is repeated again, and the new averaged data replace to the previous ones, this process continues until the user gives a stop.

The irradiance profiles, generated with this semi-spherical prototype, were presented using bubbles schemes. An X-lamp LED (figure 7) of warm white light, with an emission diameter of 1.9 cm, was tested. Its irradiance profile and irradiance pattern are shown figures 8 and 9, respectively. This meter can be used as a quality control device for illumination sources such as lamps and bulbs. In the obtained discrete profiles, the following fact was considered: according to the Pointing vector physics, the irradiance is proportional to the voltage intensity detected in each sensor of the meter. These voltage values permit to obtain the corresponding profile of each source and give the capability to choice of more adequate sources for specifics tasks.

Fig. 6. flowchart of the developed program.

Fig. 7. Photograph of X-lamp LED.

Fig. 8. Irradiance profile of the X-lamp LED.

Fig. 9. Irradiance pattern of the X-lamp LED.

Some disadvantages of this static meter are given by the use of the detectors array produce, which produces a not uniform response also at the same co-latitude angle, as can be appreciated in figure 6, especially in the last two external trajectories of detectors. These differences in the spectral response were produced basically for the fabrication processes. As it is known, even in LEDs from the same manufacturing batch, a difference in response exists, although it could be minimal. This fact produces errors in the determination of the irradiance profile from 12% up to 90% in critical cases. The error could be reduced being more careful with the sensor selection, and replacing them when it is necessary, but always it would be present due to their inherent differences. This fact shows the importance of the individual characterization before the selection final elements of the array. The alignment of the illumination source is another important source of error, that can be appreciated in the corresponding data fitting using Zernike polynomials (Sanchez-M. et al., 2003).

The irradiance pattern (figure 7) generated considering the line sensors shown in figure 2 has another inconvenient, the appearance of a piece linear graph produced by the small number of sensors (only 9), and the variations in symmetry produced by their differences in the spectral responsivity. In order to reduce these inconvenient, the use of a single detector is suggested, coupled to a mobile mechanical structure. Although the XY table is very expensive, its availability in several optical labs permits to think in them as a very practical solution, after a certain adaptation, and considering its precision. The automation of the movements could be realized, using step motors or servomotors, without an excessive inversion. The use of recyclable convenient surfaces are recommended. In this case, the use of a CD ROM platform is analyzed.

2.2 Rectangular irradiance meters for convergent sources. Another application of the XY table automation

Manufacturers employ photometric curves for electric lamps, referring them at 1000 lumens, when their emitted fluxes are different of this quantity a normalization is used. These curves are obtained as a section of 3D intensity distribution, for all the solid angles, generally are indicated in polar coordinates, but for specific applications are also provided in Cartesian coordinates, such as in the case of projectors. The attention in this section is focused on the

last representation, convenient to convergent sources, for whom the utilization of rectangular irradiance meters is suitable.

The use of XY tables for different applications has been widely reported (Gwirc, S., et al, 2007, Jaimes-V., et al, 2005) and the case of three grades of liberty has also analyzed (Yañez V., et al, 2008). In this section, a rectangular prototype, based on an XY table, used as irradiance meter is proposed. The use of only one detector makes necessary the implementation of a mechanical mobile support. The implemented detector is a photodiode OPT301. The semiconductor photodiodes have some advantages, above the LEDs used as detectors, that must be mentioned: they are small, light, sensitive, fasts, and can operate with just few bias volts. In order to increase the response, a preamplifier must be integrated onto the same chip as the photodiode, producing an Integrated Detector Preamplifier (IDT), which is the case of the OPT301. The spectral responsivity and its linear response to irradiance can be consulted in [www. Alldatasheet.com](http://www.Alldatasheet.com). Clearly this response is bigger than the LED one, which generally have widths of 20-50 nm (Palais, 1984).

The rectangular prototype was designed on a CD ROM unit, in order to build a very low cost mechanical structure, with the following characteristics:

- The mobile part of the XY table is used to describe the linear trajectories on X and Y axes. It has a total area of $19 \times 14 \text{ cm}^2$. The scanning area is of $4.5 \times 3.5 \text{ cm}^2$. The total height of the base is of 7 cm.
- The square grid was established for simplicity of 14×15 detection points.
- The displacement was controlled by means of servomotors.
- The detector is assembled at one corner of the mobile base (figure 10).
- The illumination source is located over the central part of the mobile area.

Fig. 10. Meter (a) diagram and (b) photograph.

The XY movements were programmed on the base of the diagram flux shown in figure 11. A photograph of the complete detection circuit and the diagram, using an OPT301M as detector, a dsPIC30F4011 for the movements programming and a display as a graphical interface to the user are shown in figure 12 and 13, respectively.

Servomotor movement

The servomotors normally have a capability to move from 0 to 180 grades in accordance to a signal control (figure 14). The control program is based on the generation of a very precise rectangular signal, with a period of 200 ms, the width of the pulse is modified depending of

the desired position of the rotor, if a position of 90 degrees is required, the sent pulse must be of 1.5 ms. In this application, for the control pulse generation, two timers of 16 bits were implemented, one for the period and the other one for the pulse duration (figure 15).

Fig. 11. Flow diagram

Fig. 12. Photograph of the rectangular meter composed by a XY table and the detection circuit.

Fig. 13. Schematic of the detection circuit.

Fig. 14. Relationship among the control signal and the movement of the servomotor.

```
void Scanning_table_xy(void)
{
    int i,j,data_RD;;
    int long retardo;
    delay=10000;          //useg
    for(i=0;j<30;j++)
    {
        motor_X=0;          //move Y
        time_pulse_Y=time_pulse_Y+50;
        _delay_1(retardo);
        motor_X=1;          //move X
        for(i=0;i<26;i++)
        {
            time_pulse_X=time_pulse_X+50;
            _delay_1(retardo);
            data_RD =Read_ADC(); //Read data of optical sensor
            WriteUART2(i,j,data_RD);
            _delay_1(retardo);
        }
        time_pulso X=900;
        _delay_1(80000);      //Delay function
    }
    //Delay function
    Void _delay_1(int long time)
    {
        while(time!=0) time--;
    }
}
```

Fig. 15. Main program of scanning, reading and sending data to PC.

They were also implemented interruptions (figure 16), which permit to each timer “to notify” to the CPU when each temporization finishes. The control signals for the two motors of the system XY are implemented at the pines 3 and 1 of the D port, respectively.

Communication system between the mecatronic system and the computer

The serial port US-232 is used to transfer all data read by the optical sensor in each swept point of the table (x, y coordinate) to the computer. A program developed in C, and compiled in the compiler for C of Microchip for family DSPIC30F was implemented. The obtained data are storage in a txt file in the PC, and after, the corresponding graphs are generated using suitable software, as ORIGIN.

```

void __attribute__((__interrupt__,no_auto_psv)) _T1Interrupt(void)
{
    IFS0bits.T1IF = 0; /* clear interrupt flag */
    if ( motor_X == 1)
    {
        PORTDbits.RD3=1;    //motor X
        ini_tmr2(time_pulso_X);

    }
    else
    {
        PORTDbits.RD1=1;    //motor Y
        ini_tmr2(time_pulso_Y);

    }
    return;
}
//interruption to define the period time
void __attribute__((__interrupt__,no_auto_psv)) _T2Interrupt(void)
{
    IFS0bits.T2IF = 0; // clear interrupt flag
    if ( motor_X == 1) PORTDbits.RD3=0;    //motor X
    else PORTDbits.RD1=0;    //motor Y
    return;
}

```

Fig. 16. Interruptions.

```

// Send data to PC
WriteUART2(Txdata_x,y);
while(BusyUART2()); // Wait for complete transmission
Config_uart2 (void)
{
    unsigned int baudvalue;    // Rate value
    unsigned int config1 ;
    unsigned int config2;      CloseUART2();
    ConfigIntUART2(UART_RX_INT_EN & UART_RX_INT_PR6 &
    UART_TX_INT_DIS & UART_TX_INT_PR5); //Interrup config
    // config frequency of transmission
    // Baud = Fosc/(16(UBRG-1)); UBRG=(Fosc/(16*Frec Baud))+1
    baudvalue = 25;           //for 9600bauds

    // Config1 UART2 for 8 bit transmission with one bit stop
    // Also Enable loopback mode
    config1 =    UART_EN & UART_IDLE_CON &
                UART_DIS_WAKE & UART_DIS_LOOPBACK &
                UART_EN_ABAUD & UART_NO_PAR_8BIT &
                UART_1STOPBIT;
    config2 =    UART_INT_TX_BUF_EMPTY &
                UART_TX_PIN_NORMAL &
                UART_TX_ENABLE & UART_INT_RX_CHAR &
    //UART_TX_ENABLE & UART_INT_RX_3_4_FUL
                UART_ADR_DETECT_DIS &
                UART_RX_OVERRUN_CLEAR;
    OpenUART2(config1, config2, baudvalue);
}

```

Fig. 17. Data sending and configuration function for UART (Universal Asynchronous Receiver-Transmitter).

Results

The photodetector was biased with 13V, and without a source of illumination, a lecture of 0.606 V was registered. Three luminaries were analyzed with this meter (figure 18), a dirigible X-lamp LED IL51, a lamp conformed by an array of three LEDs IL1 LED3; and a single ultra bright white LED. The distance between the X-lamp LED and the photodetector was fixed at 13 cm, and due to the different sizes of the lamp with three LEDs, the distance was reduced at 10 cm. In the case of the single white LED, the distance was of 17 cm.

Fig. 18. (a) Dirigible X-lamp LED IL51, as a sample and the XY table. (b)Lamp IL/1 L3 (with a 3 LED array; and (c) single white LED

As can be appreciated in figure 19b, the illuminated area produced by a dirigible X-lamp is almost regular, showing a deviation of only 0.25 units considering a radius of 4.35 distance units. These deviations can be attributed basically to the differences in the gear teeth driven by each servomotor. The high directivity of this illumination source permits to suggest its use in architecture and landscape lighting, for visual inspection, among other possible applications. The level of analysis achieved with this prototype permits us to observe very little details, which are very difficult to observe with other devices, as the case shown in figure 20, where we present the irradiance pattern generated by a spherical mobile prototype developed also by our research group, using the same detector and the same detection circuit. In the last case, the beamwidth is easily determined, and complements the information about the source under test.

Fig. 19. Irradiance profile of dirigible X-lamp LED (a) complete and (b) top view.

Fig. 20. Irradiance pattern of the dirigible X-lamp LED.

The use of high brightness LEDs in lamps improves several fields of interest in illumination, such as energy-saving, uniform covering and longer lifetime. The level of directivity of lamps based on LED technology has been modified with the use of special metallic covers, as in the case of the dirigible X-lamp LED IL51. For other applications, such as for decorative exterior in gardens, or for paths illumination, lamps like the IL/1 L3 can be used. Its corresponding radiance profile is given in figure 21. As can be observed, it provides a wider illumination angle than the dirigible X-lamp, covering almost uniformly to the total scanning area. In figure 22, the irradiance pattern obtained with the same spherical prototype of the figure 20 is presented. In both cases, the flat surface on the illuminated area is evident.

Fig. 21. Irradiance profile of lamp with three LEDs (a) complete and (b) a zoom in on the left side.

Fig. 22. Irradiance pattern of the single ultra bright white LED generated by the spherical prototype.

Finally, a single ultra bright white LED was tested with the prototype. The corresponding irradiance profile is shown in figure 23. This LED showed problems of stability that means variability in the voltage measurements, and a little asymmetrical response. The same

behavior was observed using the spherical irradiance meter and a lux-meter. Its maximum illuminance was of 84 lux at a distance equal to 27 cm, very lower compared with the illuminance produced by the lamps based on a power star LEDs of high brightness, such as the dirigible X-lamp LED, where 1700 lux was measured on the top.

Fig. 23. Irradiance profile of the single ultra bright white LED.

Fig. 24. XY table used as irradiance meter.

In order to increase the scanning area other suitable recyclable surface could be used, such as the conformed by the photocopiers rails (figure 24). Its optical sensor, photodiodes for visible light like BS520 (www.datasheetcatalog.com), designed to applications in precise optical instruments, is useful to use for our purposes, due to its higher stability compared to the semiconductor photodiode used in the CD ROM platform. The BS520 photodiode is most expensive, but the possibility of recycling permits to consider it as a good option. Generally, the absence of the serial numbers of the elements in the photocopier diagrams makes necessary to characterize the detector spectral responsivity before to use it. The data fitting for rectangular geometries can be realized by means of Chevyshev Polynomials (Tecpoyotl, 2006). As we known, the disperse data may lead to large errors unless we use a discrete reduction, as it happens commonly in image analysis.

It can be concluded that the implementation of a single detector in irradiance meters reduces the measurements error due to variations in the spectral responsivity. The precision in this

case is determined by the control of the XY displacements. In absence of the servo motors implementation, manual control can be also carried out, keeping the reliability of the measurements, due to the worm drives coupled to the XY table. Similar structures can be realized on the base of the meter presented here, for example, using recycled printer rails or making mechanical structures of low cost. The bigger inversion would be realized on the detection circuit, which involves the DSPIC programming. A total scanning area, at least at 20x20 cm² is suitable in order to realize measurements of the luminaries of larger sizes. Also it is suggested to be very careful in the selection of all parts of the prototype, because as we mentioned, the little variations for example in the gear teeth can produce deviations in the generated profiles.

The implementation of the rectangular meter permits to observe with a great detail the profile produced as a result of the beamwidth of the illumination source under test. The generated information permits us to realize a comparison with other spherical prototype developed by our research group, and to have complete information about the total irradiance profile. The rectangular prototype provides empirical information necessary not only for manufacturers, but also for research activities. We found this prototype very useful due to the controllability of position, which increases the feasibility of the measurements, and provides a very complete irradiance pattern for the case of directive illumination sources. The application of the XY table automation shows the high potential of this type of devices.

3. An artificial intelligence development tool to micro engraved with laser (MGL) to control and optimization of the laser engrave process

The purpose of this project is to make devices that can be used in the optical fiber sensors, which requires micrometric dimension engrave. The process consists of two AutoCAD design that acts as reproduction by controlling 2 steps motors adapted to move X, Y axis mechanism. Case Based Reasoning (CBR) methodology is used to optimize the process. In a simple way, CBR resolves a new problems (new case) by a comparison with the other resolved problems (case library), it takes one or more solutions from the most similar cases, the proposed solution is evaluated and if it is necessary, this is adapted. Finally, if the proposed solution solves the problem, the new case is saved in the case library, in contrary case, it is not saved and the comparison continues. In this way, the systems infers knowledge or experience, given better results in accordance with its case library extension. The laser power approach is obtained under this procedure, as a function of the new material properties (per example, the hardness). The comparison of the specific properties with other cases or materials already characterized, makes possible to optimize the process by reducing engraving probes in new materials.

Nowadays, any line of development or research depends on the existing materials and equipment in other areas or development lines very near to it. This it is the case of the area of sensors and optical fibers, which depends mainly on the development of equipment in the communication area, where they are mutilated or modified with other pieces to be able to be used. This kind of problem can be reduced, if each device, considering its material, is designed and made in accordance to the proposed procedure.

The main problem is to make devices in order to apply them in the area of sensors from common materials. This entails two new problems:

- To characterize the materials
- Method of engraving

The devices fabrication can be realized by several methods, such as (Trimmer, 2005):

- Micro mechanized by ablation laser
- Micro mechanized by diamond
- Micro perforated
- Stereolithography or micro molded photo
- LEAGUE (X-ray lithography with metalized)
- Using Excimer laser

From the previous methods, if the purpose is to reduce the costs of the project to the minimum, the most viable for us is the one of engraving laser. For its utilization, it is necessary to account with a high-power laser and the possibility of using different materials from waste (like wood, plastic, paper, among others) to realize the engraving tests. The laboratory of Optics of CIICAp has all these conditions, making possible to realize here all test for the engrave laser process.

Based on the previous research, two lines of work are considered:

1. To characterize the materials to use (like the dimension and depth of penetration of the channel) by means of the CBR Technique (Software), and
2. To design a mechanical device to control the displacements in X and Y axes

In CBR systems, in order to adapt and evaluate a possible solution, frequently it is necessary to consider new recovered cases (representing the problem as a case). There are many cycles in the process (figure 25). Each case typically contains a description of the problem (attributes or characteristics of the problem), a solution and its result (García et al., 2005).

Fig. 25. Basic Cycle of CBR.

In order to find the laser power to use in a new material: the new case (material) is compared against the cases in the case library by means of the near neighbor technique based on the equation 2.

$$\text{Similarity} \quad (T, S) = \sum_{i=1}^n f(T_i, S_i) \times W_i \quad (2)$$

where:

T is the new case

S is the case source

n is the number of attributes in each case

i is an individual attribute from 1 until n

f is the function of similarity for attributes i in cases T and S

W is the importance (the weight) of attribute i

The weights of each attribute are assigned by the expert (a person that assigns the weight to the attributes based on the quality of the engraving), which are designated by an annotation generally going from 0 to 1. For example: the hardness of the material has a weight of 0.60 whereas the translucence has a weight of 0.05. But, not all the attributes (characteristic of the material) are not taken into account, such as the case of the material color, since it is not useful for the analysis.

The values of similarity between the materials change whenever a new material is added to the case library. While greater it is the number of attributes (n) and it is counted on an extensive Case Library, the time in calculating this similarity will be greater for example, if we have 5 attributes in each case and a case library with 100 cases, 500 calculations cases will be realized (5*100). Some authors recommend having a base of cases smaller than 100 cases (Lake, 1996).

The recovered more similar cases are used to suggest a solution that is reused and tried on successfully. In case of being necessary, the solution will be reviewed and adapted by the expert. In addition the expert can make a suggestion like adding wet paper or other techniques that help to obtain an engraving with greater quality. Finally, the present problem and the final solution are conserved as a new case (material characterized). Any solution and/or characteristic of some material can be modified later by the user; while more cases have the system will be able to approach an ideal solution for the engraving of a new more case.

The calculation tool was developed with the programming language Java SDK standard edition 1.42 with more than 3.000 classes (Chan, 2002), along with JBuilder X, they are used to create applications in graphics mode multiplatform (Easttom, 2003). It was necessary to use usesPort and parport-win32 libraries for the shipment and reception of data by the parallel port. The user interface is based on the principle of easy and friendly software (Schildt, 2001).

The system is based on the following process for the accomplishment of the engraving (see Figure 26):

1. The user uses software to interchange the design created in AutoCAD to another one with DXF extension, in ASCII code (Tajadura, 1999). At the moment, designs with lines are only processed (command line).
2. The software only has the data necessary to realize traces (lines made in Autocad), reducing the size of the DXF archive. It transforms the simpler archive MGL (with the same name but with the extension mgl).
3. The user selects the material of the materials base. In case of being a new material, it is added to the system providing its characteristics. The system realizes the CBR process

- to suggest the power for the new material, on the base of the resolute cases (material characterized) and the tests of the new material. The fundamental parameters considered for the engraving quality are: the power for engraving and the focal distance, while for the material are: basically the hardness and the roughness, for future analysis the new cases also would consider: information about translucent, heat resistance, and metallic or not metallic characteristics.
- Continuing with the process, the user selects the lens for the engraving considering the focal length and the diameter of the focal point.
 - The software based on the Autocad file of the design, kept with the extension mgl, realizes the outlines through a communication stage (parallel port), to control the displacement of a milli-machined table. The objective is to control the rotation of the two motors. An improve in the mechanical system was realized by adding the a variable height, and a third motor, which functions as an shutter in order to avoid not desired engravings.
 - At the end the tool, the description of the engraving will be required to the user, using the RBC. The information is stored in the bookstore of cases to make future comparisons between engravings, in order to find an optimized design giving a solution improved for the task that the user wishes to realize. The RBC contribution in the control software is to suggest the power required for engraving in order to reduce the range of the necessary tests for the characterization of the new material. The characterized cases are considered to realize the similarity process.

Fig. 26. Schematic diagram of the operation of the calculation tool for the engraving with laser.

The material characterization has been realized considering 4 different tests, based on:

- The focal distance
- The laser power
- Variations on the exposition time
- Traces and sizes (using an Autocad template)

The focal distance tests permits to determine the smallest possible diameter of the focal point. The variable power test produced, depending of the material characteristics, a proportional dependence between the damage and the applied power; the utilization of RBC, by the accumulated experience permits to reduce the range of realized tests. The variation in the exposition time produced the best defined channels, but it takes a lot of time. The variations in trace and sizes tests provide satisfactory results, in spite of some mechanical problems.

The application of CBR to the system produced satisfactory results, better than of those than it was expected, such as the realization of engravings with channels less wide than the same optical fiber (approx. 145 μm) and engravings become attached to the dimensions in the design obtaining in this way a significant advance in spite of the used equipment. The quality of the engraving also depends of the used material. The system continues under development. The present work outlines a prototype with currently obtained results.

It can be concluded that the system has wide possibilities to be more than a tool used in the devices design for sensing area, due to its capacity for both, to engrave and to realize cuts in different materials. The following stage of this project will be the accomplishment of a communication interface between a Palm and a mechanical system by means of electronics to control the precise movements of servo motors, as well as a more reliable and precise mechanical system. Another stage would be to control a new parameter, the displacement in Z axis, which would permit to control the depth of the engraving as well as arcs, ellipses and other more complex geometric figures.

4. Computer tool for engraving by means of PDA (Personal Digital Assistant) based on RBC

This section describes a computing tool on the Interface Development Environment (IDE), that was developed in an environment of development Code Warrior V9, in "C" language. This IDE accounts with an emulator, which allows to make tests before installing the program in the PDA. The goal of this tool is to characterize materials through the Artificial Intelligence technique named Case-Based Reasoning (CBR), with the help of this technique and a few of instructions, the characterization of the materials can be optimized. The development consist in choosing a few of parameters that allow us to do the search in the case library through the CBR and then process the data in the PDA. The information is send to the serial port, which after is sent to the receptor that transmits it to the motors.

The engraving techniques in their origins were realized by equipment of great sizes. Nowadays the computers are more and more small and economic, and so the use of the CNC (Computerized Numerical Control) has been extended to all type of machinery: winches, rectifiers, machines to sew, among others.

Development of a measure tool, that through CBR, handles the information of different materials

The objective is to characterize materials besides executing the program in a portable device that allows the adaptation of the user to the work area. The device that will serve like

control is a PDA that has capacity of processing and data storage. These devices count with series and infrared ports. The difference between them is that first one depends on a physical connection, while the infrared does not. The series port requires of wires, but they can be larger than the corresponding to parallel port, and the number of wires is smaller. The pines Tx, Rx and GND of the connector DB9 are used to connect the PDA to the microcontroller. The data conversion is realized by means of the UART module.

The final mission is to characterize material through a complete system that includes our proposed calculation tool, a control module and actuators, as well as a laser.

The CBR is a technique of Artificial intelligence, its methodology is used in our computer tool. The CBR allows having an optimization in the characterization of the materials; some of the data that are being handled to be keeping in the case library are: material name, thickness, translucence, and the figure to be engraved. The CBR accounts with a basic cycle (See Figure 27) that includes the four r's:

- To recover the case(s) more similar;
- To reuse the case(s) to try to solve the problem;
- To review the propose solution in case of necessity, and
- To retain the new solution as it leaves from a new case.

Fig. 27. The Basic Cycle of RBC [adapted of the proposed by (Aamodt & Plaza, 1994)].

A new problem is compared against cases in the cases library and the more similar cases are recovered. A solution is suggested as a result of the similarity analysis, which later is reused and tested in order to achieve the success of the solution. Unless the recovered case is a very similar case, the solution will probably have to be reviewed producing a new case that can be conserved. This cycle happens, currently, rarely without the human intervention (see figure 28). For example many tools of CBR (Ochoa et al., 2004) act mainly as recovery of the case and reutilizing systems. The revision of the case (also call adaptation) is realized often by the ones in charge of the Case Library. Nevertheless, this does not have to be seen like debility of the CBR, since it permits to work as a tool of making decision, with the human collaboration in aid of the best decision (Wainer et al., 2005).

The Code Warrior V9, under the "C" programming language, provides an atmosphere, which allows to build an interface of easy handling for the user. The diagram of figure 28 shows how the system works.

Fig. 28. Blocks under which the developed tool works.

This process begins when choosing the kind of the design to realize from:

- 1. Predetermined design or
- 2. Design at free hands,

If the first option is chosen, a window is opened, where the user has a series of designs previously made, after the selection of one of them is realized, the next step is to introduce data of the material to use. A new window with a list of materials is displayed; if the desired material is not previously registered previously in the list, the program provide a series of fields for fulfill its corresponding information. With this information the system realizes tests if it is desired, to acquire a suggested power for engraving. This last data is obtained with all the previously acquired data and processed by the methodology of CBR (Morales et al., 2005).

In this way, the program accounts with all necessary information to complete the process and send the information through the series port to the control module of the actuators. The procedure concludes with the laser engraving (figure 29).

Fig. 29. Conceptual diagram, showing the Process of control by means of PDA.

The computer tool was development to realize different tests of engraving, as in the case of the system shown in section 2. About the hardware, the motors are moved bi-directionally, they are controlled by a PALM and have the capability to realize different types of trajectories to engrave surfaces. Several tests were realized with texts engraving. The use of recyclable material permits the development of the system with minimum costs.

The system is in the stage of finals tests and runs in a PALM 100m (Wilding-McBride, 2004), the electronic module already is in operation; and the bookstore of cases accounts with information of different materials. It is tried that this system can be used from any place where the user is located by means of Internet (WWW). In addition, the possibility to storage more parameters of the materials provides more precision in their characterization.

5. Future trends

The technique called Electrochemical Machining (ECM) is an anodic dissolution process. It utilizes an electrolytic cell formed by a cathode tool and an anode workpiece with a suitable electrolyte flowing between them. The anode workpiece is dissolved according to Faraday's law when a sufficient voltage is applied across the gap between the anode and the cathode in which electrolyte is filled. Electrochemical processes for drilling small and fine holes by controlled anodic dissolution invariably use a weak acidic solution as electrolyte (Shan, 2004). These include electrochemical drilling (ECD) and acid based ECM drilling processes: shaped tube electrolytic machining (STEM), capillary drilling (CD), electro-stream drilling (ESD), and jet electrolytic drilling (JED). The advantages of acid based electrochemical hole drilling processes are:

- Good surface finish;
- Absence of residual stress;
- No tool wear;
- No burr and no distortion of the holes;
- Simultaneous drilling of large number of holes.

The use of acid electrolytes in ECM hole drilling processes facilitate dissolution of metals and the removed material is carried away as metal ions thus making it possible to achieve smooth finish with closer tolerances and deep holes of high aspect ratio (Bellows and Kohls, 1982).

Another Laser (continuous or pulsed) technique named Laser Beam Machining (LBM) is one of the most used techniques, based on thermal energy, of type non-contact. This process can be applied for almost whole range of materials. The lasers used for machining in the industries are CO₂ and Nd:YAG. This two lasers are the most stable. In this kind of work, the use of power and focusing are everything needed to monitor.

The mechanism of material removal during LBM includes different stages such as

- a. Melting,
- b. Vaporization, and
- c. Chemical degradation (chemical bonds are broken which causes the materials to degrade).

If a high energy density laser beam is focused on the work surface the thermal energy is absorbed, which heats and transforms the work volume into a molten, vaporized or chemically changed state that can easily be removed by flow of high pressure assist gas jet (which accelerates the transformed material and ejects it from machining zone) (Hirao et al., 2001). The schematic of LBM is shown in figure 30.

The interesting part is that each material possess a different response to the light. Some interesting materials have been studies as drilling of gamma-titanium aluminide (Biswas et al, 2009). Among the most important materials in optoelectronic devices, the Glass is found, with a high transmission from the UV to IR wavelength region, excellent thermal and electrical properties, and high chemical resistivity (Weber, 2003; Hirao et al., 2001). Furthermore, the glass properties are controllable by adjusting the composition during

Fig. 30. Basic setup of LBM

development and fabrication. However, these properties make the glass a challenging material to machine (Herman, 2000). Due to poor thermal properties, fabrication of finely machined features using laser-based processes e.g. grooves, channels, microholes, stand-alone levers, etc., in glass materials has been quite a difficult task.

Laser technologies based on nanosecond (ns), femtosecond (fs) and laser-induced plasma processing were investigated in order to obtain high quality laser micro-fabricated features on glass materials. Direct write laser using short pulses from ns and fs lasers influences the quality of processed glass significantly and produces crack-free, clean machining with careful control of the associated thermal processes. Laser-induced plasma machining technique allows fabrication of small-size, shallow features along with superfine surface finishes within the channels. The potential of these technologies have benefits in the fabrication of complex features for biomedical, microfluidic, MEMS and optoelectronic devices.

6. Conclusions

This work confirms the relevance of the automation in optics applications. For the realization of all the prototype, it was required of a multidisciplinary team, involving basically programming, electronics and optics knowledge.

7. References

- Aamodt, A. & Plaza, E. "Case-Based Reasoning: Foundational Issues, Methodological Variations, and System Approaches. *AI Communications*, 7(i): pp 39-59.
- Bellows G., Kohls J.B., Drilling without drills, *American Machinist*, Special Report 743 (1982) 173-188.
- Biswas R., Kuar A.S., Sarkar S., Mitra S. "A parametric study of pulsed Nd:YAG lases micro-drilling of gamma-titanium aluminide". *Optics & Laser Technology*, In Press, Corrected Proof, Available online 20 May 2009.
- Chan, Patrick "The Java Developers ALMABAC 1.4, volume 1", Addison Wesley 2002.
- Easttom, Check "JBuilder 8.0 JFC and Swing", Wordware Publishing; 2003.

- García, Luis A.; Basurto-Pensado, Miguel & Ochoa, Alberto. "Herramienta de Cómputo para Grabado con Láser", Universidad Autónoma de Zacatecas, ENINVIE 2005.
- Gonzalez-Roman A., Tecpoyotl-Torres M., Escobedo-Alatorre J., Pal-Verma S. and Sánchez-Mondragón J. "A semi-spherical Irradiance meter used as a quality control device". Proceedings of the First Multiconference on Electronics and Photonics. MEP 2006. Pp. 253- 256 (2006).
- Gwirc, S.; Rigotti, J.; Federico, A.;Acquaticci, F. 6o. Jornada de desarrollo e innovación tecnológica. Imágenes Ultrasónicas con Transductor Piezoeléctrico de Película. Instituto Nacional de Tecnología Industrial, (2007).
- Herman P.R., Marjoribanks R.S., Oettl A., Chen K., Konovalov I., Ness S., Appl. Surf. Sci. 154/155 (2000) 577.
- Hirao K., Mitsuyu T., Si J., Qiu J. (Eds.), Active Glass for Photonic Devices: Photoinduced Structures and Their Application, Springer-Verlag, 2001.
- James C. Maida. "An illumination modeling system for human factor analyses". Space human factors laboratory/Flight crew support division/NASA Johnson Space Center.
- Jaimes-Vera Edith Alíne, Basurto- Pensado M.A., Escobedo-Alatorre J. Jesus. Diseño y programación de una mesa para mili-maquinado., ENINVIE 2005. Encuentro de Investigación en Ingeniería Eléctrica, 2005.
- Lake, David B., "Case-Based Reasoning- Experiences, Lessons, & Future Directions", Edit. The MIT Press 1996.
- Morales, J.; Basurto, M. & Ochoa, A. "Herramienta de Cómputo para Grabado mediante PDA", Zacatecas, Zacatecas 2005.
- Ochoa A. et al. "Proceedings of Doctoral Forum, PRICAI 2004, Auckland University of Technology, August 2004.
- Palais, Joseph C., Fiber Optic Communications, Fourth Edition, Prentice Hall, (1984).
- Paul Horowitz, Winfield Hill. The Art of Electronics. 2nd Edition. Cambridge University Press. Pp. 996. 2001.
- Sánchez-Mondragón, J., Tecpoyotl-Torres M., Andrade-Lucio J. A., Torres-Cisneros M., Dávila-Alvarez A. and Carpio-Valadez M.. "Data fitting on a spherical shell". Proceedings of SPIE proceeding Vol. 5181. Pp.51-55 (2003).
- Schildt, H. "Java 2: The Complete Reference, Fourth Edition", Edit. McGraw Hill 2001.
- Shan H.S., Advanced Manufacturing Methods, New Delhi, 2004.
- Tajadura, J.A. et Al. "Autocad 2000 Avanzado", Edit. Mc Graw Hill, 1999.
- Tecpoyotl-Torres M, Partida-Rivera E., Gonzalez-Roman I. A., Ibarra-Manzano O. and Sánchez- Mondragón J.. "Reconstruction of atmospheric vertical reflectivity profile images". Proceedings of the First Multiconference on Electronics and Photonics. MEP 2006. Pp. 262-265. IEEE CN 06 Ex1524. (2006).
- Trimmer, William "Micromechanics and MEMS" Wiley & IEEE book, ISBN 0-7803-1085-3, 2005.
- Yañez Valdez, R. *, M. Ruiz Torres, E. Morales Sánchez, E. Castillo Castañeda. Diseño y Construcción de una Mesa de Trabajo XYθ basada en un Mecanismo Paralelo Planar 3RRR. Tecnólog@ Vol. 1, No. 2, may- ago/2008 © 2007 CICATA-Querétaro-IPN. ISSN en trámite. México.
- Wainer, J.; Borgonovi, Luana & Ochoa, A. "Ornithological Classification using case-based reasoning for discovered new species", UNICAMP Postdoctoral program; Radamaelli, Brazil. January 2005.
- Weber M.J. (Ed.), Handbook of Optical Materials, The CRC Press, Boca Raton, Fl. 2003.
- Westinhouse. Manual del alumbrado. 4ª edición. Limusa. Noriega Editores. Madrid (2000).
- Wilding-McBride, Darly. Java Development on PDAs, Addison-Wesley 2001.

Advances in Lasers and Electro Optics

Edited by Nelson Costa and Adolfo Cartaxo

ISBN 978-953-307-088-9

Hard cover, 838 pages

Publisher InTech

Published online 01, April, 2010

Published in print edition April, 2010

Lasers and electro-optics is a field of research leading to constant breakthroughs. Indeed, tremendous advances have occurred in optical components and systems since the invention of laser in the late 50s, with applications in almost every imaginable field of science including control, astronomy, medicine, communications, measurements, etc. If we focus on lasers, for example, we find applications in quite different areas. We find lasers, for instance, in industry, emitting power level of several tens of kilowatts for welding and cutting; in medical applications, emitting power levels from few milliwatt to tens of Watt for various types of surgeries; and in optical fibre telecommunication systems, emitting power levels of the order of one milliwatt. This book is divided in four sections. The book presents several physical effects and properties of materials used in lasers and electro-optics in the first chapter and, in the three remaining chapters, applications of lasers and electro-optics in three different areas are presented.

How to reference

In order to correctly reference this scholarly work, feel free to copy and paste the following:

Margarita Tecpoyotl-Torres, Alberto Ochoa, Jesus Escobedo-Alatorre, Miguel Basurto-Pensado, Arturo Garcia-Arias and Jessica Morales-Valladares (2010). Artificial Intelligence Tool and Electronic Systems Used to Develop Optical Applications, *Advances in Lasers and Electro Optics*, Nelson Costa and Adolfo Cartaxo (Ed.), ISBN: 978-953-307-088-9, InTech, Available from: <http://www.intechopen.com/books/advances-in-lasers-and-electro-optics/artificial-intelligence-tool-and-electronic-systems-used-to-develop-optical-applications>

INTECH
open science | open minds

InTech Europe

University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China

Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821

© 2010 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the [Creative Commons Attribution-NonCommercial-ShareAlike-3.0 License](https://creativecommons.org/licenses/by-nc-sa/3.0/), which permits use, distribution and reproduction for non-commercial purposes, provided the original is properly cited and derivative works building on this content are distributed under the same license.

IntechOpen

IntechOpen