Your comment was:   
2.6 Evaluation of Visualization Systems (see papers such as “Empirical Studies in Information Visualization: Seven Scenarios” as well as the papers it references and the papers that reference it )

**2.6 Evaluation of Visualization Systems**Visualization evaluation is a complex task since it involves complex data structures or patterns, or it can exhibit various interconnected information of complicated systems.Researchers and practitioners in this field have faced many challenges in different phases when designing, planning, conducting, and executing an evaluation of a visualization systems. It can be a difficult task for evaluator to design the suitable evaluation questions to ask the participants, to pick the right variables from visualization artifacts, to decide and develop an efficient way to test data sets and pick the proper methods of evaluation. Existing literature guidelines can help to solve these problems for example, Heidi et al. [64] came up with seven scenarios of information visualisation from their research that includes evaluating visual data analysis and reasoning, evaluating user performance, evaluating user experience, evaluating environments and work practices, evaluating communication through visualisation, evaluating visualisation algorithms, and evaluating collaborative data analysis. They suggest different approaches to reaching decisions about what could be most effective evaluation of a given visualisation system. Among them some of them are related our study, so we briefly discuss about those in the following section.

**User Performance**   
User performance is mainly measured in terms of objectively measurable metrics such as time, error or accuracy rate, or work quality but the task completion time or task completion accuracy is commonly used. Output of the tasks are generally numerical values analyzed using descriptive statistics such as mean, median or standard deviations. They can also come from the user interactions, perception, and cognition for specific types of visually presented techniques. Most widely used methods are the controlled experiments or quantitative evaluation. A controlled experiment requires real-life simple tasks that can be performed by large number of participants in different study sessions. It is not imperative the participants to be domain experts, hence non-experts can also participate in such experiments. To answer evaluation questions with quantitative and statistically significant results, evaluations in the user performance group require high precision. The commonly used methodologies involve an experimental design with only a small number of variables changed between experiment conditions such that the impact of each variable can be measured J. McGrath [66].

**User Experience**Evaluation of user experience is done by study people’s subjective feedback and opinions in written, spoken form or online feedback with a set common questionnaire to all participants. It seeks to understand how participant react to the presented visualisation. A visualisation can be initial design sketch, a basic prototype, a finished product, or part of a complex system. The goal is to understand what extent the participants’ eyes can perceive the intended tasks conveyed by the system such as perceived effectiveness, perceived efficiency, perceived accuracy. Other measures such as satisfaction, trust, features liked/disliked, effort required, time required, etc. The collected data in such a study helps designers to explore gaps and limitations in the visualised system, as well as promote the researchers to take necessary steps to enhance it further stage. So, the evaluations can be short term to assess current or potential usage and long term to assess the adoption of a visualization in a real usage scenario.

**Usability Test**How participants perform a set of predefined tasks is observed to carry out the usability test. For each session, the evaluators take notes of interesting observed behaviors, suggestions given, comments provided by the participant, lack of understanding, and major problems in interaction. The specialities of this method are the careful preparation of tasks and feedback material like questionnaires and interview scripts. Its main goal is to perfect the design by spotting major flaws and deficiencies in existing prototypes [65]. Nonetheless it can also serve the purpose of eliciting overlooked or missing requirements.

Heidi et al. [64] classified the scenarios into two broad categories called *process* and *visualisation*. The main goal of process group evaluation is to understand the underlying process and the roles played by the visualisations. In contrast, evaluations can focus on the visualisation itself, with the goal to test design decision, explore a design space, benchmark against existing systems, or to discover usability issues. Again Bonneau et al. [16] classified the types of evaluation into three groups:

* Theoretical evaluation: the method is analyzed to see if it follows established graphical design principles,
* Low-level visual evaluation: a psychometric visual user study is performed to evaluate low-level visual effects of the method,
* Task oriented user study: a cognitive, task-based user study is conducted to assess the efficiency or the usability of the method.

Usually in these evaluations, a part of the visualisation system is tested. In this context, we intend to evaluate only the basic concept of Chromatic Aberration against VSUP [35] although we implemented and utilized them in some complex charts. To evaluate user experience and performance with the help of a set of questionnaires, we developed an online webpage containing the relevant exercises of visualisation. Instead of asking questions as interviews, we presented everything visually (explained in study design section in chapter 6), so that participants can provide their rating easily. For Example: in system usability test, we presented 10 questions in 5 scale ratings (1-5) and for Nasa-Tlx we presented 6 questions in 22 scale ratings (1-22).

**2.7 Limitations of related works**

As stated in the related works section, a plethora of studies have been conducted in these domains, for example: predicting modeling and augmentation of algorithms, time series analyses and comparisons on different diseases and/or on other temporal data, real time predictions from models, measuring chromatic aberration from image distortion, effect of color and light on display devices, uncertainty visualization and decision making, texture analyses and assessments, perceptual textures to represent multi-dimensional dataset, and etc. In our knowledge predictive uncertainty has not been represented with chromatic aberration. Furthermore, our approach of three dynamic variables visualization in two-dimensional space with texture is also a novel idea. In the following section we briefly explain specific limitations of some papers listed in the references. (You reviewed this paragraph earlier)

Your comment was:   
(in addition to this section that summarizes limitations, you should also briefly note the limitations of each prior work as you discuss them in sections 2.1 to 2.5)

Muhammad Ali et al [2] conducted their research of forecasting COVID-19 only with statistical ARIMA model where they suspect it may perform poorly in case of nonlinear trends. Researchers in [1, 4, 6] used different versions of ARIMA such as ARMA, SARIMA, PROPHET models to conduct time series analysis but have not used any machine learning or deep learning algorithms to compare with. In [5] researchers have formulated a best model of XGBoost machine learning algorithm for cholera epidemics predictions linked with weather variable, but they have not studied with real world data from health-care systems. Climate change with dengue epidemic, a predictive modeling [7] was conducted and concluded that neural network models (MLP, LSTM, GRU) significantly outperforms traditional machine learning models but they have not given analysis background reasoning and no indication of if they tried with optimal hyperparameter settings, since they play key role in such modeling. A decision-supporting tool [8] for medical centers and health-care services has been proposed for influenza prediction with limited data for Belgium which could be tested with more sophisticated and diverse dataset and the similar issue noticed in [9] where they conducted their study on performance evaluation of prediction of machine learning models with liver disease by taking some sample data.

Lateral Chromatic Aberration can lead people to misjudge information shown on displays. Researchers of [10] proposed a simple correction method and design guidelines to attain promising results but that is limited to certain eyeglasses and some common objects and didn’t extend it real and generalised environment. Color illusions on liquid crystal displays and design guidelines in information visualisation system [11] is investigated with only limited domain experts and kept open the scope for further study of understanding the cause of the colour size illusion effect. Chromatic Aberration occurs due to refractions of each color channel and hence the [11] addresses the use of image warping to reduce this effect but without calibrating the model for different zoom/focus level, displacement, and deformation. Only lateral effect with image warping is considered in a proposed a system [12, 13] to resolve such problems but not considered about longitudinal, geometric or other forms of optical distortions. These uncovered issues are partially resolved by [14, 15] but their rendering mechanism is limited to single light sources, undergoes with rasterization aliasing effect, interaction with painting metaphor and temporal interpolation with event-driven control. Correll el al. [35] directly integrated uncertainty within a shared chart instead of using tooltip/supportive charts with the strategy of Value Suppressing Uncertainty Palettes but they intentionally suppressing data with high uncertainty which ultimately eliminates complexity.

Since most visualizations do not explicitly represent uncertainty information, Hullman [36] conducted study and came up with suspicious results due to the possibility of biased/unconfident responses from the participants. Through a controlled study, Guo et. al [37] found that users experience more confidence to determine uncertainty values but that requires the participants need to be domain experts. Korporaal et al. [38] conducted study find the effects of uncertainty visualization on Map-Based decision making under time pressure but didn’t test with experts like helicopter pilot, limited to a cartographic display, given brief training to participant neglecting diversity of uncertainty. Sensory information is noisy and insufficient to uniquely determine the environment and natural perceptual systems use to cope with systematic uncertainty. [17] shows that subjective uncertainty in this case is connected to objective uncertainty by using their custom noise model which should be tested with more generalised noise models. Probabilistic animation methods [20] have been presented as an effective approach for uncertainty visualization by which an effective expansion of decision-making support can be achieved by physician running the visualization but still that need to be studied in real clinical environment.

Lucchesi et al. [43] presents three approaches to include uncertainty on maps but have not conducted user studies to determine whether the methods effectively communicate uncertainty. To address the conformity of appropriate uncertainty visualisation MacEachren el al. [44] presents two conceptual perspectives but the study does not cover both data and uncertainty at a the same symbol and didn’t tested the impact of symbol size. Reveiro [45] provides a general overview on uncertainty representations techniques and theoretically evaluate the weakness and strengths of the uncertainty visualizations representations. R. Finger [49] describes utilization of graphical formats to convey uncertainty in a decision-making task but uses of icons with numerical probabilities causes users hesitating and additional assitance. Skeels [53]

classified uncertainties by reviewing existing literatures of various domains and came up with a concept of ‘layers’ of uncertainty but due to complexity it is kept as open task to visualize.

To reduce the computational cost Netzel et al. [22] introduced particle tracing and line integral convolution that are parallelly and independently used on every pixel of texture but coupling with exponential filter it fails to handle trends appropriately. Texture-based feature tracking technique [23] has been proposed to overcome some limitations of previous relevant studies such as hampering illustration and visualization of dynamic changes, but it has limitation of drifting problem (move in a direction without input). A new technique [24] of utilising the overlay of two different LIC textures to combine the visualization with vector fields but that doesn’t support higher dimensions and yet more refined investigation is required to quantify the effectiveness. To avoid color blurring and inconsistencies in such LIC textures, Huang et al. [25] introduced a novel image-space that also mitigates expensive computation, memory cost but suffers with popping artifacts (too far/close viewpoint). A method for the generation of anisotropic sample distributions and interactive rendering of anisotropic Voronoi cell by Kratz et al [26] is not experimented properly for influence of adding noise to the cell boundaries. Weiskopf [27] has proposed a set of guidelines to stimulate a better awareness for the opportunities and problems involved with the perception of moving color stimuli but not well studied the guidelines with miscellaneous applications in visualization and computer graphics. Healey et al. [28] presents a method for combining three texture dimensions height, regularity, and density to form perceptual texture elements (or pexels) but not investigated yet the effectiveness of orientation for encoding information, and the interactions that occur when multiple texture and color dimensions are displayed simultaneously. R.P. Botchen et al. [29] a generic texture-based strategy to visualize uncertainty in time-dependent 2D flow and they think further extension for 3D flow will be a challenging task.