# Heatmap Analysis of Webpages

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## Abstract

**These days, as everything has gone online and virtual, we use websites on a regular basis in our daily lives. However, in order to match user needs, the question of how website admins would learn what the user wants emerges. So, using techniques like mouse clicking, this project captures information about user activity on a web page, and then using the appropriate technology, it converts the data into meaningful and insightful heatmaps. Its main goal is to make websites more user-friendly by providing web administrators with valuable information about users' activities.**

***Keywords :*** **Heatmap, statistics, user experience, user interface, web tracking, websocket**

## I. INTRODUCTION

To allow new experiences to be generated and delivered to clients, business platform models usually demand ongoing adaptation and agility. According to investigation [1], in about 50 milliseconds (0.05 seconds), visitors express an impression about your webpage, deciding whether they like it or not, and whether they will remain or leave. 57% of internet users believe they will not recommend an organization that has a poorly designed website. After a terrible experience, 88% of online visitors are less likely to return to a site. Realizing the advantages as well as disadvantages of your website's design and architectural structure, as well as its usability necessitates an understanding of what the user does and how he does it on a website [2]. This project will provide valuable insights into how users interact with web pages. This is done using mouse tracking, which means that whatever the user does on the web page is collected, all of the data of mouse clicks from the user are transformed into a vital enlightening heatmap using suitable techniques.

## II. MOTIVATION

We now use websites on a regular basis for education, job search, entertainment, shopping, and a variety of other activities [3]. Around 71% of small businesses have a website. Furthermore, given the severe struggle in the online sector, people choose one system over the other based on not just the functionality it provides, but also how user-friendly it is. To satisfy user expectations, many web admins change their design and layout on a regular basis [4]. However, it is unclear how they will figure out

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what the consumer wants [5]. As a result, this project will assist administrators in gaining valuable insights and making necessary changes to their websites so that users can use them more efficiently and effectively.

## III. RELATED WORK

In [6] the researchers gathered information such as clicks per element, mouse interaction scroll, travel position, and user input keystrokes. Every time a user visits, a new url is generated for data storage. The Javascript SDK collects user data before sending an AJAX post request to the API server. Finally, the data is transformed into a heatmap by mapping it to a webpage. This data is displayed statistically and allows for automatic statistical analysis and quick comprehension.

In [7] the authors conducted a brief poll to determine perceived utility and ease of usage. Croncbach's alpha was one of the techniques utilized. They then calculated aggregate perceived utility and perceived ease of use using the Shapiro-Wilk test. In this paper, we look at the relationship between mouse movements and learners' adoption of a web-based experiential learning environment for web development courses in terms of reported ease of use and perceived usefulness. A case study on e-learning site of University for 30 students is also looked at.

In [8], the researchers developed a Mouse Tracking-based User Experience Tool (AIMT-UXT). This tool gathers information about user behaviour from a website and then organizes and preprocesses the data before delivering the results in the form of a heatmap and single views. The results of a case study on the Brazilian Federal Revenue Service were accomplished by utilizing the tool to monitor user interactions on the Web interface including mouse movements and navigation parameters, among other things. These findings support the possibility of evaluating the UX solely through mouse tracking.

In [9], the researchers developed different heatmaps with the use of the user's eye tracking approach. They already have city map datasets and eye tracking data from 40 users. However, in our project, we will collect data live from the user. They leveraged the d3.js library to illustrate the heatmaps, which is really handy and has a lot of built-in functionalities. The information is storedin a CSV file, which is then analyzed using the d3.csv function in the d3 package. After that, they endeavored to generate a heatmap utilizing the available data; the shade used for the heat map is defined using a sequential colour scale built into d3.js . Thus, it helps to see the data in precise form.

In [10], the authors experimented with an eye tracking heatmap in their study. They invited 11 students to see their website and acquired eye tracking data from them. The website exhibited several graphics regarding climate change and came to the conclusion that animated features, independent of their strength of relationship to the content, attract greater attention. Based on quantitative and qualitative data, we present significant recommendations to improve the website's design and improving the overall user experience.

In [11], the authors explain a visual analytics tool for algorithmically and visually analyzing dynamic graphs. Because the tool's representations are tough to comprehend for non-experts with hardly any experience in graph visualization, visual analytics, or knowledge discovery in general, the tool's primary target audience are visualization and data analysis specialists and scholars. The visualization tool is developed on the Python framework Dash by Plotly. The results suggest that animated features attract more attention regardless of the strength of the relationship to the content based on quantitative and qualitative data, we know the possible recommendations to improve the website's design and improves overall user experience.

In [12] the researchers focused on the use of mouse tracking measurements and movement patterns in the context of online survey-based data collection which is demonstrated in this study. The survey asked multiple questions, each of which was responded on a 5-point Likert scale. The authors demonstrate that a wide range of behaviours may be extracted using only mouse movement data (sent the data to a server computer through AJAX, where it is then recorded as a file in a data base).

In [13] the authors proposed the design and prototype implementation of a framework for collecting information about online user behaviour on heterogeneous devices and aggregating it into a single heatmap are provided in this paper. The idea is to quantify the amount of attention that different regions of a page receive. The most popular method is to track changes in the size and placement of the viewport and build a heat map with colours representing the amount of time each area has been shown to the user. Heatmaps based on

viewports are particularly useful for mobile and touch-based devices since online navigation requires frequent scrolling and zooming.

## IV. PROPOSED METHODOLOGY

Website heatmaps display the most popular (hot) and least popular (cold) components of a webpage using co-ordinates on a variety of axes. By consolidating user activity and presenting a quick snap of how people interact with an individual website page, what they click on, scroll through, or ignore; heatmaps help to identify trends and optimize for future engagement. The heat map is one of the most valuable and sophisticated data analysis tools available in business intelligence. It is a data visualization feature that assigns distinct sizes and color to the cells that represent each row to arrange numerous rows of data in a logical sequence. This is our project's system design, which comprises a client layer, a server, and our own data storage layer.

This entire proposed methodology can be studied in four stages:

- In the first stage, this project installs javascript module on the client website, which will establish a web socket connection with our server. This connection would send the client's x,y data to our server, where it would be stored in our database.
- The second stage includes the usage of websocket. Web- Socket is a bidirectional protocol that is used in the same way as HTTP, but it begins with ws:/ or wss:/ instead of HTTP. It is a stateful protocol, which means that the connection between the client and the server will remain open until either party terminates it (client or server). When either the client or the server terminates the connection, it is revoked on both sides.
- This information could be accessed through an API server. The frontend would use this API server to access data for the specific page for which we want to generate heatmaps, this will be the third phase.
- In the last stage, project ensures that every webpage will have distinct historical data stored in the database, ensuring that no two webpages have the same page-id.

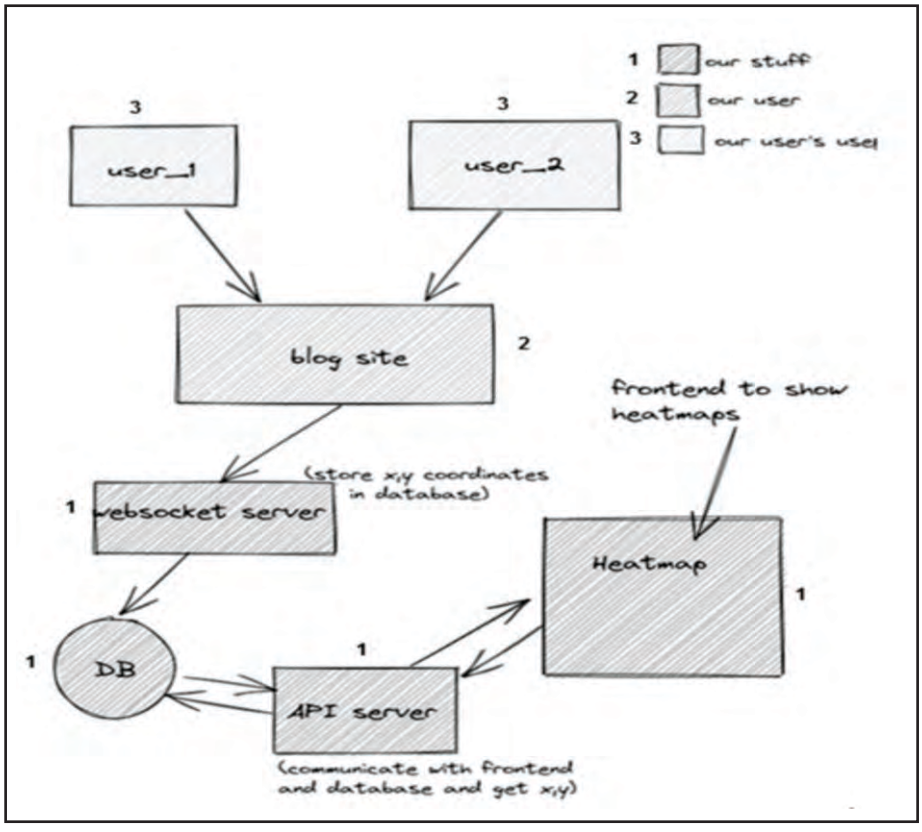


**Fig. 1. System Design**

Following are the modules used:

**(1) Heatmap.js :** Heatmap. js is a clear and simple, lightweight JavaScript library for displaying three-dimensional data. It is used to add new value to a project, build a business around it, research and illustrate users' behavior, or create something completely awesome.

**(2) Overview :** First, this project will install a Javascript module on the client's website, which will establish a web socket connection to the server. This connection would send x, y data from the client to the server, where it would be saved in the database. This information could be accessed using an API server. This API server will be used by the frontend to call the data for the specific page for which the users wants to generate heatmaps. Each webpage will have separate historical data stored in the database, that is, no two webpages will have the same page id.

**(3) Database :** This is the database schema, which would be used to store data of the client. id - unique primary key x

↳ represents the x coordinate of the users.

↳ click y - represents the y coordinate of the users click user id

↳ random id suggesting the users session page id - this would be unique, as each page would be different from the others. For the database, this project uses PostgreSQL. The database consists of five columns in the table for storing the client interactions that have occurred on the client's web pages.

```
heatmap-# \d heatmaps
                    Table "public.heatmaps"
 Column  |  Type   | Collation | Nullable |      Default
---------+---------+-----------+----------+-------------------
 id      | uuid    |           | not null | gen_random_uuid()
 x       | integer |           |          |
 y       | integer |           |          |
 user_id | uuid    |           |          |
 page_id | uuid    |           |          |
Indexes:
    "heatmaps_pkey" PRIMARY KEY, btree (id)
```

**Fig. 2. Database Schema**

```
(aonan@slowpoke-/BE_proj/heatmap_analyzer/test_server/ws_server (main) $ python3 app.py
Successfully stored for page_id 91092828-2644-4d9d-b0a2-09f06f23f6fd
Successfully stored for page_id 91092828-2644-4d9d-b0a2-09f06f23f6fd
Successfully stored for page_id 91092828-2644-4d9d-b0a2-09f06f23f6fd
Successfully stored for page_id 91092828-2644-4d9d-b0a2-09f06f23f6fd
```

**Fig. 3. Websocket server listening to client and storing x,y co-ordinates**

**Fig. 4. Frontend Dashboard**

**(4)** Web socket server listening to client and storing x and y coordinates: This is the format in which the system stores the value received from the client via websocket. It uses the page id to set the value and display the outputs to the users.

**(5)** API endpoint call to get coordinate: This image depicts an API request made to the API server. The URL is: /get xy/page id. Once the flask server is up and running, it returns the IP address of the local host and directs the site to the coordinates. This depicts the overall operation of the frontend and the API server.

## V. RESULTS AND DISCUSSION

This is the front end dashboard, where the admin will enter the page-id which is to be analyzed; user attention and clickmap will then call the API request that will retrieve the data for the page-id. Later, the image would be superimposed on a conveyer with a heatmap visualization of user clicks.

After entering the page-id, all of the data from the user clicks will be generated, as shown in the image. These are the x and y coordinates of a click. These are stored in database and displayed here, and this will be connected to the frontend, where a heatmap will be generated.

The proposed system has been deployed on two web-pages that have been hosted, the first of which is seen in the image (Fig. 6). '1' indicates where users have clicked most times in that location, while '2' indicates where they have clicked the least. All of the data collected is real-time, and it is transformed into an informative heatmap in a matter of seconds.

The accompanying image is a screenshot of the second webpage that has been hosted, from which also the result has been obtained in the form of heatmap.

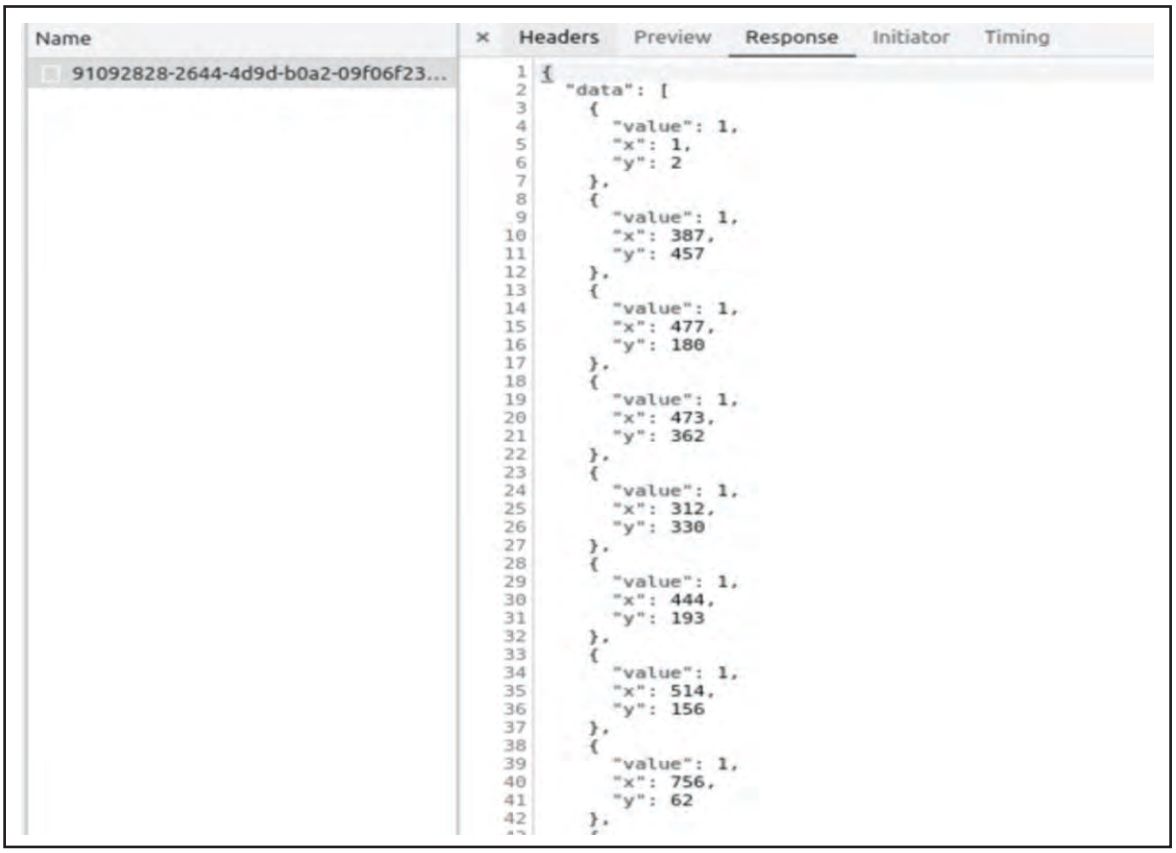


**Fig. 5. Values of x,y Co-ordinates of User Clicks**

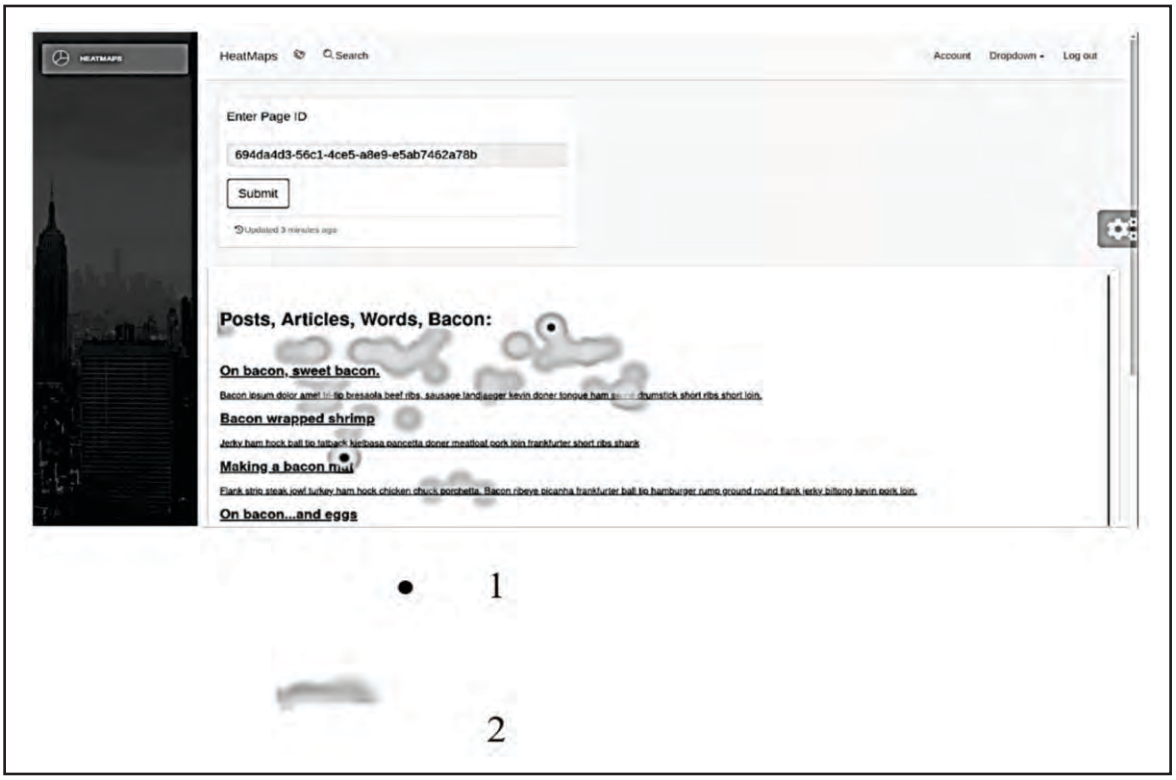


**Fig. 6. Result page 1**


**Fig. 7. Result page 2**

## VI. CONCLUSION

Usability and accessibility are two of the most important aspects of a web page nowadays, and a good balance between them is required for the page to provide good service to its users [14]. This project collects information about user behaviour from a website, organizes and preprocesses the data, and then presents the findings as a heatmap and single views. The results of a case study on the Brazilian Federal Revenue Service [8] were achieved by using the tool to track user interactions on the Web interface, such as mouse movements and navigation parameters. These data back up the idea of measuring the user experience only through mouse tracking.

The design and prototype implementation of a framework for collecting information about online users' behaviour on heterogeneous devices and aggregating it into a single heatmap are provided in this paper. The idea is to quantify the amount of attention that different regions of a page receive. The most popular method is to track changes in the size and placement of the viewport and build a heat map with colours representing the amount of time each area has been shown to the user. Heatmaps based on viewports are particularly useful for mobile and touch-based devices since online navigation requires frequent scrolling and zooming. Our solution would use the viewport methodology as it changes for different devices in the future for more accurate user experience research.

Existing approaches, such as Google Analytics and Matomo collect user interaction data such as the number of visits and conversion ratios [6] [15], but other critical information (such as mouse and keyboard interaction) is not stored. As a result, in this proposed system, there is a method for automatically collecting all possible information about user activity on websites (clickmap).

This project is still in an initial stage, we intend to add lot more features in the future. Some of the features include video recordings of all users who interact with the webpage so that the administrator can see the mouse

hovering in real time. The second is to make it dynamic; dynamic means that the coordinates change as we navigate across the website. Hence, this feature is essential.

## AUTHORS' CONTRIBUTION

Ankitkumar Chaudhary, the author and the other project team members did the project's study and implementation. Internet technology and networking are two of the authors' interests. He therefore, handles the connecting process and the service delivery. Also the UI part was implemented and handled in the project.

## CONFLICT OF INTEREST

The author certifies that he has no affiliations with or involvement in any organization or entity with any financial interest or non - financial interest in the subject matter or materials discussed in the manuscript .

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