Object Tracking Mobile Robot with Visual Feedback and Zigbee

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***Abstract*—With the advancements in technologies we have entered an era where human intervention from various processes can be eliminated by the use of robots designed to achieve the specific tasks. Object tracking and monitoring is just another field in which 24x7 human assistance is demanded. To obtain this particular task we have proposed this project. The aim of the project is to implement an Object Tracking Mobile Robot. The proposed system consists of a Personal Computer (PC), a mobile robot, an Internet Protocol (IP) based camera and a Zigbee series 2 wireless communication module. The IP based camera is placed on the mobile robot which provides the video feed of the arena to the PC which in turn processes the data using Matlabwith the help of Track Learn Detect (TLD) algorithm and provides the control signals to the Arduino on robot through the Zigbee module for wireless communication.**

***Keywords*—Object Tracking, Robot, Internet Protocol (IP), Matlab, Zigbee Wireless Communication Module, Arduino.**

I. INTRODUCTION

Video surveillance is the most active research topic in computer vision for humans and vehicles. Here the aim is to develop an intelligent visual surveillance system by re-placing the age old tradition method of monitoring by human operators. The motivation in doing is to design a video surveillance system for object detection and tracking. The area of automated surveillance systems is currently of immense interest due to its implications in the field of security. A wide range of research possibilities is open in relation to video surveillance and tracking. With the rise in the field of robotics and automation, it is becoming essential to find out various ways for detection and tracking of malicious objects. The aim of this project is to design an object tracking robot which uses visual feedback and wireless communication. This report present the design of such a robot whose basic components consists of an Internet Protocol based camera, a wireless communication network based on Zigbee and a computer to perform the required computations. Based on the efficiency, Track Learn Detect (TLD) algorithm has been selected to implement the required design.

II. IMPLEMENTATION

Configuration of required softwaresthat is Matlab, Visual Studio, Open CV, CMakefor generation of required binaries and then compilation and execution of algorithm is the first step. This produces the result of tracking for a pre-recorded video on computer as shown in Fig.1.

In order to make the project real time the changes had to be made so that the input should be a live camera feed instead of a pre-recorded video. For using the camera as a real time input device for real time tracking it is necessary to obtain the following things of the camera we want to use, which are :- Adaptor name, Device ID, Format (user dependent). After acquiring all these the frames number of frames need to be set for which we want to do the tracking. After changing the structure from pre-recorded video to the camera and specifying everything the program is run which lands up on the first frame acquired by camera as shown in Fig.2 and tells to select us the region of interest that is the object which we want to track. Selection of the object as shown in Fig.3 in which we selected the eyes as the object or the region of interest to be tracked in the further frames is done. Hence further from the second frame till the last frame set by us the same object is tracked.

A basic serial communication was first established between Matlab and Arduinoover the COM port to which the Arduino was connected. This communication was carried out at a baud rate of 9600 on both the sides that is at the Arduino board and the computer. The medium of this serial communication was the USB to SERIAL cable.

The basic serial communication implemented was then used to communicate with the robot. The robot was first assembled with the parts like the Arduino UNO board, L293D IC, Battery, Buzzer, Wheels, Motors, Chasis.The assembled robot was then connected with computer for serial communication at the time of the object tracking. For this the position and the status of the object had to be analyzed. Accordingly in all from a total of 6 different states, 1 can be present at a time. The 6 states are LEFT, RIGHT, FORWARD, BACKWARD, PERFECT and DISSAPPEARED. The camera streaming format and the resolution of computer give us the values of extremes of X and Y co-ordinates. Using this values we ourselves can decide what to range and threshold to set for the deciding if the object is in right, left, faraway, too close. If the bounding box is not there then the centrepoint cannot be calculated and it will return Not a Number (NaN). This means that the object has disappeared and for this states particular symbol will be sent. We sent 3. If the bounding box is present then the centre point is calculate and then checked for left and right using the thresholds set. Accordingly the symbols are sent. We have set 4 for right and 5 for left. These are sent continuously unless the object is in centre. When the object is in centre then difference between the extreme points of the bounding box is calculated and this difference is compared with that of the first frame with a tolerance of +10,-10. Accordingly

the symbols 6, 7 are sent for the Forward and Backward actions.If none of the above states happen to take place then it means that the object is at the perfect position and for this case a symbol of 8 is sent representing the Perfect position.

The next step was to implement the wireless communication of these control signals via Zigbee. Two Zigbee Series 2 modules were configured using the X-CTU software. In the software the PAN ID, sender and receiver address for both the modules was provided.

The wireless video transfer was executed using the IP camera which helps to transfer a video over a network wirelessly on the port 8080. It's just required that the camera and the computer should be connected to the same network as shown in and in and later on using RF communication as in Fig.4.

Finally the complete setup is assembled and can be seen in Fig.5 and Fig.6.

Fig.1

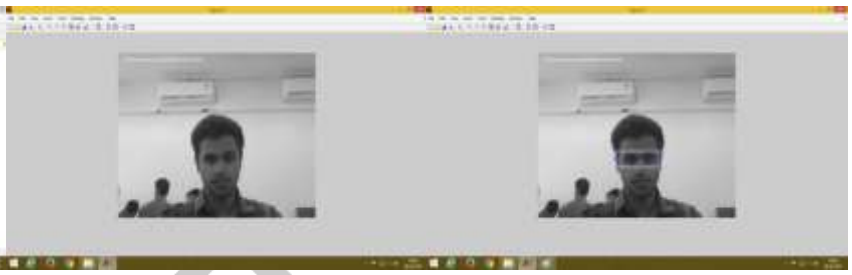

Fig.2

Fig.2

Fig.4

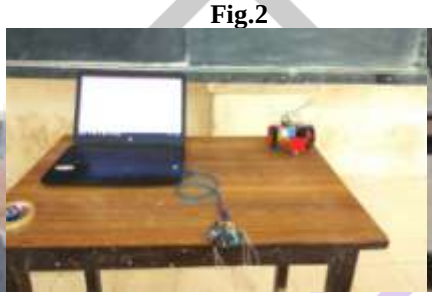

Fig.5

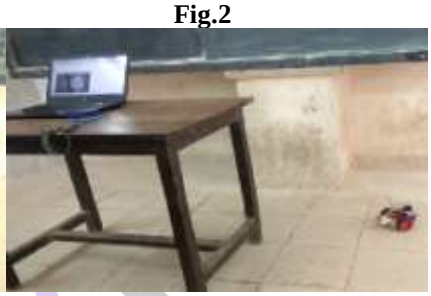

Fig.6

III. RESULTS AND DISCUSSION

The TLD algorithm stands efficient on the stages of tracking in terms of accuracy and other difficulties like gradual shape change and most importantly partial occlusion. The results of the tracking are then saved into a text file so that they can be analyzed.

The serial and the wireless communication take place properly at the baud rate of 9600 bps whereas on the other baud rate the buffer either throws garbage values or it doesnot take place at all. The range of wireless data is limited to the range of Zigbee whereas that of video to the range of network.Overall the project acts as surveillance as well as an efficient object follower where we get the freedom to choose the object

15 frames were tracked down for two cases which are normal tracking and tracking with partial occlusion and the results can be seen below. The last column is the NCC or you can say it as the confidence from the TLD algorithm[3].

Table.1

Normal Tracking				
X co-ordinate of the 1st point	Y co-ordinate of the 1st point	X co-ordinate of the 2nd point	Y co-ordinate of the 2nd point	Confidence
160	97	226	131	1
160.17	96.705	226.26	130.75	0.9947
159.67	97.351	225.77	131.4	0.99091
160.11	97.536	226.22	131.59	0.97405
159.96	96.75	225.94	130.74	0.95059
160.3	96.883	226.31	130.89	0.98115
160.53	96.684	226.46	130.65	0.94474
160.79	97.173	226.7	131.12	0.95708
160.89	97.156	226.87	131.15	0.95177
160.96	97.236	226.85	131.18	0.95022

Table.2

Tracking with Partial Occlusion				
X co-ordinate of the 1st point	Y co-ordinate of the 1st point	X co-ordinate of the 2nd point	Y co-ordinate of the 2nd point	Confidence
170	80	239	135	1
167.12	81.472	236.92	137.12	0.89662
166.24	80.564	237.02	136.96	0.88636
165.89	80.092	237.21	136.92	0.86856
165.89	79.853	237.26	136.71	0.84915
165.45	78.775	237.91	136.49	0.84941
170	80	239	135	0.75184
NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN
NaN	NaN	NaN	NaN	NaN

IV. Conclusion

In this project the three sides of the problem were followed: recognition, localization and tracking, starting from the theoretical study phase, continuing with the general architecture and analysis, to the implementation phase. It uses an implementation method, an algorithm, but also both hardware, and software implementation of each module, taking into account features and possibilities of technologies and devices used. This lead to a sufficiently robust method for recognizing an object in a real time video.

We have determined a way to locate an object in the visual space, using information from a single sensor and existing geometric relations.

The equation belowhelps to determine the NCC of a particular frame that is the confidence and this is stored for all the frames. These values can be used to analyze the performance.

$$\text{Efficiency of Tracking} = \frac{\text{number of successfully tracked frames}}{\text{total frames}} * 100$$

When it comes to around 15 frames of normal tracking the efficiency is around 100% whereas for more frames like 50000 the efficiency is still quite close to 100% that is around 98% - 99%. When it comes to tracking with partial occlusion and drifting, other algorithms fail but TLD gives an efficiency of around 95%.

V. Future Work

By changing the algorithm proposed in this report we can increase the accuracy and efficiency. The ICP algorithm is used to directly plot the 3D location of the desired object which will thereby determine the accurate location of the object.

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References

[1] Diana Gornea, Dan Popescu, GrigoreStamatescu, RaduFratila,"Mono-Camera Robotic System for Tracking Moving Objects", IEEE 9th Conference on Industrial Electronics and Applications (ICIEA) 978-1-4799-4315-9, 2014.

[2] Panth Shah, TithiVyas,"Interfacing of MATLAB with Arduino for Object DetectionAlgorithm Implementation using Serial Communication"International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 10, 2278-0181, October- 2014.

[3] ZdenekKalal, KrystianMikolajczyk, and Jiri Matas, "Tracking-Learning- Detection" IEEE transactions on pattern analysis and machine intelligence, vol. 6, no. 1, january 2010.

[4] M Manigandan,GMalathi Indira, "Wireless Vision based Moving Object Tracking Robot through Perceptual Color Space"Indira Institute of Engineering and Technology, ThiruvallurTaluk, Pandur, India,2010.

[5] S. Srilekha; G. N. Swamy; A. Anudeep Krishna, "computational intelligence and communication networks(CICN),2472-7555, Dec. 2015.

[6] Gi-Woo Kim 1, Dae-Seong Kang1, "Improved CAMshift Algorithm Based on Kalman Filter", Advanced Science and Technology Letters Vol.98 (CES-CUBE 2015), pp.135-137.