Comparative Study on Different Methodologies to Track an Object in Augmented Reality

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Abstract: *Augmented Reality(AR) is a view of the world around us that has been enhanced or else augmented by including objects or virtual images or data or information to the scene. Since Augmented Reality combines the real world scenes to the virtual objects, AR, interactive as well as registered in 3D. The first and the most essential step in augmented reality are to obtain the position of the objects to be inserted in the Augmented Reality applications. But tracking, registration of these objects is one of the fundamental problems that is faced in Augmented Reality, and this problem needs to be tackled. In AR the tracking of both the camera and the objects is equally important in order to combine the real world scene and the rendered object. The synthetic models need to be projected at the right locations in the real scenes. In order to simplify or get accurate results in tracking of objects various algorithms are being used.This paper compares different algorithms / methodologies to tackle different problems faced whiletracking objects in the field of computer vision.*

Keywords: *Object Tracking, Kalman Filter, Genetic Algorithm, Augmented Reality*

I.INTRODUCTION

Augmented Reality in simple terms is a combination of an actual scene viewed by the user and a virtual scene generated by the computer that augments the scene with extra information. Augmented Reality (AR) is a real-time direct or indirect view of a physical real world environment that has been enhanced or augmented by adding virtual computer generated information to it. AR is both interactive and registered in 3D as well as combines real and virtual objects. Augmented Reality is interactive because it enhances the user's perception of interaction with the real world. Augmented Reality is registered in nature because the additional information that augments the real word or the virtual objects augmented in the viewed scene must be registered. Augmented Reality aims at simplifying the user's life by bringing virtual information not only to his immediate surroundings, but also to any indirect view of the real-world environment, such as live-video stream. There are many other classes of AR applications, such as medical visualization, entertainment, advertising, maintenance and repair, annotation, robot path planning, etc. Bridging virtual and real worlds, Augmented Reality (AR) creates a reality that is enhanced and augmented. Augmented Reality can be defined as an emergent form of practice, through which the real world is improved through computer generated content that is connected to particular places or events. AR permits the digital content to be effortlessly superimposed and inter- mingled into our insights and conception of the real world. Augmented Reality (AR) systems describe the class of systems that use computers to overlay virtual information on the real world. AR environments allow the development of promising tools in several application domains.

In Augmented Reality tracking and registration of both cameras and objects is equally important to combine the real world scenes and the rendered scenes. We need to project the synthetic models at the right location in the real images. Genetic Algorithms in Augmented Reality are basically used for optimization of computer vision problems. Registration of objects is one of the fundamental problems faced in computer vision. "Genetic Algorithms are good at taking large, potentially huge search spaces and navigating them, looking for optimal combinations of things, solutions you might not otherwise find in a lifetime." "The Kalman Filter is an estimator that uses measurements observed over a time to produce estimates that tend to be more precise than any single measurement. It improves the accuracy of the location of the object and provides predictions for future location."

II.SIGNIFICANCE

Augmented Reality and the study of AR has been very significant since there is technology everywhere and in everything. And Augmented Reality can contribute to a large part of it as it can be very useful, interactive and very interesting. We could be interacting with the world around us by combining both real and virtual worlds. It helps us in various situations and different areas, it is not something only a certain kind of people will be able to use or in certain areas. AR can be introduced in all zones. For example, while I was doing my study I thought AR could be a part of only big things like in Hospitals for surgery or in big enterprises and it was later that I studied it can be

used in fashion, education, entertainment, tourism etc. and it is growing rapidly and coming into everything thing that we do. This paper just describes a small part of AR. The different ways an object can be registered and tracked in AR which is the stepping point towards creating something great.

III.LITERATURE REVIEW

Consistent with [1], the genetic set of rules is used to address one of the fundamental troubles of laptop imaginative and prescient. This genetic algorithm reveals the rotation and translation successfully of the item when the three-D shape of the object is known. inside the implementation of the set of rules, the chromosomes encode the pose and the indexes to choose points of the object. there are many algorithms that best look for the location of the set of rules but on this implementation of the genetic algorithm alongside, the position of the item a positive set of function points also are known to us. In presence of factor mismatches and outliers inside the picture, the set of rules is made even extra robust using a mismatch filtering approach. This set of rules has been examined the usage of synthetic statistics and real information so as to acquire suitable consequences. basically, this algorithm is used to estimate the location of an actual object in Augmented Reality packages. in this paper, the purpose is to estimate the pose, the Row, the Pitch, the Yaw rotation angles and the interpretation parameters of the object in three-D once its structure is given. in this approach, a fixed containing the most reliable characteristic factors of an item is searched for further to its pose in the picture sequence. This method avoids the neighborhood most useful answer as compared to the conventional finest descent techniques. This set of rules is green in except for outlier and factor mismatches.

According to [2], robust item tracking using Kalman Filters with Dynamic Covariance, on this paper there may be a couple of item monitoring algorithms used as input to a single Kalman filter out. Linear Regression defines a function that is used to determine every of the algorithms errors from its related features. the mistake is the algorithms size variance. The dynamic dimension blunders covariance taken from the estimates, they've produced a typical item monitoring filter out that combines each algorithm's first-class-case behavior at the same time as diminishing worst-case conduct. This filter out is meant to be sturdy without being programmed with any surroundings-specific guidelines. We presented a method for education a feature for dynamically adjusting Kalman clear out measurement blunders covariance, in try to tune a Kalman filter to favor better suited monitoring algorithms, and penalize unwell-suitable ones, at some point of runtime. We carried out this method using schooling and validation data drawn from actual movies and automatically generated snap shots, then tested its robustness in various environments. Our test had blended outcomes. Although the Kalman filter out accelerated monitoring accuracy in one type of environment, it turned into matched or outperformed by way of the baseline Cam Shift set of rules in most cases. For this reason, we had been best partly successful in increasing robustness over Cam Shift. future attempts to this approach may be able to enhance our outcomes via deciding on greater meaningful features for the regression (such as capabilities that span more than simply two frames), or via accumulating a higher set of education and validation statistics. Moreover, linear regression may not be a pleasant choice; perhaps a simpler logistic regression outputting a binary 'strong' or 'susceptible' score may additionally produce better effects.

According to [3], Marker Detection and Tracking for Augmented Reality Applications - Oliver Toole School of Electrical Engineering Stanford University, Dave Dolben School of Computer Science Stanford University. This paper explores a simple method for detecting and tracking "fiducial" markers in a webcam video stream. The system first uses SIFT feature matching to detect when a marker is present in a frame of the video stream. Then, the detected key points are given to a KLT optical flow tracker, which tracks the key points frame-by-frame as they move through the video. In this paper, we will describe the method in detail, and present our results and analysis. Detecting and tracking markers is a useful process in augmented reality. This technique gives augmented reality applications a simple way to estimate the position and orientation, in 3-space, of an object in a video stream. From there, it is trivial to overlay 3-dimensional content to the video stream in real-time, in a way that makes it appear consistent with the scene. This project explores one method of detecting and tracking these so-called "fiducial markers" in a webcam feed, using the OpenCV computer vision library. This method first uses SIFT key point matching to detect the marker in the video stream. This gives us a set of keypoints in the video frame, and their corresponding locations on the marker. This is enough information to compute a homography between the clean image of the marker and the marker's location in the video frame. After acquiring keypoints in the video frame, we use a KLT optical flow tracking algorithm to track the motion of these key points frame-to-frame. By maintaining the correspondence between our tracked key points and those on the clean marker image, we can compute a new homography for every frame. This allows us to track the orientation of the marker as it moves in the video.

In line with [4], Polyhedral item Detection and Pose Estimation for Augmented truth applications - Ali Shahrokni, Luca Vacchetti, Vincent Lepetit, Pascal Fua laptop images Laboratory, Swiss Federal Institute of generation In augmented truth programs, tracking and registration of both cameras and objects is needed because, to mix actual and rendered scenes, we should venture artificial fashions on the right vicinity in real pix. Despite the fact

that a good deal work has been carried out to tune items of the hobby, initialization of theses trackers frequently remains manual. This papers work aims at automating this step by way of integrating item recognition and tracking into an AR gadget. The emphasis is on the initialization section of the monitoring. This paper addresses all the 3 important aspects of the trouble of model-to-image registration: feature detection, correspondence and pose estimation. they have advanced a unique technique based totally on face detection that substantially reduces the variety of viable characteristic correspondences making it viable to without delay compute the transformation which satisfactory maps the three-D object to the image plane. This paper says that this approach offers a one-fold velocity up over present methods. The emergence of Augmented fact strategies permits the advent of blended environments wherein actual and virtual elements coexist. this is valuable to implement powerful interplay techniques for the subsequent motives: first of all, research has proven that setting customers in real surroundings, including a familiar room, enables them to perform or to research their actual duties. Secondly, including digital factors will increase flexibility and allows the introduction of new conditions or situations at little or no cost. despite the fact that tons work has been carried out to track objects of hobby, initialization of theses trackers often remains guide. This mission work goal at automating this step. in this work, we recommend an initialization approach that is based totally on green model based item reputation tuned for Augmented fact programs for monitoring polyhedral items.

IV.METHODOLOGIES

Three most prominent methods were chosen to identify the best among them to be implemented in Object Tracking in Augmented Reality. Studies of all the three algorithms were done based on certain parameters in order to propose which algorithm would fit better in the process of registration and tracking of objects in Augmented Reality. The following algorithms are implemented. They are:

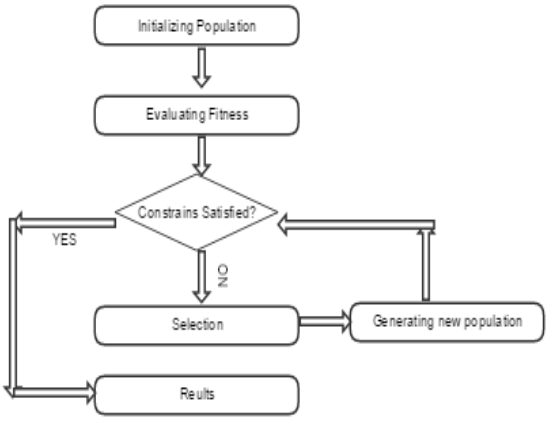
- Genetic Algorithm
- Kalman Filter Algorithm
- KLT Tracker Algorithm

Genetic Algorithms are mainly used for solving optimization problems in the field of computer vision. The major applications of Genetic Algorithm are Augmented Reality, Image Guided Surgery, Rendering of real objects in gaming environment. Using Genetic Algorithm we can register images to images and register images to 3D Models. There are three major steps involved in implementing Genetic Algorithm for this purpose, the steps are,

- Sampling which means slicing the 3D model
- Defining the cost Function
- Then solving for the optimization

When using the genetic algorithm ne need to know the basic units that are used for the implementation, Genes, genes are the most basic component of the process. A gene is a hereditary unit used for inheritance. When multiple genes are combined or stringed together it forms a chromosome. A gene when shown in an organism is known as its trait. The off springs inherit these traits from their parents and a gene may or may not get mutated during the mating process. Agiven problem will have n number of possible solutions; Genetic Algorithm introduces the concept of evolution which will search for the best solution among these n number of possible solutions.

Figure-1: Process of Genetic Algorithm



In Figure 1 the process of genetic algorithm is shown. There are 4 parameters of genetic algorithm, Fitness Function, in a population of n individuals each individual is evaluated to see how good each one is and a fitness function is given to each individual. The second parameter is the mechanism of selection where the individuals will

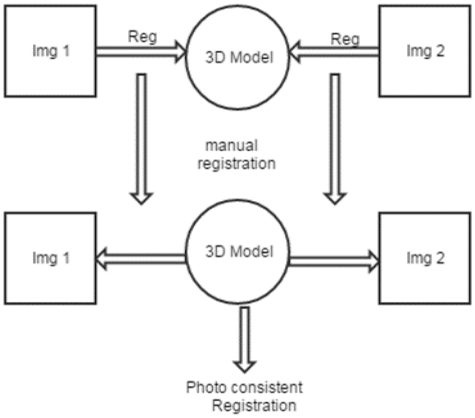
be selected based on their fitness function value. There are different selection methods, Roulette Wheel Selection, Tournament Selection, Rank Selection, Elitist Selection. In Roulette Wheel Selection the main idea is that better individuals have a higher chance of getting selected. All the individuals are selected based on the probability that is assigned to each of them based on the fitness. Tournament selection is divided into two categories; Binary Tournament where two individuals are randomly chosen and the fitter one out of these two are selected as the parent. Larger Tournament is the second category where n individuals are randomly chosen and the fittest one out of them is selected as the parent. Based on the fitness of individuals of the population the rank is assigned to them using the rank selection method. Crossover happens while generating offspring from two parents that are selected. The different crossover techniques, Single point crossover, Two-point crossover and Uniform crossover. Mutation is where each gene is altered independently with a probability p_m, where p_m is called the mutation rate. The initial population of the projection matrices of genetic algorithm used for the registration is estimated using manual registration.

In Figure 2 the block diagram of the registration method is seen.

The overview of the genetic algorithm.

- Generate a random population consisting of n chromosomes.
- Calculate the fitness cost of each chromosome.
- Select the parents from the present day population the use of the roulette wheel proportionate choice for copy.
- Create a temporary population of off springs by the mutation or crossover of the mother and father consistent with the corresponding chances.
- Pick out, with the roulette wheel proportionate selection, the chromosomes into the subsequent technology from the pool of the off springs and contemporary technology in step with the chance of alternative.
- Repeat the stairs till one or more of the following conditions has been reached:
- Fitness of chromosome reached the desired value.
- Until no more improvements.
- If the time limit is exceeded.

Figure-2:Block diagram of the registration method is seen.



The Kalman clear out is an estimator that makes use of measurements found over a specific time to produce positive estimates that tend to be more particular than every other single measurement. The Kalman filter technique improves the accuracy of the object vicinity and presents predictions for the objects future vicinity. basically, The Kalman filter out the set of rules is used for the tracking of moving items. Video tracking is defined as an action that estimates: the trajectory of the object inside photograph aircraft when its movements in the scene. A tracker will assign constant labels to the gadgets which are tracked in distinct frames of the video. tracking of an item may be carried out by means of continuous detection to localize the regions, the points or the functions of a specific photograph frame via the frame. Tracking of an item is done with the aid of predicting the object's function from the information this is recognized previously and verifying the existence of the object at the expected position. The discovered feature and motion model ought to be learned through a few sample of photo sequences before monitoring is achieved. The Kalman clear out is a fixed of mathematical equations that give a green computational method to estimate the nation of a technique in numerous aspects: it supports estimations of beyond, gift, and even

future states, and it can do the equal even if the proper nature of the modeled device is unknown. The Kalman filter out estimates a process by using the usage of a shape of remarks control. The filter estimates the method country at some time after which obtains comments inside the form of noisy measurements. The equations for Kalman filters fall in companies: time update equations and measurement replace equations. The time update equations are answerable for projecting forward (in time) the modern-day nation and error covariance estimates to acquire the a priori estimate for the subsequent time step. The dimension replaces equations are liable for the comments. that is used for incorporating a new size into the a priori estimate to acquire a stepped forward a posteriori estimate. The time update equations also can be the idea of as predictor equations, whilst the size update equations can be the notion of as corrector equations. The time update initiatives the contemporary nation estimate in advance in time. The size replace adjusts the projected estimate with the aid of an actual dimension at that point. monitoring of shifting item has been achieved using Kalman clear out. Tracking of the object may be completed by means of supplying the body range from which monitoring has to be started. From the chosen body any object can be picked for monitoring through placing the position of the mask after which the object may be tracked in subsequent frames.

V. DISCUSSIONS AND RESULTS

Inside the Genetic algorithm every chromosome will contain a randomly generated function vector within parameter sure and a random combination of the function points that are selected. This algorithm is then carried out to estimate the position of the item with various population sizes and the selected feature factors. This desk indicates the various parameters which might be required as a way to practice the genetic algorithm. This indicates the settings of the set of rules parameters used for this technique.

Parameters	*Values*
Population size	150
Probability of mutation	0.4
Probability of crossover	0.6
Probability of replacement	0.7
Number of selected ponit features	20
Number of chromosome generations	130
Search range of [Yaw Pitch Roll]	0-5 degrees
Search range of $[t_x\ t_y\ t_z]$	0-5 millimeters

The advantages of using the genetic method is as follows:

- A way for computing the pose of an item based on the genetic set of rules framework. On this method, we search for the set containing the most reliable feature points of an item further to its pose within the image collection.
- This technique has the advantage of warding off the nearby ultimate solutions as compared to the traditional finest descent strategies.
- This set of rules is likewise efficient in except outliers and point mismatches.

And the limitations are as follows:

- This set of rules cannot deal with the shape from motion hassle.
- Each the 3D model and the pose of the object is recovered from 2nd pix without any a prior information of the object shape.
- This genetic set of rules may be prolonged to look for both the structure and the pose of the object.
- The structure from motion trouble suffers from shape and poses ambiguities with a few of the best descent searches.
- Testing the efficiency of the Kalman Filter Algorithm has two main components that need to be checked and they are as follows,

The Kalman filter algorithms robustness in certain environments, and robot deployment.

Kalman filter out Robustness: to check the Kalman clear out's robustness, the Kalman filter is made to run on diverse video streams from three hand-picked 'hard' environments. the error metric for this check is greater excessive-degree and exertions-intensive than the one utilized in schooling in which each video is a trial, and each trial is successful best if a human choose decides that the Kalman filter has behaved effectively. All of those testing

effects of the Kalman clear out algorithm may be as compared to the CamShift algorithm alone as a baseline.

KALMAN FILTER ROBUSTNESS TEST RESULTS

Algorithm	Lighting	Background	Obscured
Kalman Filter	20%	84.62%	57.14%
Baseline (CamShift)	20%	61.54%	71.43%

This table shows the results of the Kalman Filter Algorithm after testing and after comparing it with the CamShift Algorithm, lighting fixtures adjustments: those films start by tracking an object in a single lighting fixtures surroundings. The object then actions right into a differently-lit environment, and then returned to the original surroundings. for instance, the item may be under bright ambient lights in the first frame, after which pass in opposition to a harsh backlight earlier than finally returning to its place to begin. Fulfillment is executed whilst the Kalman clear out is glaringly nevertheless tracking the object in the final frame.

Distracting heritage:

This set has movies in which the goal item could be very similarly colored to the heritage. for example, the target can be a darkish blue shirt, even as the history incorporates a further dark blue armchair. The filter is considered a hit if it nevertheless tracks the object as the object actions through the heritage and returned.

Obscured object:

These videos concerned the goal object transferring in the back of an obstruction and rising from the other side, then returning to its starting area. Trials are a success if the filter surely tracks the item as it movements via the obstruction, then again to its place to begin.

VI.CONCLUSION

The purpose of the study was to identify the most suitable Algorithm or methodology to be applied in Registration and Tracking of Objects in Augmented Reality. This study has helped to understand which algorithm can be used to acquire a better and more accurate result in tracking objects in Augmented Reality. Since Augmented Reality is a combination of the real world with the virtual worlds and also it superimposes the virtual objects and information into the real scenes there are certain special parameters to be considered while choosing the algorithm. These parameters have to be very specific so that an appropriate algorithm can be chosen. The efficiency and improved working will be based on performance of the algorithm. The most prevailing algorithms Genetic Algorithm, and the Kalman Filter Algorithm are chosen in order to identify the most suitable one.Both these algorithms have their own advantages as well as limitations and both have their level of efficiency mentioned before depending on the situation the object is being tracked.

VII.LIMITATIONS

This study has certainly helped to find different methods to track objects in Augmented Reality and how these methods are different from each other also the similarities between them. But along with the advantages comes a few limitations in tracking and registering objects in Augmented Reality. For both these Algorithms, the parameter need to be very specific so that we can get accurate results. Getting accurate results could be difficult at times. Also the setup that is required to be done in order to detect the positions is pretty tedious and could take a while. The results and the outcomes might not always be that efficient in working in order to achieve one must be very precise.

Directions - Future Research

This paper just shows two most important algorithms that are used to track objects in AR or in computer vision. Further study can be done by doing a study on more algorithms and implementing those algorithms. Also many of a times due to some reason the results might not be accurate and in order to make it more accurate or to increase the accuracy in the outcomes there could be certain changes that could be made to the Algorithms is order to get accurate results at all times.

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