# CHAPTER II

# LITERATURE REVIEW

## 2.1 INTRODUCTION

In the compression of video sequences, the important entity considered for the compression efficiency improvement and the performance improvement is the motion estimation. The Motion estimation plays an important role in the process of video compression. In many of the standard video coding techniques, like MPEG-1/2/3 and H.261/263/264 etc., the temporal redundancies among the consecutive frames in the video are exploited using the motion estimation and compensation process. In the video sequence taken for the compression course, successive frames may contain the same object. The objects may be in the still or moving condition in the successive frames. By only considering the object with different visual content and neglecting all other blocks that are same as the reference frame, the video compression efficiency can be improved. The motion estimation process finds the movement of the object in the image sequence and motion movement is represented using the motion vectors. Motion compensation by using the knowledge of the reference and the candidate frame associated with the object movement, to achieve the data compression. Also, the correlation between the successive frames also generates the temporal redundancy, which can be a crucial affecting factor in the interframe coding can also be eliminated using the motion estimation and compensation. Due to the difficulty in compensating the object movement in line with rotation, some assumptions are made in the motion estimation algorithm. They are:

i. Object motion is only in the translational plane, neglecting the effect of the zoom and the object rotations.
ii. Uniform illumination.
iii. Uncovered background and the object occlusion are abandoned.

In the search algorithm based motion estimation, the best-matched block is found by a search within the entire search window. Various search algorithms, like three-step search, 2-D logarithmic search, and four step searches are developed to minimize the redundant data and maximize the PSNR and SSIM. The monotonic property of the

Block Distortion Measure (BDM) is used to estimate the motion vectors in these search algorithms. In the real video sequences, the degradation in the quality of the video introduced by these search algorithms is comparatively high. By considering the motion vectors within the neighboring picture frames, (stationary or quasi-stationary characteristics) in the search, the quality degradation can be limited. Some of the search algorithms without quality degradation of the video sequence are cross search, octagon search, and hexagon search. The effectiveness of the search algorithm can be increased by the adaptive search range change. The search range is the possible location in which the search is done exhaustively. By controlling the search range with the initial cost of the search center, the complexities in the motion estimation can be decreased within the adaptive search range and the search algorithm determines the optimal matching block.

## 2.2 SURVEY OF LITERATURE

The literature of the research works considered for the review is considered into two types. They are,

i. Search based motion estimation
ii. Non-search based motion estimation

Accordingly, many researchers regarding the motion estimation are reviewed. Some of the researchers are associated with the different types of the search algorithm. The search algorithms used are, fast search, three step search, full search, fast full search, cross search, diamond search, cross diamond search, hexagon search, octagon search, and octagon-triangle search.

In the non-search based motion estimation, three of the researchers are presented the model-based object movement estimation.

### 2.2.1 Search based motion estimation

In the search based motion estimation, many researchers using different search algorithms for the optimal matching block prediction are reviewed. Based on the type of the search pattern used, literature is classified as follows:

*i. Three step search:*

Jianhua Lu *et al.* [47] presented a motion estimation scheme depending on the Three-Step Search (TSS) algorithm. By obtaining the search direction in addition to the TSS, the complexities in the computations of the motion estimation were reduced using the

TSS algorithm. They have used the three step search as the searching algorithm because of its simplicity and the improved performance in the real-time video applications. Initially, the search direction for the thorough search was defined, and TSS was engaged. The computation associated with the direction chosen and the complexity minimization was different in the proposed system. Even though the processing time was increased, the performance of the system was enhanced. On comparing with the every possible block in the eight possible directions of the TSS, the block in the minimum error location was chosen as the optimal matching block, and the motion vector associated with that location was compensated to attain the compression. The speed of the TSS in this search algorithm was incremental by the predefined search location initiation.

Renxiang Li et al. [48] have explained an optimized New Three-Step Search (NTSS) algorithm for estimating the fast motion in the video files. The NTSS has a series of the three steps for the motion estimation. The search operation in the three steps varies from one another. The NTSS algorithm uses a center-biased checking point pattern at the initial step to reducing the computational costs. The proposed NTSS algorithm uses an objective function for motion estimation. The objection function defines the average distance measure for the frames of the video content. The centre-biased search point pattern used in the NTSS adds eight extra checking points in the initial step process. These extra checking points act as the window center neighbours.

The video compression is done by reducing the average distance between the frames. The addition of the checkpoints in the first step process reduces the average distance between the frames. The three steps in the algorithm have a fixed search pattern. This serves as an advantage as it reduced the complexity of the algorithm. The NTSS algorithm has no thresholding operations in the search process. For applications such as real world image series videos, the bitrates of the sequences are very low. Hence, the NTSS algorithm better utilizes the motion distributions of videos in these applications. For the lower bit rate videos, the NTSS algorithm is more adaptive, and the algorithm stops at second or the third step. From the simulation results, it can be concluded that NTSS is more vigorous, generates small motion compensation errors, and it has higher SSIM, PSNR when compared to the TSS. The NTSS algorithm, when compared with the TSS algorithm, produces better results. The proposed NTSS has better results regarding motion compensation error and robustness when compared

with the existing TSS approach. The NTSS algorithm has the advantages such as simplicity and regularity. The computation of the fast motion estimation during the video compression can be done by skipping the steps. This reduces the overall computational complexity of the algorithm. The algorithm uses the halfway stop technique to be compatible with the other algorithms. The proposed NTSS algorithm provides less motion compensation errors than the conventional TSS algorithm and has a more robust nature. The use of the motion field subsampling techniques in the NTSS algorithm does not affect its performance.

Humaira Nisar and Tae-Sun Choi [49] have discussed an Advanced Center Biased Three-Step Search (ACBTSS) algorithm for estimating the fast block motion. ACBTSS method performs the video compression through the fast block estimation. The proposed makes use of the Unimodal Error Surface Assumption (UESA) for estimating the compensation error between the video frames. The use of the UESA algorithm in the proposed model reduces the computational complexity for performing the video compression. The center biased search strategy performs the searching of the frames in the video content for the compression process. The UESA model increases the possibility of receiving the perfect motion vectors for the video compression. The UESA model utilizes the half stop technique to increase the speed of the block matching process. The UESA model, when compared with the conventional TSS algorithm, shows a better performance. The image quality of the video content has improved with the use of the UESA model. The UESA model monotonically increases the residual block matching error due to the movement of the checkpoints in the various positions. The checkpoints move apart from the global minimum position. But, in the real world video application, the previously stated condition fails. The position of the motion vectors depends on the local minimum points. This model is compared with the various full search algorithms. The performance parameters such as computational complexity and error performance define the compression rate of the proposed model. The efficient central biased search strategy used in this model decreases the chances of acquiring trapped in the local minimum points during the compression process. The models, such as half stop technique and quadrant selection approach employed in this model decreases the requirement of computation for performing the video compression. The ACBTSS search algorithm performs the motion estimation with the improved results. The ACBTSS algorithm has robustness

since the video compression is independent of the image sequence motion in the video.

Hussain Ahmed Choudhury and Monjul Saikia *et al.* [50] have presented a Reduced Three Steps Logarithmic Search (RTSLS) algorithm for the block matching process and the motion estimation. This model has the higher computational efficiency than many of the conventional approaches since the model reduces the step required for the video compression. The proposed model when compared with the traditional TSS and the NTSS model produces better results regarding the computational complexity. This model reduces the checkpoint usage by 50% than the conventional TSS model. The performance of this model can be computed by applying the model to the various real-time video contents. From the simulation results, it can be clear that this model outperforms the traditional model with the improved computational complexity. The performance of the model depends on the number of search points needed and the PSNR value. The RTSLS depends on the 2 DLS models and the conventional TSS algorithm. This model, when applied to the 'missa' video sequence with Mb size of 16x16, shows better results. The proposed model takes a 50% computation than the TSS model and a 60% computation of the conventional NTSS model. The proposed RTSLS algorithm has a lesser number of the checkpoints for motion estimation than the existing models but, the PSNR value has not been altered. The compressed video content has better qualities with the proposed model than the TSS and NTSS search model. This model has the same PSNR value, and it serves as a disadvantage.

*ii. Full search:*

The motion estimation using the Full Search (FS) algorithm was used in many of the motion estimation and compensation schemes. The ME using the modified FS was developed by Madhuri Bamankar *et al.* in [51]. They used the threshold-based object movement detection. In the modified full search algorithm the matching block was reduced without any change in the signal to noise ratio as similar to that of the normal FS block matching algorithm. The complexity reduction was attained by neglecting the Sum of Absolute Differences (SAD) calculation of the background pixels.

The number of SAD calculations with the background elimination method aids in block changes over with the removal of the constant block in the current frame. When the initial frame is the reference frame, the difference in the consecutive frames revenues the background frame. If the attained background pixel value was less than

the threshold, the current frame was made zero, and if greater, the current pixel was selected as the foreground pixel upon which the motion vectors were estimated. Their results obtained shows 50% reduction in the computational complexity with the tolerance of about +3% to -3%.

Sufyan Salim Mahmood Aldabbagh *et al.* [52] have presented the Full Search Block Matching Algorithm (FSBMA) for estimating the motion. This model reduces the computational load of the video compression process without major deprivation of the video image quality. The real time video files are subjected to the video bowing and the video testing. For video bowing this model decreases computational intensity with 90% and for video testing, it minimizes the computational intensity with and 95% when compared with the conventional approaches. The performance metrics, like the SAD and SSIM, assess the performance measure of this model. The simulation results provide the best values than the conventional Four-Step Search (FSS) algorithm and the TSS algorithms. The performance parameter SAD of this algorithm has better values than the SAD of the conventional, TSS and the FSS algorithms. The FSBMA model uses a FS approach for the Motion Estimation (ME). The Video compression standards utilize these block-based motion compensation methods since they can remove temporal redundancies in the frames of video contents. The IFSBMA model, when used in the integrated circuits, requires high computation standard and the estimation of the motion vectors in the video sequence results in large power consumption. The FSBMA model when used in the ME processor results in the 60-80% computational power for the total encoder present in it. This makes the battery operated portable devices such as cell phones and camera with real-time video contents to suffer from a disadvantage since; these devices are in need of the low power requirement. The improved FSBMA minimizes the complexity in the computation of the traditional FS algorithm and makes it suitable for the battery operated applications. The FSBMA model eliminates the blocks with the zero values and reduces the CPU time required for the computation. The FSBMA model has an improved CPU time and the SAD value than the conventional approaches. The proposed FSBMA suits for the video applications in the battery operated and handheld applications.

Eduarda Monteiro *et al.* [53] have presented an algorithm for the ME which depends on the parallel GPU-based solution. This model finds application in the video

encoding system. This model estimates the motion by the full search block matching algorithm in the CUDA architecture. The motion estimation is done by reducing the number of steps needed for the computation of the video compression. This model when compared with the conventional search models and OpenMP library shows an increase in the performance. This model, when subjected to the video compression of the various contents, shows an increase in the speed by the factor of $O(n^2/\log^2 n)$. This model depends on the full search model. This model performs the compression of the video files obtained from the applications based on the GPU Architecture. The video coding process with the GPU architecture allows better motion estimation than the other models. The sequential and parallel models in the CPU and GPU improve the execution time and speedup potential of the proposed model. The FS BMA with the parallel version, when used in the NVIDIA CUDA architecture, improves the SAD value of the motion estimation. The proposed version, when compared with the use of the OpenMP and sequential versions, shows better motion estimation criteria. The proposed model evaluation of the video standards such as CIF, HD720p, and HD1080p with the search area of 12x12 to 128x128 shows an increase in the speed and the improvement in the other performance metrics.

The proposed model has an increase in the speed value of 600x gain when compared with the sequential version and an increase in the value of the speed of 66x when compared with the OpenMP, version model. The proposed model has achieved 27% increase in speed for the search area of 16x16 which is better than the conventional models. The increase in the value of the gain with the proposed model has the implementation of the optimized mapping of conventional FS approach in CUDA architecture. The proposed model with the suboptimal block matching algorithms for applications of the real-time video encoding is a challenging task.

Tsung-Yi Wu *et al.*[54] have presented an optimized full search algorithm for estimating the motion. This model uses the embedded SRAMs in the FSBMA chip for the storing of the frames of the video sequences. The PEs in the FSBMA chip reads the series image data from the video content from the embedded SRAMs to perform the compression of the video. The proposed model uses three types of the embedded SRAM arrays for storing the frames. The frames in the video contents are the current frame, a reference frame, and a prefetch frame. The three embedded SRAMs store each of the frames. The FSBMA chip used in the proposed model used eight input

pads for reading the off-chip image data from the video. The proposed model processes 704 frames per second for the videos in the CIF format. By increasing the SRAM contents in the chip, the proposed model processes 34 frames per second for the videos in the High Definition Television (HDTV) resolution. This model when compared with the conventional models such as FS algorithms, it shows better results.

*iii. Fast search:*

The modification of the FS algorithm with a surge in processing time leads to the development of the fast search algorithm. S Ranjbar Avar *et al.* [55] have introduced a fast search motion algorithm for detecting the motion vector accurately in the successive image frames. This fast search algorithm was the modification of the full search algorithm with the improvement made on the computational complexity reduction occurring in the FS because of the cumbersome computations. They have compared the candid block with the reference block and the block with the least matching minimum Mean Square Error (MSE) was selected as the optimally matched block. MSE was used in place of the SAD in the proposed system because of the accuracy provided by it. The processing time required for this fast search algorithm was more than the full search algorithm. The degradation of the video quality in the reconstructed image produced by the fast search algorithm was minimal. By eliminating the highly impossible location with the maximum mean square error value, the redundancy removal was attained in their system. By making use of the center-biased and cross center shape, the number of search locations in the search algorithms was reduced. The simulation results of fast search are returned an approximation of about 99% i.e. the proposed fast search algorithm attained the optimal matching block with the processing time 99% greater than the full search algorithm.

Soongsathitanon *et al.* [56] have presented a fast search algorithm for block based motion compensation. The Orthogonal Logarithmic Search (OLS) algorithm reduces the computational error4 occurring during the motion compensation process. To assess the performance of this model, the model is applied in the benchmark video files in the real time. The benchmark video files have the standard of 176×144 pixels Quarter Common Intermediate Format (QCIF) files. This model is compared with the conventional video compression models such as TSS algorithms. This algorithm finds its applications in the international video coding standards, like ITU-T H. 263 and ISO MPEG-1/2. These video standards have the real time video contents. The performance

metrics such as time and Peak Signal to Noise Ratio (PSNR) evaluates the quality measure of this algorithm. The simulation results of this model in the standard real-time videos show that it has a better speed of operation than the conventional three-step search algorithm and the full search algorithm. The speed of this model is 87% higher than the conventional full search model and is 23% higher than the TSS approach. The proposed algorithm has more accurate video compression than the other traditional search algorithms. This model depends on the logarithmic search approach. The traditional model has the disadvantage of the uniform search patterns for the compression of the video contents. The OLS algorithm reduces the candidate blocks for searching motion vectors by eliminating the uniform search patterns. The quality of the images from the video compression through the proposed model is better than other conventional models. This model when used for the compression of the real-time low bit rate communication videos it has a better quality. The reconstructed frames from the compressed video contents with the use of the proposed OLS model have better quality than the traditional FSA method and the TSS model.

Yasser Ismail *et al*. [57] have presented a set of computationally correct and efficient, skipping methods for estimating the motion. This model uses not only the Partial Internal Stop Search (PISS) method but also uses the External Stop Search (ESS) method for the motion estimation. The PISS method, when employed in this model, skips the internal SAD operations among the current block and the reference block. This is done by utilizing an accurate adaptive threshold model in the ISS method.

The ESS method, when employed in this algorithm, reduces the unnecessary operations for the video compression through the skip all the irrelevant blocks present in the search area. This model performs the block matching motion estimation with the increased efficiency. The parameters such as compression efficiency, computation time and the error performance estimate the performance of the proposed model. The complexity in the computation of the algorithm can be decreased through the time saving of the motion estimation encoding process. The results of the simulation prove that the implementation of this model in the standard video contents decreases the time needed for estimating the motion by 71.26% than the conventional approaches. The reduction in motion estimation time is obtained through the reduction in the PSNR value by 0.03 dB and a minute increase in the frame bits by 2%. This model skips the

skip the redundant operations in the video compression process with the use of the ISS and the ESS approach.

*iv. Fast full search:*

The hybrid search algorithm combining full and the fast search algorithm are used for the motion estimation with the aim of decreasing the computational complexity problem. The Fast Full Search (FFS) algorithm uses different matching error measures or criterion for the impossible candidate block rejection. Also, the fast full search algorithm with predefined search order also has a significant effect on the complexity reduction in the matching block detection. Using the Sum of Squared Difference (SSD) as the error measure, Param Kusam AV *et al.* [58] has presented a fast full search block matching algorithm. Depending on the homogeneity regions present in the images of the video sequence taken for the compression, the efficiency of the proposed algorithm alters in other word frames with the homogeneity blocks can be processed with increased speed. The best block searching with the far lower computations was made possible in the proposed system, with the current frame blocks having small variance values. The SSD criterions of the candid block in the frames were calculated separately without lack in consideration of the localization point. In addition to the temporal redundancy reduction, the spatial redundancy reduction was also exploited in the proposed system. The block with minimum SSD measure was chosen as the best matching block on comparing the reference as well as the candid block. The search result of the proposed fast full search algorithm was identical to the full search algorithm with the improved performance and less computation. The single error measure based fast full search algorithms are limited based on the condition of the images. By considering the multiple error measure for the prime block match detection, the limitation associated with the single criterion can be eliminated.

Apart from the conventional MSE as the error measure, FFS algorithm based on three additional error measure criteria was developed by Yih-Chuan Lin *et al.* in [59]. The comparisons of the reference block with the candidate block within the range of the defined search window were completed using the multiple matching criteria. They have utilized the matching criterion which was extracted from the integral projections because of the ease and the providence of the relevant feature to the block of pixels. They are vertical projections, horizontal projections, and massive projections. The

integral projection is nothing but the sum of the spatial pixel along the fixed direction in the block of pixels. They have presented the multiple criterion based block selection with the computation complexity of the sum of the three error measure is lower than that of the MSE. The accuracy reached by the proposed fast full search algorithm was better than the conventional full search algorithm. The block matching with MSE utilizes the conditional results of the integral projection based measures to reduce the time consumption.

The FFS algorithm depends on the immediate elimination of the impossible candid motion vectors were presented by Jong-Nam Kim *et al.* [60]. They have used the idea of interlink among the block matching error and the reference block's complexity. By using the image complexity, the impossible candidate vector rejection was done more rapidly. The inappropriate motion vectors with increase SAD values were eliminated firmly, reducing the computation in the matching procedure. By making use of properties such as square sub blocked matching, predetermined dithering, and complexity based block matching, the goal of the reduced computation was attained. The Larger matching error was obtained by calculating the matching distortion of the image area with larger gradient magnitudes. Depending on the complexity of the image area, the matching error value gets incremented. The experimental results obtained about 30% reduction in the unnecessary computation of the full search algorithm proposed in this paper. In addition to the image complexity based error prediction, defining the order of the search and the search region in the fast search algorithm can also decrease the problem concerned with the computation.

An adaptive fast full search algorithm by the partitioned region and the optimized search order was presented by Soonjong Jin *et al.* in [61]. Detection of the matching error in the video sequences with the rapid motion was the tedious task which is perfected in the adaptive search algorithm. The adaptive search algorithm was based on the fact of the multi-level Successive Elimination algorithm (SEM).

In SEM algorithm, the rejection was done based on the inequality. By reducing the SAD calculations, with the immediate finding of the minimum matching error block matching is acquired. They have reached the destination in two stages. Primarily, the search range was partitioned, and search order was defined using the predicted motion vector. Median and mean prediction method was the motion vector prediction schemes adopted in the proposed system. Lastly, within the defined region order, the matching

errors for the entire candid block in the frames were calculated in an optimized search order. The optimal ordering was maintained in a way that sub-blocks with the largest matching error were checked first, thereby reducing the overall computation and the processing time. The search order was obtained from current candid block's the image complexity. On comparing the conventional search algorithms, the proposed system provides the motion estimation with 96.6% reduction in the complexity. The need of multiple slicing of the blocks for the searching i.e. current sub-block into 16 sub-blocks with 4 x 4 was the disadvantage in the motion estimation system.

*v. Cross-search:*

The search of the block matching algorithm with the different shape and size of the search pattern has a massive influence on the speed of the search and the distortion performance. Cross search pattern for the best matching block detection with five checking points i.e. search located at the end of the cross structure has reduced the computation. With the dual cross search structure i.e. small and large cross search pattern evaluation, the computation can be further reduced. An efficient block matching algorithm using the dual cross search patterns was developed by Xuan-Quang Banh *et al.* [62]. By adapting the center prediction in the initial search and the termination in the early search, before the dual cross search pattern evaluation of the endpoints for the best block matching is done carefully. They have used the blocks with the minimum SAD value as the Initial Search Centre (ISC) to determine the optimal motion vector. The optimality of the chosen ISC was compared with the threshold, if the ISC fails to meet the SAD threshold, the search will be eliminated. By the early search termination, the cost of computation was also reduced with the significant effect on the video quality. The $2\times2$ and $4\times4$ were the double cross structures used. Initially, SAD of the four endpoints of $2\times2$ cross search pattern respective to the cross center was estimated. The cross search stops, if the center checkpoint is with minimum SAD otherwise $4\times4$ search pattern took over its part to find the optimal search point. They have also developed an adaptive dual cross search to further speed up the search.

The performance of the cross search pattern is greater even considering to the current search algorithms like the hexagon search, diamond search, TSS and full search. The cross search relied on the alternative search patterns also increases the performance of the compression system. Such an alternative block matching algorithm was developed

by Wen-Feng Li *et al.* [63]. The BMA algorithm has employed cross-shaped search pattern at the initial step, and the block matching was done by the fusiform shaped search pattern. The shape pattern of the cross and fusiform was different, but with the cross aided fusiform search, the PSNR value attained were significant to the conventional search algorithm. In the real video sequences, the motion vectors were majorly issued in the center. The search pattern with the center biased characteristics can only help in exploiting such vectors; cross search pattern is of such type. The search center with minimum block distortion matching point was predicted by the cross search in the proposed system. By making use of the horizontal and the vertical fusiform search patterns, the best block matching was found over the cross search evaluated endpoints. Fusiform search pattern was the improved form of the hexagon search. Without the adaptation of the cross search for the minimum BDM point selection, the block matching computation increases rapidly. Their experimental result shows that the adaptive cross-fusiform search was the fastest algorithm, with better MSE performance. They have also concluded the fact that, smaller the motions in the video sequences, faster the block matching.

Xuan-Quang Banh and Yap-Peng Tan [64] have presented BMA method for estimating the fast motion in the compression of the video files in this thesis. This model finds its application in the motion-compensated video compression. This model was based on the conventional BMA algorithm. The search operation in this model contains three steps. The primary step is initial search center prediction which enables the searching of the redundant frames. The second step is early search termination, and the third step is dual-cross search where the motion estimation is done. The BMA method, when compared with the traditional algorithms, like NTSS, TSS, orthogonal search, and the diamond search, shows better performance results. The parameters, such as PSNR and the number of search points evaluate the performance of this model. The Dual Cross Search (DCS) and the Adaptive Dual Cross Algorithms (ADCS) presented in this work have outperformed the existing BMA algorithms. The DCS and ADCS differ from the setting of the threshold value which terminates the search operation. The DCS algorithm uses a threshold with the constant value whereas the ADCS uses the varying threshold values. This model decreases the complexity in the computation with the greater video quality and it was better than the conventional algorithms. This model achieves better performance due to the following factors. This

model utilizes the correlation among adjacent motion vectors and eliminates it during the video compression. The number of search points needed for performing the video compression was decreased through the early termination of the algorithm. The above process does not reduce the image quality. The DCS locates the optimal motion vector. The performance of the proposed model during its application in the standard video contents shows the accuracy of the model. The DCS and the ADCS speed the search process by a factor of 3.3-7.6 as balanced with the conventional DS algorithm and 1.3-3.0 with the existing ARPSZMP algorithm. The PSNR value is better than the conventional models. In real-time video applications, like video streaming and video calling, the ADCS model shows a better performance since its computational cost is low.

*vi) Diamond search:*

The Diamond Search (DS) pattern is generated from the cross structure. The DS pattern employs two search patterns, namely small diamond search pattern, and large diamond search pattern. Here, the Small Diamond Search Pattern (SDSP) has 5 search points and the large diamond pattern has 9 search points incorporated with the center point. Using the simple small diamond search pattern or the Large Ddiamond Search Pattern (LDSP), the block matching algorithm can be done effectively.

Shan Zhu *et al.* [65] have presented a BMA using the DS algorithm. They have used both the Small and the large diamond search patterns. The search procedure starts up with the large diamond search. When the search resulted in the least MBD point at the middle of the large diamond search, the small diamond search took over the abode. But without the MBD at the middle of the large diamond search, the process gets iterated until the salvage. The search point out of the large diamond is further searched using the small diamond search and the optimal matching search point for the motion vector generation was found out. The advantage of the proposed system was a limitation of the search window size by which the searching strategy is made free. They have developed the block matching algorithm with 22% reduction in the computation comparing to the TSS, NTSS and 4SS algorithms.

The video sequences with heavy motion movements need larger search window for the motion vector search. By making use of SDSP and LDSP in such video sequences, compromise in the video quality is for sure. In accord with the multiple diamond structure, the block matching algorithm can be done using the small diamond shape-

based search itself. The block matching algorithm with Small Diamond shape Based Search (SDBS) with efficiency enough to meet the video quality requirements and decreased motion vector search time was introduced by Shen-Chuan-Tai *et al.* [66]. The SDBS was a multi-stage motion estimation algorithm because of the search region division. The multiple stages involved in the proposed system were; i) Initial search ii) Multilayer motion search iii) Refinement search and iv) Hand shakes search. The search regions were divided into the un-overlapped small diamond regions, and the SDBS evaluates the larger motion movements in the sequences. In addition to the optimum reachability, avoidance of the mistaken optimal matching block was also an important characteristic of the proposed matching algorithm. Here, the checking points within the search window are classified into sampled point and the unsampled point. Finishing off with the sample points, the un-sampled points were checked.

Shan Li et al. [67] presented a novel block matching algorithm depends on the Multilevel Adaptive Diamond Search (MADS). The MADS algorithm depends on the following steps; frame-level motion complexity estimation, block-level motion compensation and adaptive search modes of the diamond pattern. They have used the information regarding the reference frame texture and macroblock residual value for the frame level motion complexity estimation in which the intensity of the motion is reflected. Using the threshold setting and the initial search prediction, the efficiency of the search was improved. The block level complexity was estimated by the assistance of the spatial-temporal correlation. After the complexity detection at the frame and the block level, diamond search pattern was utilized for the optimal checkpoint selection. Here, the three modes of the diamond search pattern, namely Horizontal Diamond Search Pattern (HDSP), SDSP, and Vertical Diamond Search Patterns (VDSP) were utilized. SDSP was associated with the low motion blocks. HDSP was associated with all the blocks of the simple frame and VDSP was associated with the high motion blocks. The diamond shape-based search pattern had covered a vast range of the video with higher search precision and fewer search points.

*vii) Cross-diamond search:*

The hybrid search algorithm containing the cross and diamond search takes advantage of the cross search as well as the diamond search. The larger motion movement video sequences can be searched with the reduced computation cost by the cross-diamond search. Nijad Al-Najdawi *et al.* [68] have developed a hierarchical search motion

algorithm for compressing the video with a cross diamond search algorithm. By adapting the cross-diamond search method, the number of comparisons for block movements among the consecutive frames of the video can be reduced. Coarse sub-sampled versions of the image followed by the successive higher resolutions were used by the hierarchical search algorithm. By the motion vector estimation in the sub-sampled locations, from the high to the low level, the computational complexity was reduced with the high-quality motion vectors. The search algorithm used at the hierarchical level varies according to the type. At higher levels, full search algorithm was used since the complexity is very low. The search point location with minimum SAD generated by the cross search was evaluated alongside using the diamond search to find the optimal search location. Here, the large diamond search pattern was used. Compared to the full search algorithm used at the lower hierarchy level, the complexity reduction of about 83.45% was achieved by the porpoise cross-diamond search.

Shiping Zhu et al. [69] have proposed a Cross-Diamond Search algorithm (CDS) for estimating the motion and compensation. This model depends on the distribution characteristics of the motion vector in real-time video contents. The CDS algorithm uses the cross search which differs from the diamond search patterns. The proposed CDS model uses the halfway technique for increasing the speed on estimating the sequence with stationary blocks. The proposed model depends on the Modified Partial Distortion Criterion (MPDC) for minimizing the search points and thus reducing the distortion in the video images. The simulation results reveal that the CDS model has a 16% gain than the conventional CDS model through the constant maintenance of the prediction accuracy. The CDS model has a high speed and lesser distortions than other conventional fast BMA.

Bin Sun and Haixia Zhang [70] have presented an unsymmetrical Dual Cross-Diamond Search (DCDS) algorithm for estimating the motion in the real-time video sequences. This model depends on the unsymmetrical cross-search patterns in the first steps then, employs the usage of the small diamond search patterns for the latter steps in the fast block motion estimation. Here, the first step depends on the center-biased search characteristics. Hence, they employ a well searched horizontal and vertical search pattern. The DCDS algorithm identifies motion vectors in the video sequence with fewer search points using the halfway stop technique and produces the better

quality results. The parameters such as computational complexity and the search time assess the performance of this model. The DCDS algorithm has more robustness and a shorter search time for finding the redundant frames than the other than fast block-matching algorithms. This model has a reduced image distortion rate. This model has a better search tree algorithm than the conventional cross search patterns. This model has the advantages of the reduced computational complexity and an improved PSNR value. This model effectively reduces the unwanted redundant frames and thus provides a better video compression. The compressed video content has a better quality image and thus image degradation is less than other models. The proposed model reduces the Motion estimation speed and improves the compression process. The CDS model finds application in the high definition and super definition video sequence applications.

*viii) Hexagon search:*

Similar to the diamond shape search pattern, based on the number of checkpoints the hexagon search is also classified into small hexagon search pattern that has five checking points and large hexagon search pattern that has seven checking points. The search path originates via the large hexagon, and small hexagon follows up the path ending in the solution reachability. The hexagon shaped search pattern exhibits faster search speed. The motion estimation algorithm with improved speed by incorporating the hexagon search was presented by P. Tham bidurai *et al.* [70]. The speed improvement in the search was achieved by considering the already processed motion vector's angle and direction. The correlation present in the temporal direction of the successive video frame was expected to flow in the similar direction and this correlation is the basis for the initialization of the algorithm. The search area of the motion movement was narrowed down using the displacement angle of the picture block from the last two frames. The hexagon search at the limited search area was done resulting in the search point with minimum block distortion. The resulted checkpoints were further evaluated using the small size hexagon with the consideration of the angle of displacement of the detected MBD point to the current point. The hexagon based search has found its use over the medical video application because of the computation time reduction of about 40% attained in the experimental results.

Tsung Han Tsai *et al.* [72] also presented a hexagon search algorithm for estimating the block motion considering the speed improvement of the search procedure as a crucial factor. They have worked on a 3-D predict hexagon search algorithm as the BMA. The complexity in the size prediction of the hexagon was well maintained by the proposed algorithm by defining the prediction of the search pattern size. The root center biased behavior of the proposed 3-D algorithm with the probability detects the motion vector. They have used Small, and Large Predict Hexagon Search Pattern (SPHSP and LPHSP) in the search process. The cost point with minimum SAD at the center of the LPHSP and SPHSP were evaluated for the estimation of the final point for estimating the motion vector. From the experimental results, it can be proved that a speed improvement of 25-75% over the conventional searching algorithms. The video sequence with the higher resolution was also processed well by the proposed algorithm [72] with a proper trace of the high motion movements and the proper maintenance of the image quality.

The coding efficiency improvement using the hexagon search is an easy one. The coding efficiency of the video compression standards can be increased by reducing the time consumption of the motion vector estimation. An adaptive motion estimation scheme using the UM hexagon search was presented by Pengyu Liu *et al.* in [4]. They have used the Un-symmetrical cross multi-hexagon grid search algorithm for estimating the fast motion. Because of the hybrid matching search pattern used i.e. the cross search as well as the hexagon search and the multiple initial search point predictors, the coding performance achieved by the proposed system was leading. The calculation redundancy of the UM hexagon search was also reduced by the assignment of the search pattern according to the motion vector distribution information. The wide search range needs a lot of the search points and the time consumption is also maximal. The search process over the divided region (32 regions) in the proposed system results in the point with minimum error measure. Depending on the size and the direction of the Motion Vector (MV), the motion vector distribution is predicted, and the motion vector is estimated resulting in finding the motion movements in the blocks of the video sequences. Without any compromise in the rate-distortion performance, the proposed search algorithm saved the motion estimation time of about 20.86%.

*ix) Octagon search:*

The octagon search pattern consists of 9 checkpoints. The candidate search location for the octagon search pattern lies on any of the checking end points. The advantage of the octagon search is that it searches the large search area with a smaller number of search points which in turn reduces the complexity and the cost needed for estimating the motion and also provides better efficiency. The directional characteristics of the SAD and the center biased behavior of the motion vectors are successfully analyzed using the octagon search pattern. Similar to the hexagon, diamond, and cross search, the octagon search also consists of two shapes altering the number of the search points.

The block matching algorithm using the octagon search pattern was developed by Yuming Wu *et al.* [73] and Zhu Weixing *et al.* [74]. The modified octagon based search algorithm proposed in uses the zero block detection method for the early termination of the search process as possible. They have initially used the small octagon for the search of the point with the minimum MBD. If the point with the minimum MBD obtained at the small octagon, by the application of the zero detection method the search process gets terminated. Otherwise, the large octagon search pattern twitches of the process to result in the search point with minimum MBD. The search point reduction in the proposed algorithm was attained by the use of median motion value of the adjacent blocks. The limitation of this algorithm is that it had the problem of local minima. But the encoding efficiency is almost same as that of the conventional search algorithm.

The local minima problem associated with the octagon based search was minimized in the multi octagon grid search algorithm proposed by Zhu Weixing *et al.* in [74]. The processing steps in the proposed octagon search algorithm involve dynamic search range technique, the adaptive threshold of the macro block and the early termination criteria, improvements on UMH search and the concrete process of MOGS algorithm. The new search range was adjusted analyzing the validity of the neighbor block. If the optimal search point lags behind the threshold, the solution will be altered over. Upon reaching the solution, the early termination of the search process tends to avoid the unnecessary computational cost and the complexity. By the improvements made in the UM Hexagon search and the MOGS algorithm, enough search points for the searching was provided. In addition to the prevention of minimum value, the search accuracy in

the middle motion sequence was also raised. The speed of the search algorithm was raised by about 42% and the processing time was saved up to 21%.

Fast motion estimation technique in the video sequences plays a major role for video compression. Lap-Pui Chau and Ce Zhu [75] have proposed an algorithm which utilizes the OCTagon-Based Search (OCTBS) pattern for the estimating of the fast block motion. They have aimed at minimizing the number of the search points and to improve the speed using the proposed model. This model is compared with the conventional diamond search (DS) algorithm. The results of the simulation prove that the OCTBS algorithm finds the motion vector in the video sequence with a lesser number of search points than the traditional approaches. This model has a better speedup gain than the other conventional algorithms such as TSS, NTSS, 4SS, and BBGDS. In contrary, the DS algorithm utilizes a diamond-shaped search pattern, which was used for processing with high speed and has the same distortion like 4SS and NTSS. The square-shaped search pattern has a speed up gain advantage. But this model utilizes a diamond search pattern and hence, outperforms the fastest square-shaped search pattern algorithm. The speed improvement of this algorithm is obtained with the slight poorer distortion performance. The use of the octagon search pattern than the diamond search pattern improves the speed better than the proposed model.

*x) Octagon and triangle search:*

The hybrid search pattern combining the octagon and the triangle search pattern aids in relieving the motion complexity in many of the motion estimation algorithms. The problem of the complexity of the computation with no compromise in the accuracy of the motion estimation is difficult. The combined action of the octagon and the triangle search pattern provides good searching efficacy and good accuracy.

Chunjiang Duanmu *et al.* [76] have used triangle and octagon search pattern for estimating the motion. Initially, they have classified the motion type present in the video sequences into the regular or irregular and smaller or larger blocks. The blocks with smaller and the regular motion were estimated using the octagon and the triangle search pattern. The block classification also assigns the suitable search strategy. In the octagon and the triangle search algorithm, the octagon search pattern fired up till the search point with a minimum value of the rate distortion cost was found out at the center. The search point with minimum sum of absolute differences selected by the octagon is further searched using the triangle search pattern. The search location with

the minimum rate-distortion value corresponds to the motion vector of this algorithm. The complexity associated with the proposed search patterns was simple. The blocks with large motions cannot be tolerated using the octagon and the triangle searches and is the disadvantage of the proposed algorithm. The early termination criterion for the search scheme upon reaching the optimal solution point is also not found, increasing the complexity.

### 2.2.2 Non-search based motion estimation

In the non-search based motion estimation, many research papers regarding the motion estimation are reviewed. The review over the non-search based motion estimation constitutes model based motion estimation scheme [77-80], pixel-based motion estimation [12, 81], optimization algorithm based motion estimation, normalized cross correlation and activity based motion estimation, 2-D and 2-bit transform based motion estimation, multiple reference frame based motion estimation, and tangent distance prediction based motion estimation [9] respectively.

*i) Model based motion estimation:*

The model-based motion estimation scheme increases the coding efficiency of the compression methods. The model based scheme does not skip any regions of the video frame in the motion estimation and compensation even if the pixels are encoded spatially and temporally. The elastic model based motion estimation was introduced in [77-79] and the texture model based motion estimation used was introduced in. Marc Bosch *et al.* [77] have presented a model based video compression scheme. They have utilized segmentation based texture and motion model for the motion compensation. The region of the image frame with the similar homogeneous motion, color, and texture properties was processed together. They have used the texture analyzer for evaluating the homogeneous regions in the frame for labeling. The segmentation of the texture happens in two ways. They are feature extraction and grouping based on the feature properties. The feature of the image frames color and edges were exploited using the spatial texture analysis. Their experimental results show 15% reduction in the data rate of the texture based cases and 30% reduction in the data rate for the motion based case. Abdullah A. Muhit *et al.* [78] worked on the elastic motion model based motion estimation scheme. In this approach, they have used the extended prediction strategy. The prediction strategy includes the non-translational motion prediction. The elastic motion model uses the 2-D cosine basis function to evaluate the

non-translational motion. The performance improvement in the proposed system was attained by taking advantage of the larger blocks with the Tree structure multi-level partitioning. The compression efficiency of the inter-frame coding in the H.264 encoder is improved by the combined action of this elastic model and the larger blocks.

The model-based techniques are susceptible to the performance degradation, interference, and complexity. By incorporating the adaptive geometry based partitioning of the regions in the elastic model based motion estimation scheme, improvement in this susceptible parameter is made possible. Mark R. Pickering *et al.* [79] developed a video coding system based on the fast geometry adaptive partitioning and an elastic model. The adaptation of the geometry based partition helps in separation of the camera motion and the background motion. Thereby the blocks with the independent motion can be sliced separately. The significant change in the effect of the elastic motion model was possible because of the adaptive geometry partitioning method. The proposed scheme has the capability to supplement the baseline profiles as well as the higher profiles in the H.264 video compression standard with the better saving of the bit rate.

*ii) Pixel based motion estimation:*

Pixel-Based Motion Estimation (PBME) scheme forecasts the motion based on a pixel by pixel the basis for comparing the pixels between the adjacent frames whereas the block-matching estimation scheme only predicts at the block level. The pixel by pixel prediction criteria avoids the need of transmitting side information. A lossless video compression method depends on the PBME scheme was proposed by Xiaolin *et al.* [12]. The PBME scheme involves two stages; initial motion vector prediction using adaptive backward pixel scheme followed by the pixel based fast search pattern. The pixel scheme utilized was the backward adaptive pixel-based motion estimation scheme. With the assistance of the backward adaptive pixel estimation scheme, computational complexity and the transmission overheads were neglected in the proposed system. The prediction scheme revised by the adaptive backward scheme provides the initial motion vector.

In [81], ZHOU Wei *et al.* also have presented a pixel based motion estimation algorithm. The ultimate intention of the proposed system was to reduce the residual coefficients. They have developed a fast hierarchical 1/4–pel fractional pixel motion

estimation algorithm depends on the H.264/AVC. The searching strategy of the proposed algorithm checks only 5 points rather than the 16 points used in the conventional pixel-based motion estimation algorithms. The computation reduction of about 64.5% was attained in the proposed pixel based algorithm and the results obtained also show negligible effects on the image quality and the bit rate in the compression. The prediction quality and the prediction speed of this hierarchical 1/4–pel fractional pixel motion estimation algorithm were considerably greater than any of the existing pixel based motion prediction schemes.

Shan Jia [82] has presented a fast sub-pixel motion estimation algorithm for improving the sub-pixel search process in this work. The proposed model aims at increasing the speed of the sub pixel search process. Primarily this algorithm got adapted to caper the sub-pixel search process for the various smooth prediction units. This fast sub-pixel search algorithm is based on the process of texture direction analysis. This reduces the computational complexity of proposed model. This model is compared with the various conventional models. The results of experiments show that the Full Sub-Pixel Search (FSPS) algorithm outperforms the conventional model regarding the computational complexity. This method decreases the encoding complexity of the entire motion estimation process with the value of 40.9% than other conventional models. The reduction in the value of the encoding complexity is achieved with the small loss in coding performance. The further reduction in the value of the computation load of this model can be achieved through the fractional pixel motion estimation algorithm. The fractional pixel motion estimation the algorithm performs both the half pixel motion and quarter pixel motion searches for detecting the direction of the frames in the video to be compressed. This model has an easier for implementation with a small overhead performance. The results of the simulation show that this model has a better coding performance regarding RD performance than the conventional models.

Huang Li [83] have presented Fractional Pixel Motion Estimation (FPME) algorithm for video compression in this work. This algorithm has the advantages of optimal scalability and cost-effectiveness than the existing algorithms. This algorithm makes the motion estimation process to be optimally fit by analyzing the various constraints of the video frames. The FPME algorithm has two aspects. The FPME algorithm has more scalability when it uses the cost-benefit analysis is used. The improved

fractional-pixel MV prediction method for the motion estimation has a cost effective priority for every search point.

The complexity of the algorithm is reduced by using the complexity adjustment strategy in the FPME algorithm. The complexity adjustment is made by matching the different performance constraints in the time frame. This algorithm, when implemented for video compression of various video contents, shows better results. The results of the experimentation show that this algorithm gives less error rate for the real-time video compression. This model adjusts the complexity of the algorithm by considering the various time constraints in the video. This model serves as the best fast algorithm since it reduces the complexity of computation by a factor 74% with a negligible loss in the values of the PSNR and bitrates.

*iii) Optimization algorithm based motion estimation::*

The difficulties in the block match based motion estimation algorithm are considered with the minimization of the sum of absolute differences. The SAD minimization is the time to consume and complex process. To overcome the BM problem accompanied by the SAD, the block matching problem can be considered as the optimization problem.

Using Fractional Artificial Bee Colony (FABC) as the optimization algorithm, Erik Cuevas *et al.* [84] have developed an algorithm for estimating the motion. The optimization algorithm helps in reducing the search location by the fitness function. Here, the fitness calculation depends on the nearest neighbor interpolation algorithm. The value of the fitness function denotes the possibility of the search on the considered window range.

The probability of finding the motion vector with the minimum SAD was maximal using the optimization algorithm because of the undefined search pattern or movement assumption. The evolutionary algorithm used in the proposed system i.e. ABC aims to determine the global minimum of the function by considering the small number of function evaluation and a large number of the estimations.

*iv) Normalized cross-correlation based motion estimation:*

The high precision motion estimation scheme is essential in the elastography and the time domain Doppler techniques. The motion estimation scheme with the high precision can be accomplished by the Normalized Cross Correlation (NCC) method

based motion estimation scheme. Jianwen Luo *et al.* [85] have developed a normalized cross correlation method based fast motion estimation scheme. They have used the sum tables for the NCC calculation. The sum table construction in this motion estimation method was based on the principle of the search region used. Sum table depends on the fact that many calculations are inessential because of the exhaustive search of the comparison window and high overlap among the reference windows. The adaptation of this normalized cross correlation approach based motion estimation provides the prediction with high spatial resolution, high quality, and high calculation speed.

*v) Activity based motion estimation:*

The motion estimation in the multilayer scalable video coding is a critical task to realize. The multi-layer involves the base layer which is nothing but the low resolution layer and the enhancement layer. The complexity in the motion estimation of the multi-layer videos can be reduced by adjusting proper search range and search center based on the base layer. Activity based motion estimation approach is the key to the problem of a certain kind.

Sang Kwon Na *et al.*[86] presented an activity based motion estimation approach for the H.264 scalable video coding. The term activity is referred to as the absolute difference between the predicted motion vector and the final motion vector. They have used the correlation in the activities among the neighboring layers to create an inner layer activity model. By making use of the interlayer activity model, the center of the search and the search location for the enhancement layer is decided by the base layer. The macro blocks in the video sequence were grouped into two regions for the ease of the estimation as boundary region and the interior region. The MVP of the base layer searched over the regions predicts the appropriate motion vector. In [87], the experimentation resulted in the reduction in the computation time of the motion estimation by 99.26% and also the Peak signal to noise ratio by 0.048 dB.

*vi) 2-D algorithm based motion estimation:*

In a video sequence, the 3-D motion represents the body motion and 2-D motion is the central projection on the image plane. The motion estimation of the feature analyzed method i.e. 2-D method is difficult because of the un-uniform and the deforming shape of the body. Dimitros S. kalivas have worked on the 2-D motion estimation algorithm exploiting the problems associated with the deforming shape. The 2-D motions

between the consecutive frames were estimated using the proposed 2-D motion estimation algorithm. The accuracy of the proposed system related to the motion parameters was maximal and a proximal in the linear 2-D motion and the nonlinear 2-D motion respectively. The proper initial value selection of the motion parameter minimizes the computational complexity of the system. The advantage was the robustness of the system to video sequence with the presence of the noise and the rejection of the intensity profile was also an advantage.

*vii) 2-bit transform based motion estimation:*

Two-bit transform based motion estimation method was presented by B. Demir *et al.* in [88]. The motion estimation method adapted was the binary block based method. The image frames of the video sequences are initially changed into two representations using the two-bit transform. Upon the two bit planes, the block-based motion estimation scheme was done. The accuracy of the binary block based method is increased by the conditional full or local searches with the use of the mean absolute difference criterion. The threshold d for estimating the motion is varied in accordance with the block detail by the block variance.

*viii) Multi reference frame based motion estimation:*

Motion estimation using the multi-reference frames was presented by the sung-Eun Kim *et al.*[89]. Redundancy present between the multiple frames was made use in the proposed multiple reference frame based motion estimation scheme. In addition to the complexity reduction, this motion estimation scheme provides the efficiency to withstand the channel error intensely. The multi-reference frame based motion estimation scheme attained the prediction with low search complexity without any compromise in the quality of the image encoded. The estimation was reached in the following steps.

a. Vector map estimation
b. Temporary predictive motion vector
c. Final motion vector.

In the vector map, the motion vector estimated using the ME between the candid and the reference frame were used. In temporary predictive motion vector, the motion vector was generated using the vector map attained in the first phase. The final motion vector was obtained using the temporary predictive motion vector refinement over the adjusted search range. The adaptation of this multi-reference frame based motion

estimation scheme helps in decreasing the computational complexity deprived of any change in the bit rate as well as the image qualities in the H.264 encoder.

*ix) Tangent distance prediction based motion estimation:*

In the block matching algorithms, the prediction of the position of the blocks over the time is performed. The prediction over the time increases the prediction error. The pixels change in the block during the prediction is also left. Jonathan Fabrizio *et al.* [9] have proposed a motion compensation scheme considering the prediction of the block over the time as well as the evolution of the pixels in the predicted block. They have used the tangent distance method for the motion estimation. The tangent distance is nothing but a type of the temporal predictor. By making use of the classic mean square or absolute difference for the tangent distance, the affine evolution of the pixels in the predicted blocks were found out in [9]. The tangent distance method was similar to that of the optical flow method with the advantages over BMA. The tangent distance prediction method also offers robust local and the constant luminance changes in the frame of the video sequence. Based on the smaller transformation between the successive frames, the comparison using the tangent distance was completed. The transformation parameter is chosen that the computation is discrete and fast. The motion estimation quality is based on the transformation. The robustness of the tangent distance based motion estimation method was proved using many standard tests such as a transparent object, deformable object, rotations, translational and zooms.

In [9], they have compared the prediction quality of the BMA, optical flow and the tangent distance prediction. The prediction error drop in the proposed method was attained by the use of the previously predicted one. The tangent distance prediction also provides the robust and simple motion estimation.

## 2.3 SUMMARY

Literature survey presents the different search algorithms utilized for the motion estimation and compensation scheme. The video compression standard must be selected considering many of the crucial factors in the search algorithms. Some of the delineations responsible for the progress of the AOCSH search algorithm are discussed below: On the searching perspective, the search classification and search partition are the crucial factors. The search algorithm partitions the areas based on the direction of the search. With the unknown direction of the search, the searching points

utilized for the selection of the proper direction of the search is increased. This is because, in every possible direction, the numbers of search points get increased because of the uncertainty. In addition, the search classification must not affect the motion vector generation [12]. The shape and size of the search patterns used for the motion detection are also significant for the matching algorithm [59]. The search pattern with the larger size increases the search points and also the smaller areas in the block remain unmatched or searched [9, 78]. The error performance of the video compression algorithm is completely dependent on the size and shape of the search pattern used [12, 79, 91]. The computational time of the search algorithm is also a substantial challenge in the motion estimation. The computational time of the search algorithm depends on the number of search points used by the search pattern [52, 79].

The perseverance of the discontinuities in the motion is a demanding task in the motion estimation. The discontinuities in the blocks because of the zooming, rotation, fast moving objects etc. is difficult to attain by the conventional searching algorithms. [4, 77, 78 & 91] The finding of the better matching points from the selected search points out of the search algorithm is also a reasonable challenge in the motion estimation scheme [84, 88].

In order to accomplish the objective of reduced number of search points for the motion estimation, an adaptive search algorithm is proposed incorporating the cross, square, and hexagon searches. By the adaptation of the cross search, the direction for the search is defined by reducing the search points and the square and hexagon search is performed to obtain the best matching points.

In Chapter 3, discusses about motion estimation for H.264/AVC, Elastic motion estimation method and its impact on the video coding is discussed.

In this research, the different adaptive order search algorithms that are AOSH and AOCSH based on the tangent weighted trade-off function are developed. The AOSH search algorithm based on tangent weighted trade-off function explained in Chapter 4. Similarly AOCSH search algorithm based on fuzzy tangent weighted trade-off function discussed in Chapter 5.