Following a bright object through a simple computer-controlled system

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Abstract

This material will describe a simple object tracker system through the processing of images brought by a camera. The follow-up system described and accomplished in this material can serve to track any object in a camera image, so it is an almost universally follow-up system. The schematic system presented follows a way how by following the movement of the sun, the solar panel with the photo element is positioned in the direction where the active surface for the light flow gets the maximum value. The result of this panel positioning is that the generated current is maximized by the fact that the energy that falls on the photoelectric panel receives the maximum value.

1. Introduction

The principle scheme of the follower system is presented in Figure 1.
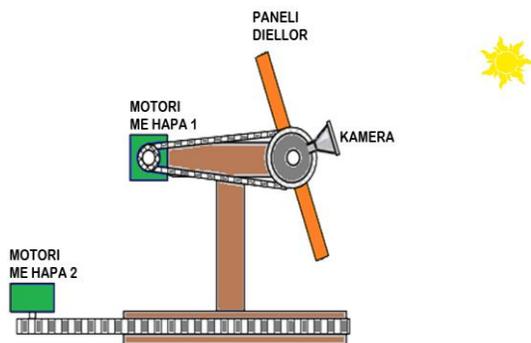

Figure 1: The principle scheme of the follower system.

The system is made up of two stepper-motors which provide the movement of the photoelectric-panel (known also as a solar panel) in two different planes, making possible the pursuit of the moving object (in this case the sun).[Tau97]

Below, there are a couple of ways on how to build the schematics which provide control for the stepper-motors [Pau84]. The stepper-motor comands come from the analysis of the pictures taken from the camera.

A more detailed system is provided below in Figure 2.

Figure 2: The system for the pursuit of the bright object

Elements that are part of this system:

- The computer.
- Module for the stepper-motor control.
- Camera.
- The solar panel with its mechanical system which provides the movement of the oanel in one, two and three directions.
- The devices that control the level of charge for the batteries, the battey system, inverter etc.

The main steps for the pursuit of the bright object are as shown below in the diagram in Figure 3. Below there is also a list of steps to be followed when we are in the pursuit of the bright object.

- We take the image from the camera and send it to the computer.
- The image is changed into a black and white picture(green scale).

- We identify the position of the bright object from the images.
- We calculate the displacement of the center of the bright object from the center of the image.
- We check if the displacements from the center are greater than a variable that holds the minimal value for moving.
- We convert the pixels calculated from the step above into number of steps for the stepper-mottor.
- We execute the commad that will move the stepper-motor using the anlge of movement calculated from the step above.
- The process is repeated starting at step 1 oncwe again, after some time.

We will analyze two simple computer-controlled systems, for the pursuit of the bright object :

- Controlling the solar panel from the computer using PIC18F4550-I/P Microchip Microcontroller & ULN2803 [Tau84]

- Controlling the solar panel from the computer using the module Stepper-Bee.

We know the functions that we need to use to controll the steps of the motor from the USB port using PIC18F4550-I/P & ULN2803 as well as the module Stepper-Bee [Tau84]

The program will control the pursuit of the bright moving object (the sun) orienting the solar panel towards the sun in order to get the maximal energy generated. We know that the panel and the sun rays need to form a 90 degree angle. In such a case, the camera that is connected with the solar panel, will have on its focus the sun. In oder for the camera not to be damaged from the sun, its lenses will be painted with a dark color or a dark lens will be placed instead.

During the movement of the sun, the bright image that we get from the camera with a dark background will be displaced from its initial position. As a result, the rays from the sun will not be perpendicular with the plane of the solar panel.
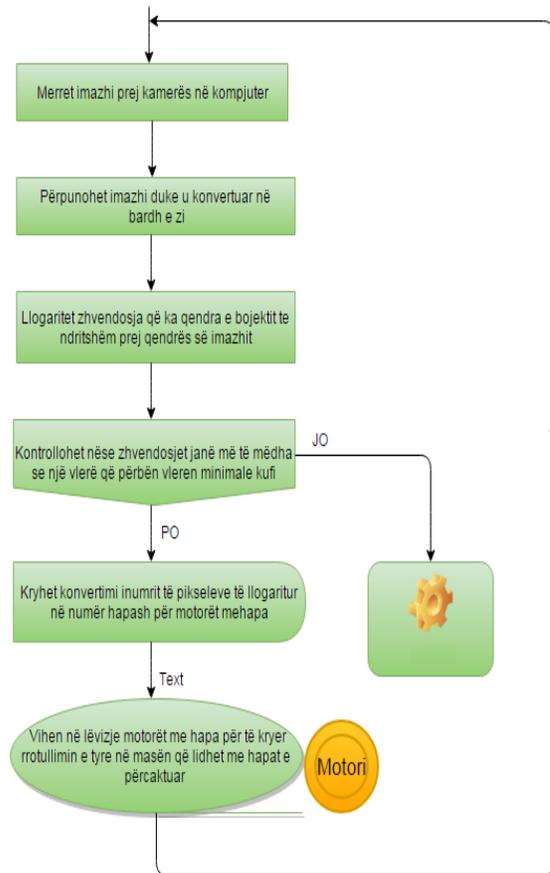

Figure 3: The main steps in realizing the pursuit of the bright object.

In order for them to be perpendicular, the image of the bright object should be displaced in the center of the image provided from the camera. This can be done only if we rotate the solar panel until the sun is on top of the center of the image we got from the camera. The rotation of the panel can be done using a stepper-motor only in one direction, following the movement of the sun from east to west. In this case , the control of the solar panel from the computer as shown in Figure 4, can be done using PIC18F4550-I/P Microchip Microcontroller & ULN2803.

Figure 4: Controlling the solar panel from the computer via PIC18F4550-I/P Microchip Microcontroller & ULN2803

The rotation of the panel can be done using two stepper motors. In this case the movement of the sun would be in both planes, from east to west and from north to south.

Figure 5: Controlling the solar panel from the computer via Stepper-Bee modul

The system can be described in the schematic given in Figure 6. The program that is built in Visual Basic 6.0 [Fra11] allows for the control of the systems that are shown in Figure 4 and Figure 5. After identifying the position of the bright object in the general image provided by the camera,we calculate the number of pixels from the center of the image of the sun to the center of the image of the camera [Gar12].

In the figure, this variables are :

NrRreshtaPixelNgaQendraObjektit

and

NrKolonaPixelNgaQendraObjektit

This two variables will be converted into numbers of steps and then we will control each of them so that they rotate according to the calculated steps. This way, the object will be displaced towards the center of the image of the camera.
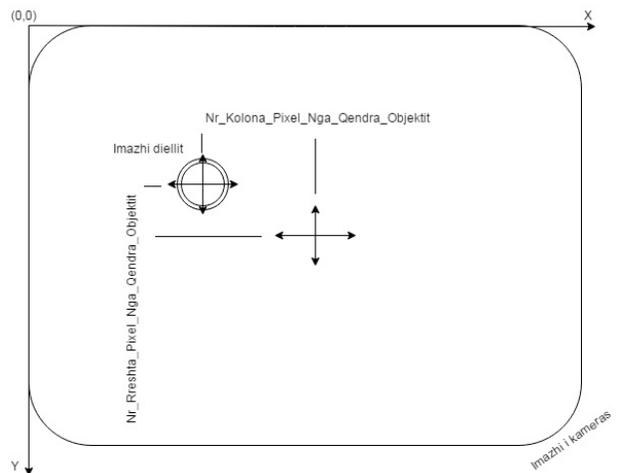

Figure 6: Scheme of tracking the sun from the system afterwards analyzing the image taken from the camera

2. Following of the bright object, commanded by the computer program

The GUI program built to control the movement of the panel in one and two axises is shown in Figure 7. The

initial activation of the program starts with the click of the button 'INICIALIZIME PER MOTORET' which creates the connection with the module PIC18F4550-I/P Microchip Microcontroller & ULN2803 or module Stepper-Bee [6]. The program has two ways of functioning, manual control and automatic control of the module. The manual control of the module allows the system to function in a manual way, allowing the user to control motors A and B. The motors can get the set of movements using the arrows shown in GUI and stop when you click on the 'Stop' button.

The codes that provide the movement of the motors are as shown below :

FilloLevizjenMotori 1, CInt(Abs(.NrRreshtitQenderObjekti - .NrRreshtitQenderImazhi) / txtInterval.Text), txtInterval.Text, 0, 1

FilloLevizjenMotori 2, CInt(Abs(.NrKolonesQenderObjekti - .NrKolonesQenderImazhi)/ txtInterval.Text), txtInterval.Text, 1, 1

In GUI we are given the calculated coordinates of the center of the object in pursuit, the coordinates of the center of the image as well as the distance of those two in pixels.

The codes are as shown below:

LlogaritKordinataXY = GjejPozicioninObjektit(Picture1, txtStep.Text)

valRreshtiQenderObjekti.Caption =
          LlogaritKordinataXY.NrRreshtitQenderObjekti

valKolonaQenderObjekti.Caption =
          LlogaritKordinataXY.NrKolonesQenderObjekti

valRreshtiQenderImazhi.Caption =
          LlogaritKordinataXY.NrRreshtitQenderImazhi

valKolonaQenderImazhi.Caption =
          LlogaritKordinataXY.NrKolonesQenderImazhi

lDistanca_QenderObjekti_QenderImazhi.Caption = LlogaritKordinataXY.Distanca_QenderObjekti_QenderImazhi

The automatic control of the module follows the same steps shown at the beginning of this paragraph. An important variable in this case will be 'allowed pixel error' which will hold the smallest value of the difference of the coordinates between the centers, for which the motors will not move. The intervals for the recalculation of the coordinates of the object that we are following are defined by another variable that is expressed through a Timer component in Visual Basic. It will get activated only when the movement of the stepper-motors is over and the cycle has restarted again with a new image obtained from the camera.

The codes for the control of the motor are as follows :

```
' Fillim i levizjes - Motor 1
Public Function FilloLevizjenMotori(
              ByVal NumberMotor As Integer, _
              ByVal Steps As Integer, _
              ByVal Interval As Integer, _
              ByVal Direction As Integer, _
              ByVal Outputs As Integer) As Boolean
     Select Case NumberMotor
     Case 1
        ' Startim i motorit 1
        FilloLevizjenMotori = RunMotor1(Steps, Interval, Direction, Outputs)
     Case 2
        ' Startim i motorit 2
        FilloLevizjenMotori = RunMotor2(Steps, Interval, Direction, Outputs)
     Case Else
     End Select
End Function
```
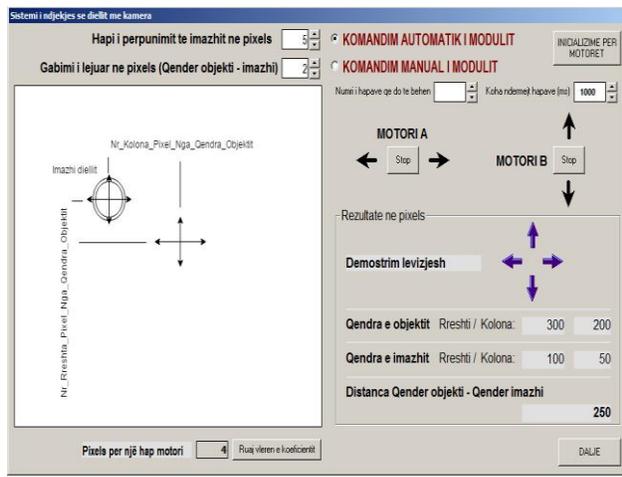
Figure 7: The GUI program built to control the movement of the panel in one and two axises.

The program built in Visual Basic 6.0 to control the modules PIC18F4550-I/P Microchip Microcontroller & ULN2803 and Stepper-Bee in the pursuit of the moving object (in our case it is related to the solar panel) was built with the help of the model provided in Figure 4 and Figure 5.

3. Conclusions

- We described a simple system that follows objects through the analysis of the images that were provided from the camera. The system that we described and built can be used for th pursuit of any bright object, making it a universal system for pursuit of bright objects.

- The system shows a way of how the solar panel with photoelectric elements is positioned where the energy generated from the light has the greatest value.

- We showed the functions that we need to use in order to control the stepper-motor from a USB port using:
  - PIC18F4550-I/P & ULN2803
  - Modulit Stepper-Bee & ULN2803 ose ULN2003

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