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FPGA IMPLEMENTATION OF EMBEDDED COLOR BASED TRACKING SYSTEMFOR SINGLE OBJECT

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ABSTRACT

This paper presents an implemented embedded vision based tracking system for single object. The paper describes implementation a one object tracking of each colour. It also describes the measurement angle for each colour Red and Blue. However, some of these studies suffer from numerous problems have been manipulated such as many camera motion and time delay in image capture, therefore object tracking is a challenging problem. Consequently, in this paper design and implemented of tracking one object (color) utilizing FPGA-SoC. The proposed method has adopted a passive tracking vision system based on platform DE1-SoC and D5M camera. As a result of our project is can be tracking of one objects each color (colors).

Keywords: embedded vision, FPGA system tracking, single-object.

INTRODUCTION

Since more than 50 years, scientists try to understand imaging and developed algorithms allowing computers to see with Computer Vision applications. The first real commercial applications, referred as Machine Vision, analysed fast moving objects to inspect and detect errors in products.

Result to improving processing power, lower power consumption, better image sensors and better computer algorithms, vision elevates to a much higher level. Combining embedded systems with computer vision results in Embedded Vision Systems. Over the next few years, there will be a rapid proliferation of Embedded Vision technology and more and more products will emerge with visual inputs for consumer, automotive, industrial, healthcare and home automation applications.

In this paper, we present a real time tracking embedded vision Blue Color using FPGA-SoC,

In spite of the fact that object tracking has gotten significant consideration nowadays, as a rule that the sensors included are static and the accentuation is in the ideal of how to optimize the ability of processing of the ready, available and accessible data. As opposed to the utilization of static sensors, the sending of portable sensors for tracking provides huge favourable circumstances and advantages. For instance, a bigger territory can be secured without the need of broadening the quantity of hubs in the tracking system. The Classification of tracking system can be two type which is Passive tracking System and active tracking System.

Passive Type Tracking System robot which senses the natural energy around the robot itself and act upon the signal received. No energy needs to be projected. The related passive tracking system research can be found in [1] discussing about a robot mounted with two wide-angle cameras at the top of the robot platform. Generally an image is enough as information to anticipate the current position of the robot. The accuracy of tracking is mostly depends on the distance between the cameras and robot. The researchers intertwine the appraisals acquired from a few cameras by a weighted normal relying upon the robots distance with the camera. Contrasted with just utilizing a solitary camera, the tracking exactness is significantly enhanced by implies.

Active Type Tracking System Active type tracking system is one kind of tracking which is able to send out the energy and measure the return values. Corresponding action will be taken according to the magnitude of the measurement. In [2], some researchers surveyed about single and multi-tracking methodologies that utilized distance-only, bearing-only, and both distance and bearing measurements. [3] In this field many challenges embedded system of design which is:

a) Hardware components challenges is select the type of microprocessor used, also select the amount of memory, the peripheral devices, and more, since we often must meet both performance deadlines and manufacturing cost constraints, the choice of hardware is important little hardware and the system fails to meet its deadlines, too much hardware and it becomes too expensive.
b) Deadlines challenges it is one the challenges how can speed up the hardware so that the program runs faster course that makes the system more expensive. It is also entirely possible that increasing the CPU clock rate may not make enough difference to execution time, since the program's speed may be limited by the memory system.
c) Power consumption challenges most important how can minimize consumption of an applications which consume power. Even no battery applications, excessive power consumption can increase heat dissipation One way to make a digital system consume less power is lo make it run more slowly, but naively slowing down the system can obviously lead to missed deadlines, Careful design is required to slow down the noncritical parts of the machine for power consumption while still meeting necessary

performance goals. Faster hardware or cleverer software.

The proposed design showed a multiple colour and multiple object for blue colour.

RELATED WORK

Watching and observing the movements of others has been a passion for humanity since the dawn of time. People have been watching and following other people who consider this kind of primitive technology, the change has led this technology from tracing the footprints on the ground to following people to security cameras and being one of the technological revolutions that changed the idea of tracking.

The researchers worked on Implemented a FPGA-based protest following framework which utilizes a foundation subtraction calculation Object following is a critical undertaking in PC vision applications. One of the critical difficulties is the constant speed prerequisite. Clarified his proposed is actualize a protest following framework in reconfigurable equipment utilizing a productive parallel design. In our usage, we receive a foundation subtraction based calculation. The planned protest tracker misuses equipment parallelism to accomplish high framework speed. They additionally proposed a double protest area look method to additionally support the execution of framework under complex following conditions. They utilized the Altera Stratix III EP3SL340H1152C2 PGA gadget. They contrasted the proposed FPGA-based execution and the product usage running on a 2.2 GHz processor. The watched speedup can achieve more than 100X for complex [4].

Offered design and implementation of a complete FPGA-based real-time face recognition system. The proposed framework assumes a part numerous applications including reconnaissance, biometrics and security. Specialists gives a conclusion to-end answer for confront acknowledgment; it gets video contribution from a camera, distinguishes the areas of theconfronts utilizing the Viola-Jones calculation, in this manner perceives each face utilizing the Eigen confront calculation, and yields the outcomes to a show. Results demonstrated the proposed how that our entire face acknowledgment framework works at 45 outlines for every second on Virtex-5 FPGA [5].

DE1-SoC vs. other platform

Since the success of any embedded system begins right from the evaluation phase, Choose the right platform is a significant step in the any design of embedded system, there are many platforms design tracking system is recommended it.

A. De1-SoC vs. Raspberry Pi

They researchers worked on [6] Introduced calculation is utilized to track single, numerous question and to evacuate incomplete and full impediment issue continuously. They are utilized Raspberry Pi the proposed effectively Implementation on ARM Cortex-A7 equipment stage and give empowering brings about constant condition. They assessed the execution of proposed calculation on created and standard database. The precision of question following and impediment dealing with, for produced database in single protest is 95.53% and numerous questions is 76.96% and for standard database in swarm movement is 85.25%. It gives hearty execution with ease and low power arrangement. Be that as it may, In PC vision application question following is a testing issue. Light and impediment are real requirements saw in protest following.

[7] It has suggested a method for tracking an object that is strong in nature and effective in lighting. Color information does not work well in luminous environments until it has made a gray world assumption and a particle filtering approach to trace the object. This approach relates to color stability in human perception and strong against rapid changes in the situation.

B. De1-SoC vs. Arduino

They worked on the design system for automatic face detection and tracking with web cameras and tracking system based on platforms Arduino The system is based on AdaBoost algorithm. They proposed can be used for security purpose to record the visitor face as well as to detect and track the face human face in real time. Shows the intersection of Image processing and embedded systems by using a program is developed using OpenCV that can detect people's face and also track from the web camera [8].

Researchers were keen for putting into this undertaking and go deeper into this active research area because it is already proofed with many fruitful systems that have been developed such as health centre assistance [9] and pedestrian tracking [10].There are two diverse kernel based tracker are actualized as Android applications which are template base tracking method [11] and color based tracking method. Either of them use OpenCV library to do the image processing. One Android device is mounted with the robot with the function of capturing images as well as oversight the movement of robot. The Arduino microcontroller powers the Android device and the servo of robot.

The experimental results of the research shows the Android and Arduino implemented robot are able to progress a robust tracking of various type of objects even though the obvious appearance changes. Researchers also ran some experimental test using the prototype they had just created. Two methods were being tested which are color based tracking method and template based tracking method. The color based tracking method is performed through an Android device being attached to the robot and the researchers had chosen Samsung Galaxy Note (1.4 GHz dual-core processor) to record and capture the frames.

Comparison between platforms

There are many Platforms that has been compared Raspberry Pi, Arduino, and FPGA

Table-1. Comparison between the platforms.

platforms	Raspberry Pi	Arduino	FPGA
Variant	Model-B	Uno	DE1-SOC
Toolkits	Open Embedded, Scratchbox, Eclipse	Arduino IDE, Eclipse	Quartus
Language	Python, C	Wiring-based (~C++)	VHDL, Verilog HDL
OS	Linux, RISC OS	-	-
Architecture	32bit	8bit	32bit
Processor	BCM2835(ARM11)	ATMEGA328	Altera NIOS II
Speed	700Mhz	16Mhz	1.6 Ghz
RAM	256MB	2KB	32MB (SDRAM)
ROM	External SD card	32KB	64MB (SDRAM)
Multitasking	Yes	No	Yes
On-Board Network	10/100 BaseT Ethernet Socket	-	10/100/1000 Ethernet
Price (RM)	159.71	106.37	800

SUGGESTED METHODOLOGY

The project was conducted according to the planned phases. A good understanding of existing and relevant knowledge was an important primer to commence the project. The entire project flow after planning is illustrated.

a. Algorithm programming framework

The most challenging part of this project was the programming element. The construction of a tracking framework was not simple and was tedious as the knowledge of the researchers was limited. There were many elements that needed to be considered, to create a stable and lean program. This subsection discusses the programming platform used to implement this project as shown in Figure-1.

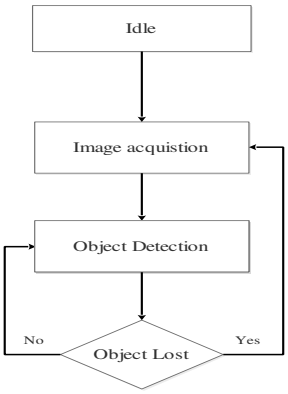

Figure-1. Flow chart tracking system.

This project used the Altera Quartus II program (version 14.1) by Altera Corporation for logical circuit design. This software provides a thorough design environment for FPGA designs. The Verilog hardware description language was used to design and verify the components that are discussed in this chapter. The FPGA controller is considered using structured libraries for design, simulation and verification, and then to convert the related model for functional prototyping using the FPGA hardware [12].

b. Threshold algorithm

In this project it have been used algorithm threshold is method of image segmentation, by technique to conversion from RGB image to a grayscale image then create binary images, It is one of the style utilized to designate a separate threshold for each of the RGB components of the image's defined the value of color object which have been tracked in the algorithm with addition colors gradient (Hue) which have been specify a specific value according to the colors gradients, according to the equation (1), threshold Algorithm was used in the which is set the color red (#ff0000) or blue (#0000ff) and adding the value of the color degree after that abolition of other color values, where are the subtraction value (Degree of color) is added to values basic colors RGB and then multiply to produce the value of the color, which has the same value desired tracking color where have been done As show RTL view design threshold algorithm in Figure-2.

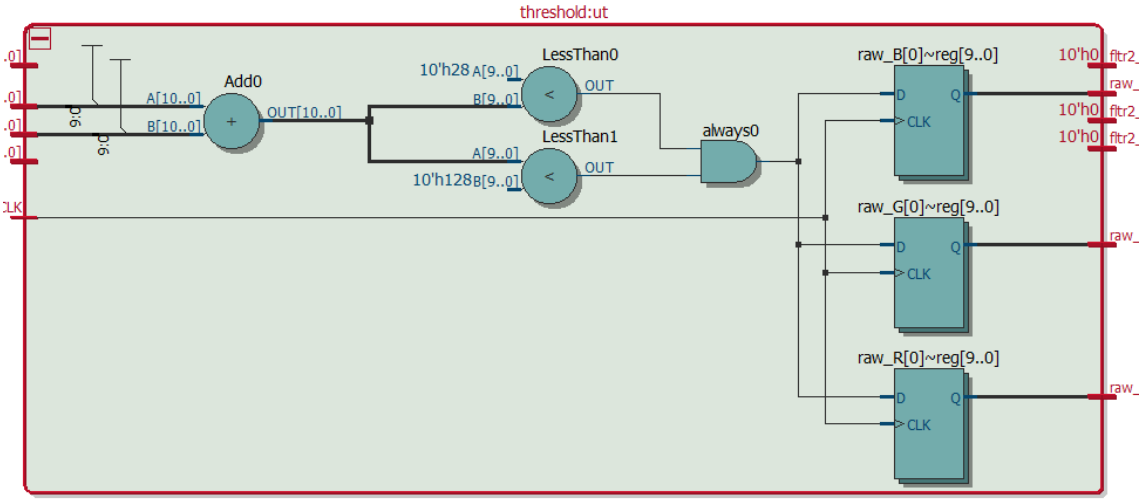

Figure-2. RTL view design threshold algorithm.

$$Trackingcolor = (DC - CRGB) * (DC - CRGB) \quad (1)$$

DC: Degree of colur.
CRGB: color of Red, Green, Blue.

c. Hue

Hue is the correct word to use to refer to just the pure spectrum colors. Any given color has been described in terms of its value and hue. In addition that value is defined as the relative lightness or darkness of a color. It is an important tool for the tracking system by the reflection object, Contrast of value separates between colors gradation objects in space. In this project have been used RGB value is decimal (255, 0, 0) this hex color code is also which is equal to #ff0000 color name is Red color, and al so it has used RGB value is decimal (0, 0,255). This hex color code is also a web safe color which is equal to #0000ff color name is Blue color. As shown in Figure-3.

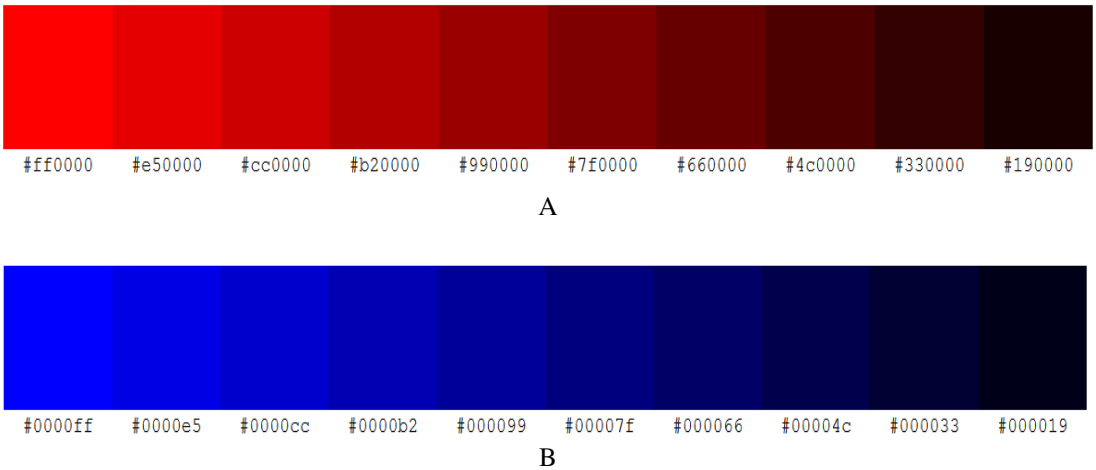

Figure-3. RGB value, (A) Red color, (B) Blue color.

d. VGA controller

In this part to explain have been discussed in chapters 2, the platform DE1-SoC includes a connection VGA which have 15 pin DC represent output with a component that has synchronous signals are provided directly from in chip Cyclone V devices AD7123 using threefold 10 bit high speed to generate analogue data signals are (red, green, blue) gives the associated layout.

RESULT

This was implemented with a series of object tracking algorithms, for the blue and red colour tracking mode, it is suggested that this experiment is run in a white environment. Tracking the separate colours: red and blue, which are defined as the red colour that appears in the red screen, other than that, are coloured to greyscale. Figure-4 shows the original image captured using the DE1- SoC, and then the horizontal and vertical angle have been calculated by using the distance between the object and the camera.

Figure-4. Original image.

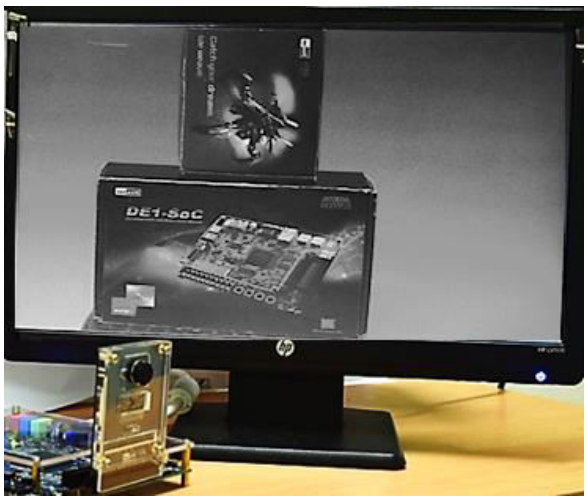

Figure-5. RGB of the frame captured captured in greyscale.

In Figure-5 the original camera capture is converted into a greyscale value when the RGB of the pixel is not in the range of the threshold value. In this project before starting the two colour tracking test and to ensure that the system is operating correctly.

Test of environment

The first phase of the experiment consists of simulating the devices that are measured between the D5M camera sensor distance, the object, and also the horizontal and vertical angle which was measured for each of the basic colours, red and blue. The measurement tools used were a protractor and a ruler tools for measurement of tracking colours as show in Figure-6.

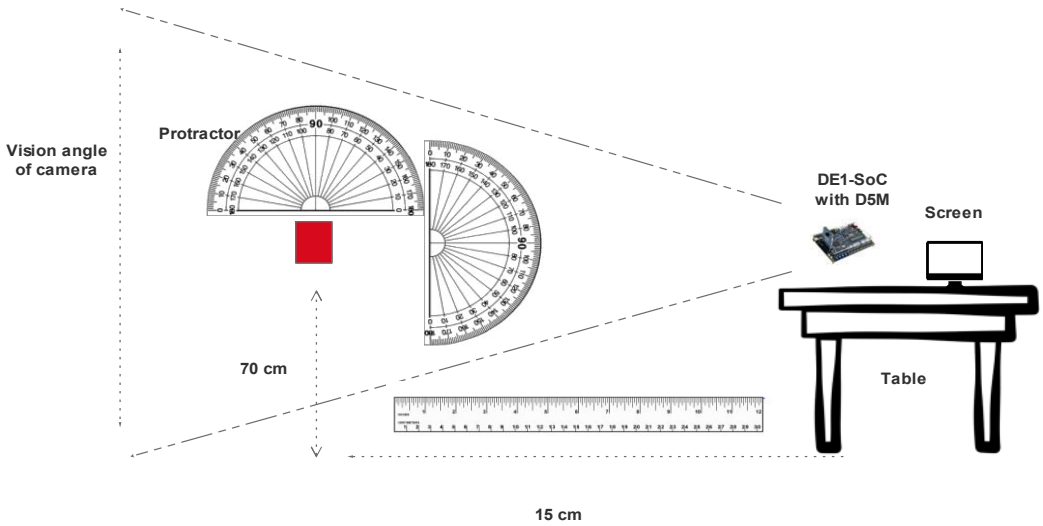

Figure-6. Tools of measurement of tracking colors.

In this experiment, the tracking size of the object was used 6.5 × 6.5 cm, the first measurement distance 15 cm between the camera sensor D5M and the object is front of the camera the same height as shown in the images in order to calculate the dimensions and dimensions and the angle.

a. Experience blue color

The tests here were carried out using blue colour, the 10 tests start at a minimum of 15 cm to a maximum of 30 m as shown in Table-2.

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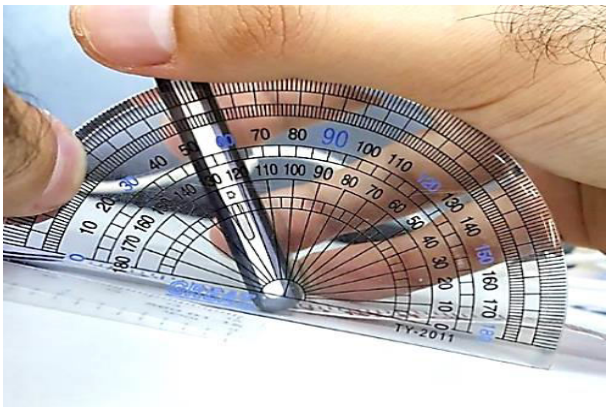
Table-2. Measurements of the color blue distance and angle (Horizontal, Vertical).

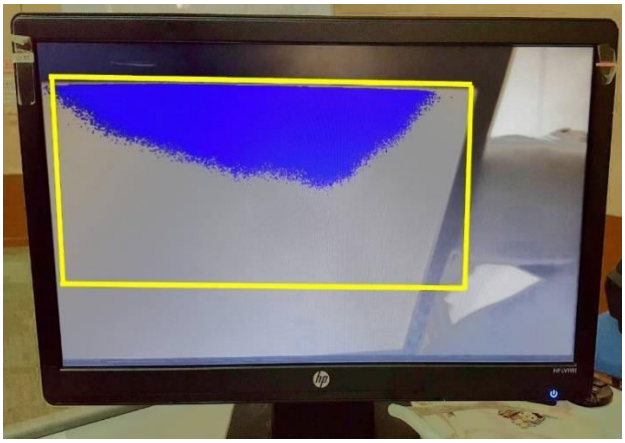
Experiment	Distance	Vertical angle		Horizontal angle		
		Right &left	Appear full	Forward	Appear full	Back
1	15 cm	45°±	0°	45°	0°	45°
2	30 cm	45°±	0°	45°	0°	45°
3	60 cm	45°±	0°	50°	0°	50°
4	2.5 mm	40°±	0°	50°	0°	50°
5	4 m	40°±	0°	50°	0°	50°
6	6 m	35°±	0°	55°	0°	55°
7	10 m	35°±	0°	55°	0°	55°
8	15 m	35°±	0°	55°	0°	55°
9	20 m	25°±	0°	60°	0°	60°
10	30 m	25°±	0°	60°	0°	60°

Experiment 1, using the blue colour, where the first reading was at a distance of 15 cm and it was observed that the first reading was measuring the horizontal angle and it started to track blue colour.

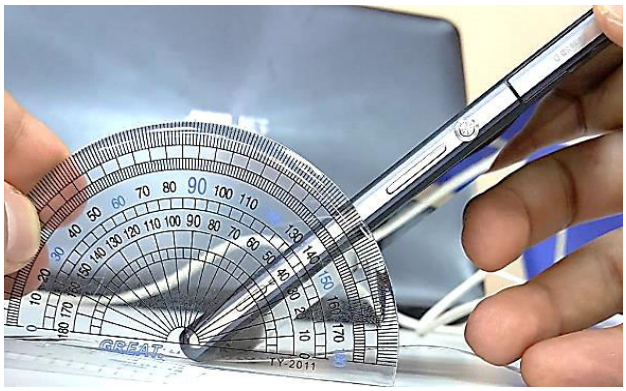
The results of measuring the vertical angle are shown in Figure-7 and the results of the vertical and horizontal measurements were shown at angle 0°, which showed the full appearance of the target.



(a) Forward at a distance 15 cm.



(b) The result of tracking color blue.

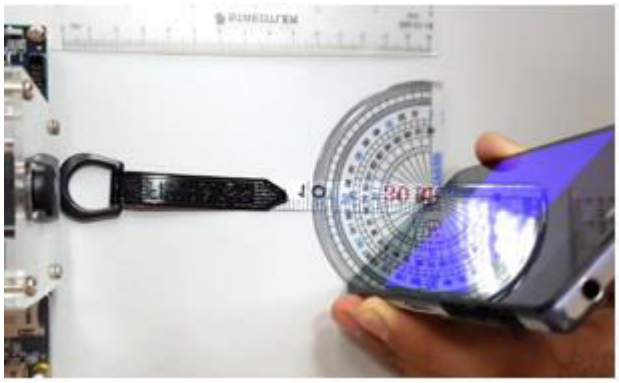


(c) Back at a distance 15 cm.

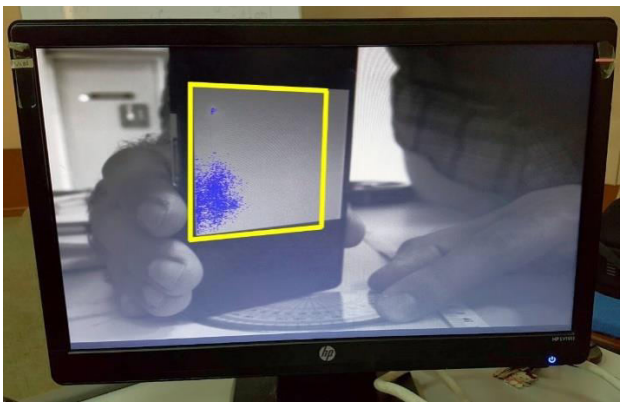
(d) The result of tracking colour blue.

Figure-7. Measuring the horizontal angle (a), (b) back 45° and (c), (d) forward 45°.

The results, as shown in the pictures of Figure-8 track the beginning of the appearance of the blue colour and the measuring of the horizontal and vertical angles, using the protractor and measuring the distance that shows the image using the ruler.

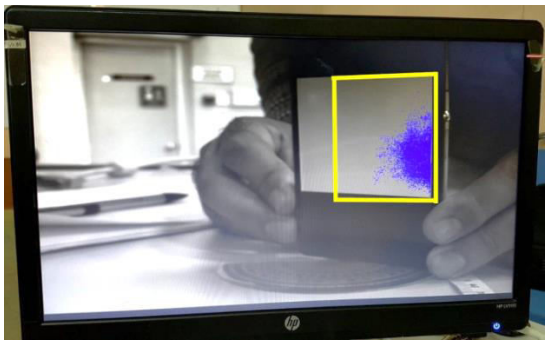


(a) Right at a distance 15 cm.

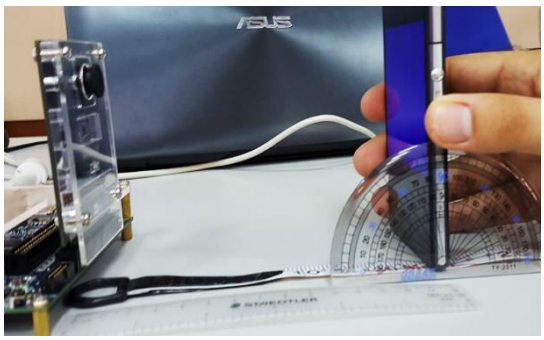


(b) The result of tracking color blue.

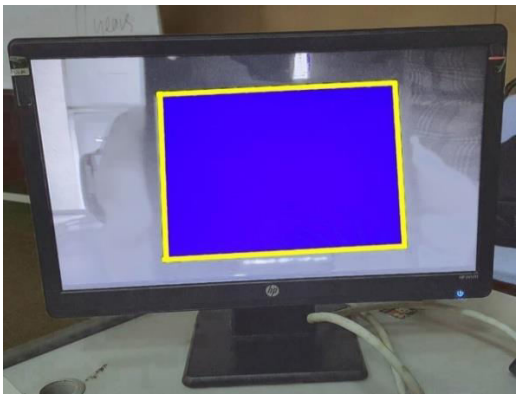
(c) Left at a distance of 15 cm.



(d) The result of tracking color blue.



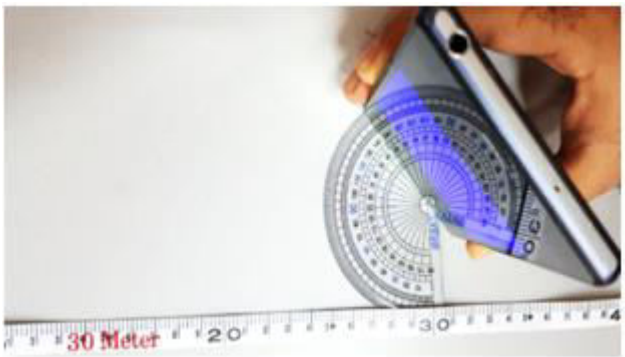
(e) Full appearance at a distance of 15 cm.



(f) The result of tracking colour blue.

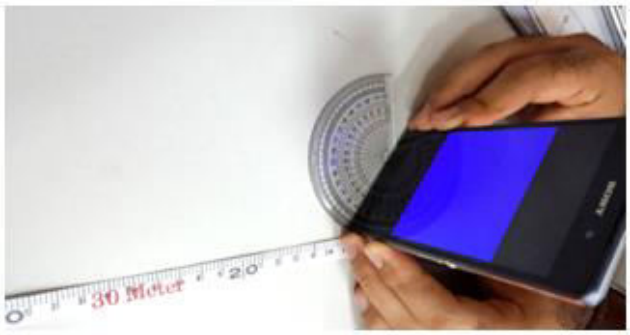
Figure-8. Measuring the vertical angle 45°±, the measurement direction right (a), (b) and left (c), (d) with measuring the horizontal and (e), (f) vertical 0° at a distance of 15 cm show start tracking fully.

It was noted that there was no change in experiment 2, the reading angle at a distance of30 cm as shown below in Figure-9 the reading was measuring the horizontal angle as shown in Table-1. With the measurement of the horizontal and vertical angles at 0°, at a distance of 30 cm show start tracking fully.

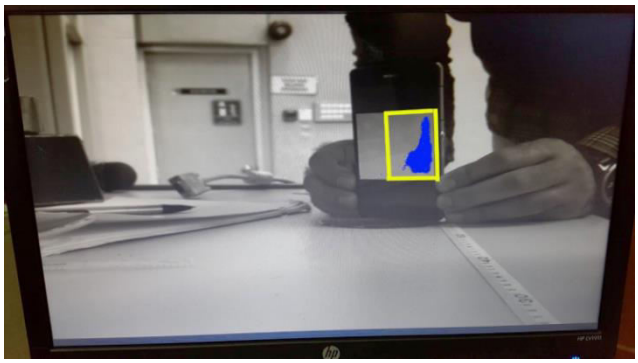


(a) Left at a distance 30 cm.

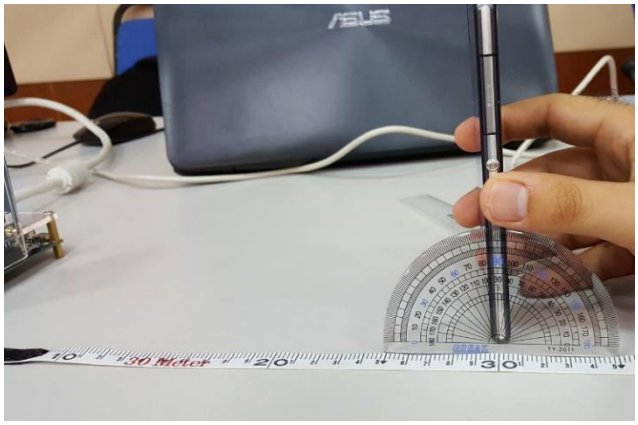
(b) The result of tracking color blue.



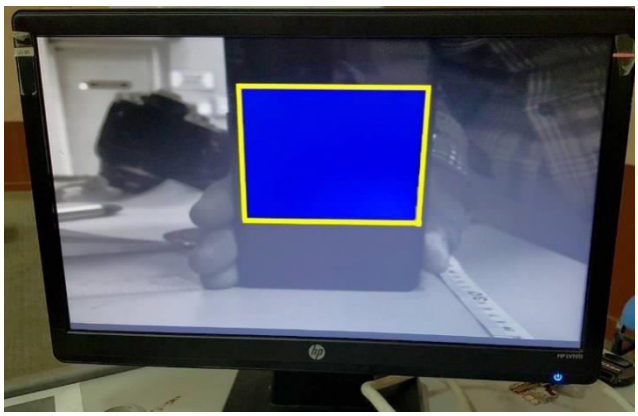
(c) Right in distance 30 cm.



(d) The result of tracking color blue.

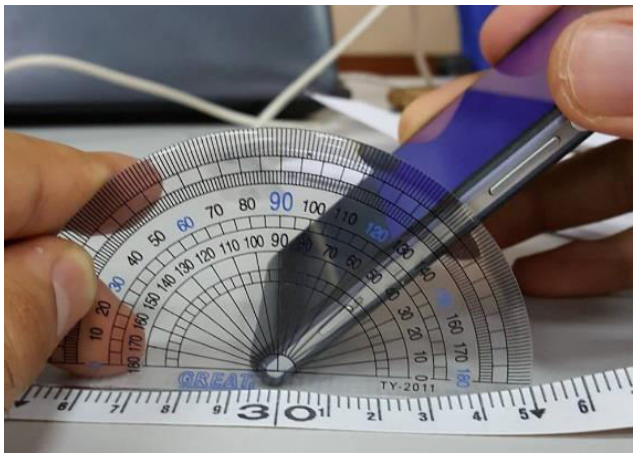


(e) Full appearance at a distance of 30 cm.



(f) The result of tracking colour blue.

Figure-9. Vertical angle of 45°±, the measurement direction right (a), (b) and left (c), (d), with (e), (f) vertical 0° at a distance of 30 cm show start tracking fully.



(a) Back at a distance 30 cm.

(b) The result of tracking color blue.

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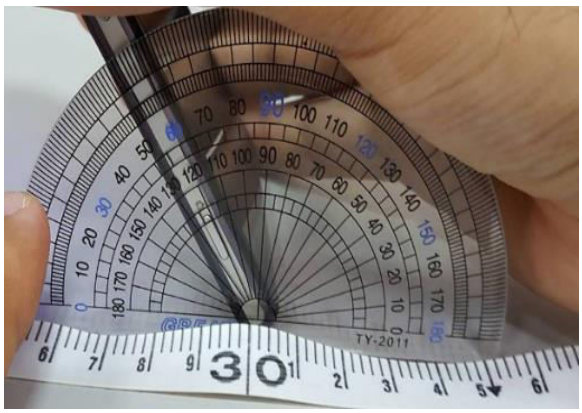
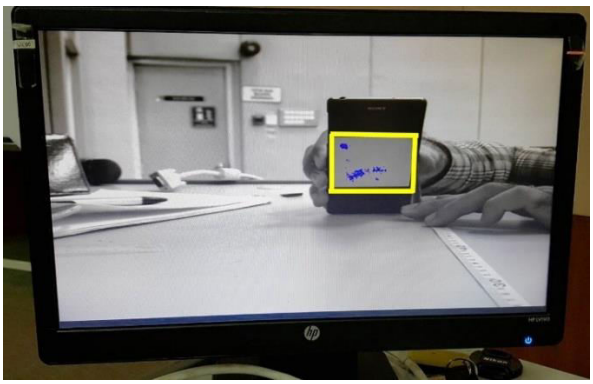


(c) Forward at a distance 30 cm.



(d) The result of tracking colour blue.

Figure-10. Horizontal angle 45° the (a), (b) forward and the (c), (d) back.

The experiment 3 results at Figure-10 showed that there is no change in reading the vertical angle at a distance of 60 cm, there is a change in reading the horizontal angle and increasing starting from angle 10°, both forward and backwards, change from 45° to 55°, compared with previous results at a distance of 30 cm.

But when the distance was increased to 2.5 m in experiment 4, the results showed that there was a change in the reading of the vertical angle from 45° to 40°; however, there was no change in the horizontal angle.

In the next experiment, experiment 5, at a distance of 4 m, the results showed that there was no change in reading the vertical angle, but there was a change from 55° to 50° in the horizontal angle.

In experiment 6 the results showed a change in the reading angle at a distance of 6 m in the vertical angle from 40° to 35°, but there is no change in the horizontal angle.

The experiment 7 results showed a change in the reading angle at a distance of 10 m in the vertical angle from 40° to 35°, there was a change in the horizontal angle from 55° to 60°.

In experiment 8 at a distance of 15 m, in the vertical angle, there is no change in either the vertical or the horizontal angle.

In experiment 9, at a distance of 20 m there was a change in the vertical angle from 35° to 25°, but no change in the horizontal angle.

In experiment number 10, at a distance of 30 m, the horizontal angle changed from 60° to 70°, as well as a change in the vertical angle from 60° to 65°.

The results for each of the ten experiments are shown in Table-3.

Several tests were carried out to test the blue color tracking, denoted by the objects in the yellow boxes, which denote the object and is shown in Figure-11.

b. Experience red color

Implemented this experiment 1 the red color where the first reading was 15 cm show Table-2 and were observed the first reading was measuring the horizontal angle it started at appearance of tracking color red show on Figure-11.

Table-3. Measurements of the red color distance and angle (Horizontal, Vertical).

Experiment	Distance	Vertical angle		Horizontal angle		
		Right &left	Appear full	Forward	Appear full	Back
1	15 cm	35°±	0°	50°	0°	50°
2	30 cm	35°±	0°	50°	0°	50°
3	60 cm	30°±	0°	55°	0°	55°
4	2.5 mm	30°±	0°	60°	0°	60°
5	4 m	30°±	0°	60°	0°	60°
6	6 m	25°±	0°	60°	0°	60°
7	10 m	25°±	0°	65°	0°	65°
8	15 m	25°±	0°	65°	0°	65°
9	20 m	10°±	0°	65°	0°	65°
10	30 m	10°±	0°	70°	0°	70°

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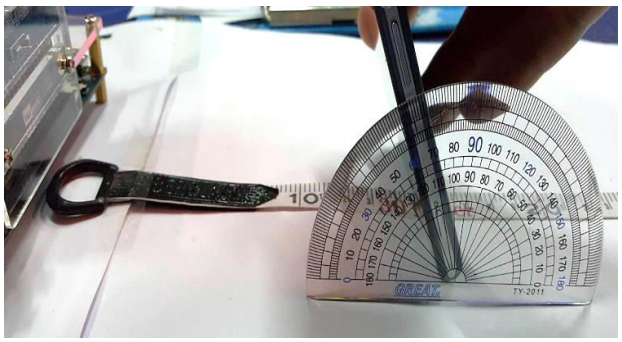
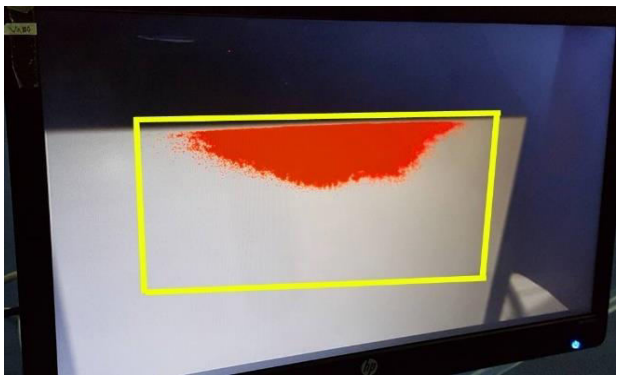


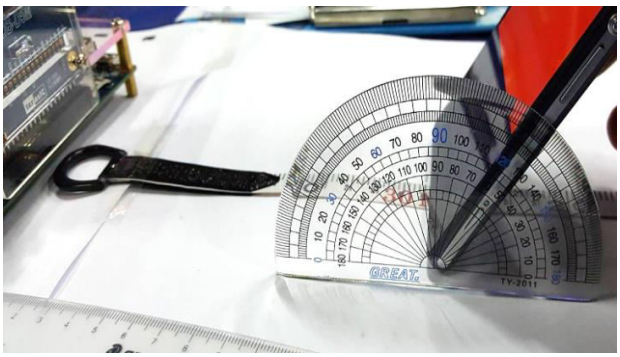
(a) Measurement forward at a distance 15cm.



(b) The result of tracking color red.

(c) Full appearance at a distance 15 cm.

(d) The result of tracking color red.

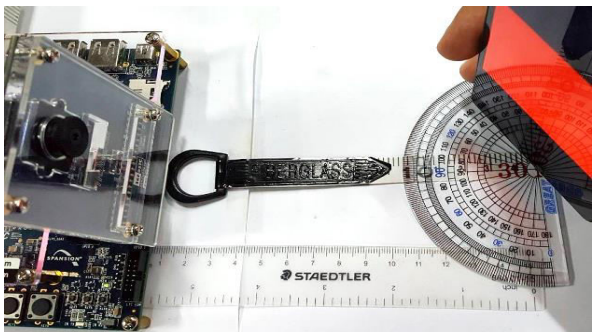


(e) Measurement back at a distance 15cm.

(f) The result of tracking color red.

Figure-11. Measure of angle vertical 35°±, the measurement direction forward (a),(b) and back (e),(f) with measure of horizontal and (c), (d) vertical 0° at a distance 15 cm show start tracking red full.

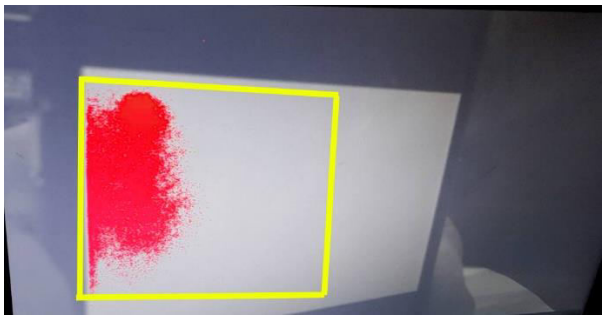
The results were shown on the experiment the results from experiment 2 showed no change in the reading vertical and horizontal angle at a distance 15 cm show in Figure-12.



(a) Measurement right at a distance 15cm.

(b) The result of tracking color red.

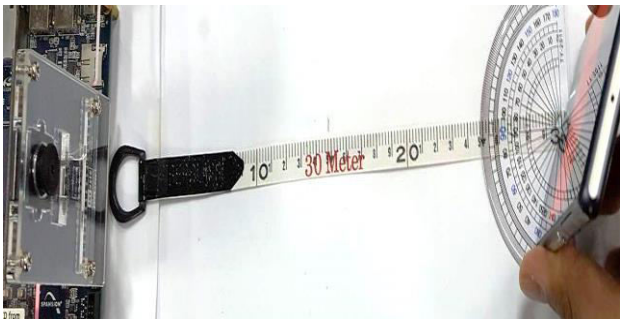
(c) Measurement left at a distace15 cm.



(d) The result of tracking color red.

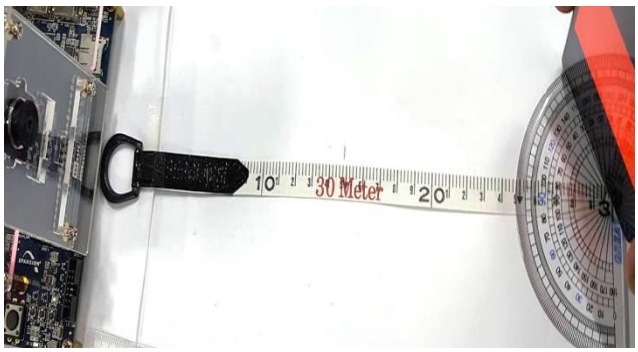
Figure-12. Measure of Angle vertical red forward and back 35° with the (a), (b) right and the (c), (d) left at a distance15 cm.

The results were shown on the experiment the results from experiment 3 showed no change in the reading vertical and horizontal angle at a distance of 30 cm Figure-14.

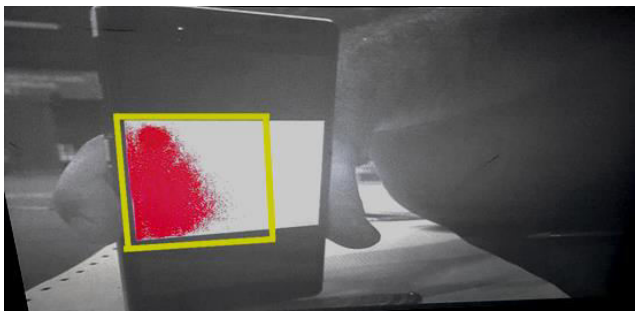


(a) Measurement right at a distace15 cm.

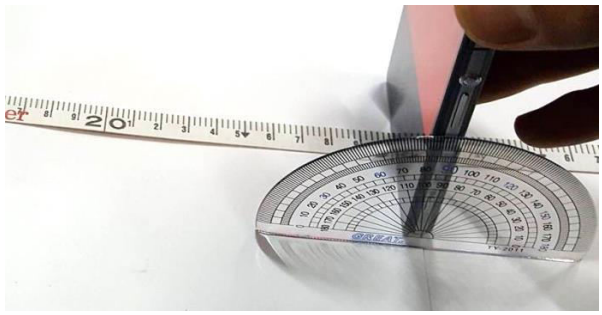
(b) The result of tracking color red.



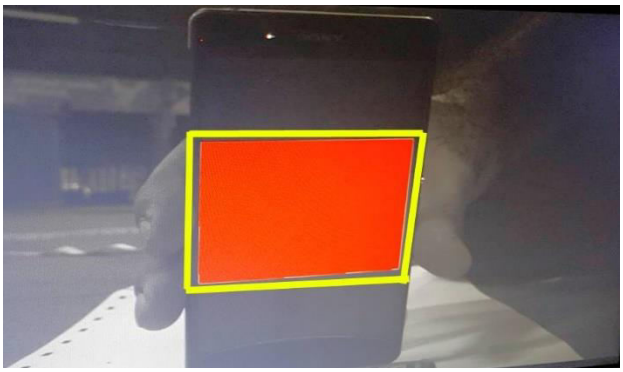
(c) Measurement right at a distance of 30 cm.



(d) The result of tracking color red.



(e) Full appearance at a distance of 30 cm.



(f) The result of tracking color red.

Figure-13. Measure of vertical angle 35°±, the measurement direction right (a), (b) and left (e), (f) with Measure of horizontal and (c), (d) vertical 0° at a distance of 15 cm show start tracking full.

In the first experiment of the red colour, the results have shown there is no change in the reading angle at a distance of30cm, as well as in vertical angle from 35°

to 30° also there was no change in reading horizontal angle.

The results of experiment 4 showed no change in the reading angle at a distance of 2.5m in the vertical angle, but there has been a change in the horizontal angle from 55° to 60°.

In experiment number 5, the results showed no change in the reading angle at a distance of4 m in the vertical and horizontal angles.

The experiment 6 results showed no change in the reading angle at a distance of 6 m in the vertical and horizontal angles.

The results shown in experiment 7 show a change in the reading angle at a distance10 m in the vertical angle from 30° to 20° as well as a change in the horizontal angle from 60° to 65° reading.

Experiment 8 showed there was no change in the reading angle at a distance15m vertical angle and horizontal angle.

Is the second to last experiment, at a distance of20 m the vertical angle changed from 20° to 10° but there was no change in the horizontal angle.

In the last experiment, at distance 30m in the horizontal angle shown there is changed from 60° to 70° but there was no change in the vertical angle.

The results from the ten experiments are shown in Table-3. In addition, the readings appear.

CONCLUSIONS

The system is implementation of embedded vision based tracking system one object real time using FPGA-SoC. We have done this project which can track more than one object in real time. In addition, measurements were made to find out the effective angle that shows the object from the beginning to the end of the tracking and was using platform DE1-SoC which contains the processor cyclone V with connection camera D5M, Furthermore, Which reaches the processor High frequency 1.6 Ghz In the image was processed and can be quickly captured the object.

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