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Target Tracking System: PAN TILT

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ABSTRACT: This project aims to develop and utilize a pan tilt system to track the target's movement. The target's movements are viewed using a camera that is mounted on the system before launching the missile. The mode of tracking may be either manual or automatic. Once, the target is fixed, the operator fires the missile which shall eventually hit the target. The pan-tilt is made by assembling the corresponding mount and motors. A joystick controls the pan tilt remotely and wirelessly through an encrypted Radio Frequency data communication link so as to prevent data breaches by the enemy in the combat area. The idea arises from the need for systems that will precisely hit the target without causing any significant damage to the surroundings, thus reducing the loss of life and property.

I. INTRODUCTION

A tracking system is used for the surveillance of objects or people on the move and giving a time to time ordered sequence of location data for next stage processing. It can be defined as the mechanism of continuously sustaining the path of the moving object and keeping track of its motion, orientation, occlusion etc. so as to extract necessary information. In older times, tracking the target during combat operations or battles was primarily achieved manually with the help of a scope. With the advent of technology, the focus has shifted to using an Electro-Optical Tracking System which consists[1] of a camera/complex lens system from which the recorded video is transmitted to an electronic control unit which processes the obtained video feed using Image Processing to compute the position of the target object in a given frame. These systems facilitate wide area surveillance with limited field-of-view in electro-optical sensors (EOT) those by which electronic detectors that convert nature of light, or a change in light, into an electronic signal, which is analyzed to trigger pre-set responses[2].

II. LITERATURE STUDY

This literature survey has been carried out in order to obtain theoretical knowledge behind the concept, working, and need of designing pan-tilt systems. Various methods and components were analyzed for their feasibility of operation and relevance and correspondingly have been chosen to be built for the prototype/project Pan-tilt systems are widely used in various applications but mostly used in standing a camera (as of novel camera). This mechanism is widely employed in industrial, camera surveillance, medicinal applications, military weaponary, agriculture, entertainment, Cinematography etc.

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Panning movement refers to the Azimuthal/Horizontal movement of the lens/camera while tilting movement describes the Angular/elevational/vertical movement. In other words, the amount of azimuth refers to pan whereas the amount of elevation refers to tilt.

[3] A pan-tilt system normally has two degrees of freedom as shown in the above figure. Sometimes, the third degree of freedom is introduced for the rotation of the camera/lens.

Typical pan-tilt systems consist of two motors, one controlling the elevation and the other controlling the azimuth. These two motors, in turn, change the way the camera faces [4]. However, researchers at the Ishikawa Oku Lab at the University of Tokyo have developed a new system called “1ms Auto Pan-Tilt". The device consists of the following: - group of lenses and two mirrors for pan and tilt [5]. Here, rather than moving the camera precisely, the two mirrors are made to move freely at rapid with the goal that the framework doesn't lose its fast reaction regardless of whether a huge, overwhelming camera is mounted[6].

This system is best suited for tracking objects of smaller dimension which are placed very near to (in the order of cm) the camera. Generally, in battlefields, the target is always very far away (in the order of km) and this shall result in the necessity of very large mirrors leading to greater procurement and maintenance costs. Considering the above constraints, the normal pan - tilt system of moving the camera using motors is found to be the most appropriate and feasible system to be implemented in the prototype with a total Azimuth angle of 360 degrees and Elevation range of nearly -20 degrees to +70 degrees. Also, it is found that deploying the system on a tripod mount increases the usability in different terrains and surfaces – a feature that is advantageous during combat. An already existent but dysfunctional Pan Tilt controller and motor setup in the lab had to be debugged and repaired in order to gain practical knowledge of a commercially available pan-tilt controller. This controller was the Secura Lens Pan/Tilt Controller. Figure 1.1 shows the pan tilt controller along with the pan-tilt motor system.

Figure 1.1: Secura Pan Tilt controller and motor

In order to get some insight before debugging the circuit,[8] the working of another existent and functional small pan-tilt controller was briefly explained.

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Taking reference from this, a block diagram for the Secura controller was drafted. It was found that the 6 wires from the controller to the motor were not properly connected as indicated on the motor. Also, certain wires were found to be not connected. [7]With the help of the apprentices in the lab, using a Digital Multimeter, the appropriate positions of the 6 wires were found out and then soldered. This entire hands-on activity not only laid the foundation of the internal working of the controller but also helped in the application of logical thinking for debugging the circuit.

III. PROPOSED METHODOLOGY

The simplified and general block diagram of the working of the developed pan/tilt system is shown in figure 1.2. Here, the operator who is in the bunker manually moves the joystick from which analog voltages are obtained corresponding to the position of the joystick. These analog values are sent to the uC (Arduino in this case) where an Analog to Digital conversion occurs along with some processing. These values are then relayed over to the receiver end by the transmitter using radio frequency. [9]The received values are then sent to a uC where the co-ordinates of the joystick are translated to the corresponding motion of the servo motors in the pan tilt system.

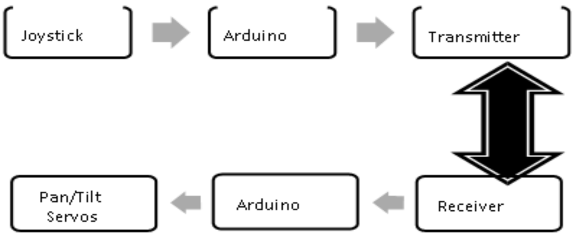

Figure 1.2: Proposed Block Diagram

As a part of the project, Windows based machines were used to run the IDE in order to program the Arduino. Therefore, the steps required for installing the IDE on Windows OS alone shall be shown below. For users of other operating systems, log onto the official website of Arduino for documentation related to installation on other operating systems shown in figure 1.3.

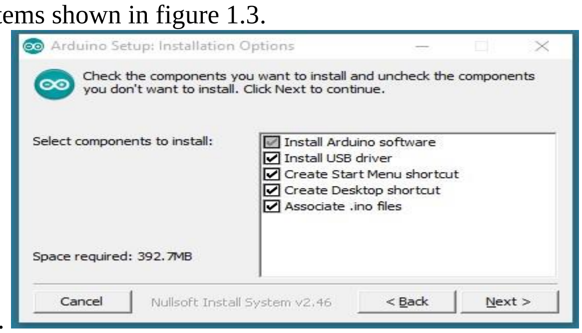

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Figure 1.3: Components to install

Next, choose the installation directory (keeping the default one is suggested) as shown in figure 1.4.

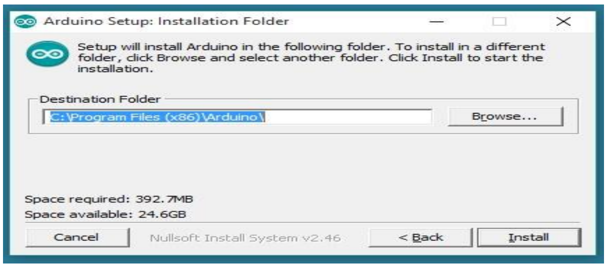

Figure 1.4: Installation directory

The process will now extract and install all the required files to execute properly the Arduino Software (IDE) as shown in figure 1.5.

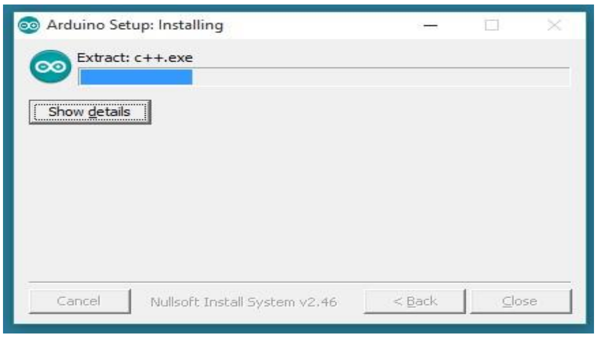

Figure 1.5: Extracting required files

3.1.1 RUNNING THE IDE

Interface the Uno load up with an A B USB link; some of the time this link is known as a USB printer link. The USB association with the PC is important to program the board and not simply to control it up. The Uno consequently draws control from either the USB or an outside power supply. Associate the board to the PC utilizing the USB link. The green power LED (marked PWR) should turn on.

Presently, open the LED flicker precedent sketch: File > Examples >01.Basics > Blink.

Select the board type and port as appeared in figures 1.6. and 1.7 It is important to choose the passage in the Tools > Board menu that relates to the Arduino or Genuino board being used.

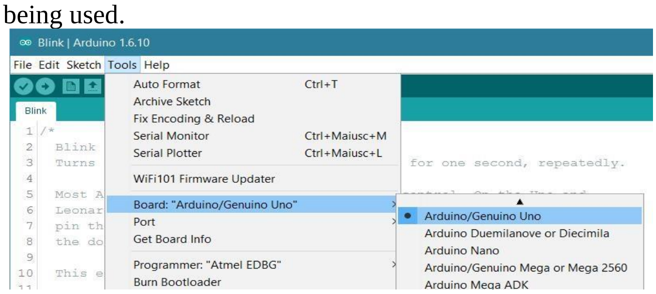

Figure 1.6. Selecting the board

Select the sequential gadget of the board from the Tools | Serial Port menu. This is probably going to be COM3 or higher (COM1 and COM2 are generally saved for equipment sequential ports).

To discover, detach the board and re-open the menu; the passage that vanishes ought to be the Arduino or Genuino board. Reconnect the board and select that sequential port.

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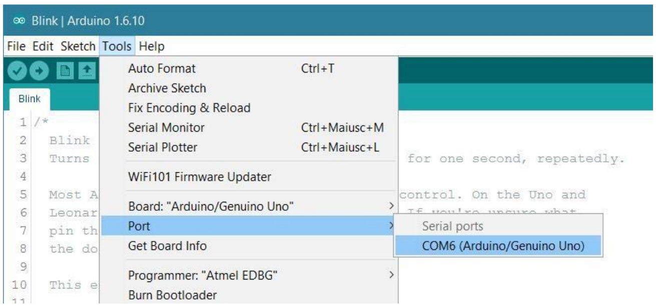

Figure 1.7: Selecting the port

Presently, transfer the program. Just snap the "Transfer" catch in the earth. Sit tight for few moments - if the transfer is effective, the message "Done transferring" will show up in the status bar. A couple of moments after the transfer completes, it is seen that the stick 13 (L) LED on the board begins to squint (in orange).

In this project, there shall be two Arduino UNOs – one each for the transmitter end and receiver end. The USB cable plugged in shall power the Arduino board and also be used to deploy code on the microcontroller. The connections of the various modules, servos and other components have been illustrated. On both these boards, the data being transmitted is encrypted using XOR encryption and is being decrypted on the receiver end. These engines are intended for more errands where an engine position should have been similar to moving an automated arm or controlling the rudder on a watercraft or robot leg inside a specific range (0-180). For standard servos, the servo. Write() function takes angle in degrees as a parameter and correspondingly rotates the servo shaft to the specified angle. On the other hand, for the S3003, the servo.write() will set the speed of the servo (with 0 being full-speed in one direction, 180 being full in anti direction). Refer to Chapter 9 to view the PWM input signal on an oscilloscope. Table 1.1 provides the list of PWM ON times in µs for the corresponding input arguments of servo.write() from 0 to 180.

Table 1.1: PWM ON Times for 0 to 180

Servo.write Parameter	Input PWM ON Time (µs)
180	2400
170	2290
160	2190
150	2090
140	1980
130	1880
120	1780
110	1680
100	1570
90	1470
80	1360
70	1260
60	1160
50	1060
40	960
30	850
20	750
10	650
0	540

The two s3003 servos are fixed in place to the pan tilt mounts (figure 7.3). This mount allows the motors to pan and tilt and they also have provisions on them to screw an external load on them (in this case, a camera). It is known that for effective and nearly lossless data transmission, the length of the antenna is taken as one-fourth of the wavelength.

If 'f' is the frequency in MHz, then the required antenna length, L (in cm) is given by the equation:

$$L = \frac{7132}{f}$$

Here, f = 433MHz

Therefore,

L = 16cm (approx.)

So, in the project, for both the transmitter and receiver ends, a single strand Cu wire of nearly 16cm curled in the form of an inductor has been used the antenna.

A remote camera comprises of an implicit transmitter to send video over air to a beneficiary rather than through a wire. Most remote cameras are in fact cordless gadgets, which imply that despite the fact that they transmit a radio flag, regardless they should be connected to a power source. And still, after all that, "remote" is the normally utilized industry term. A few cameras do have batteries, along these lines making them remote in the genuine sense. In any case, battery life is as yet an issue for expert or semi-proficient applications. In this task, the JMK WS-309AS PAL 1.2GHz remote RF camera pack has been utilized. The camera contains a transmitter whose information is gotten by the recipient. This recipient ought to be associated with a standard simple presentation or an account screen to almost certainly see the video. Here, the Sony GV D1000E PAL computerized video tape recorder has been utilized to watch the got video.

IV. RESULTS AND DISCUSSION

Currently, the camera that is being used does not have zoom feature and so PTZ based cameras and systems maybe incorporated. The camera at present works only during the day time and since battles can take place during the dark, an additional thermal imaging or 'Night vision' camera may be used along with the existing camera.

Figure 1.8: Complete project

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Addition of an automatic target tracking system using an appropriate image processing card or algorithm which may have Artificial Intelligence to identify the enemy on its own instead of the present manual control using joystick. Replace the existing encryption algorithm for the data being sent wirelessly with a military grade or best in class encryption algorithm. Modify the existing gear train system of the pan and tilt motors to obtain a smoother and stronger motion even if it comes at the expense of the speed of the motor.

Develop a fool proof system where even if the operator accidentally fires the missile without locking on the target, the missile should not get fired. Also, the pan motion may be constrained to stop before around 270 degrees so that the missile doesn't face the operator's fellow fighters accidentally, Experiment if the same system may be interfaced using the Internet securely instead of Radio Frequency so that a Mission Control Centre like room may not even require to be within the premises of the battle area so as to mitigate the psychological stress on the operator. Instead of using a single camera, a centrally controlled array of cameras or interconnected cameras may be used depending on the area under observation so that tracking over large areas shall be possible.

V. CONCLUSION

The current Pan Tilt system has been designed and developed with the theoretical and practical understanding obtained in the beginning along with an earlier familiarity of working with the Arduino microcontroller which have successfully led to the implementation of azimuthal and elevation movements of the servo motors controlled by a joystick interfaced through an encrypted communication link. The system thus developed has been made in such a manner that it resembles a real system on a smaller scale and working on it on the lines of the above future scope shall make it more efficient and reliable, our proposed system is shown in figure 1.8.

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