Adversarial Attacks on NLP Models Using Composite Function of TextAttack Library

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***Abstract*—In this paper, an attempt has been made to enhance the existing adversarial attacks made on NLP models using the TextAttack library by using a composite function to create an attack with a better efficiency than the usual attacks.**

***Index Terms*—Electric Vehicle, EV Industry India, EV India, Sentiment Analysis, Natural Language Processing**

I. Introduction

The Electric vehicle Sector is one of India's most promising and potentially promising sectors. It is a sector that not only the government is promoting a lot, but also there is rising public awareness amongst the common Indian audience towards electric vehicles. One of the most fundamental things everyone in the decision-making body should keep in context should be the general perception of the Indian public towards electric vehicles as after all it solely depends on the people of India on how they will accept this major change in their country's automobile industry. The rising need for an alternative to the current vehicles which are operated on Diesel and Petrol as it is expected that the demand for these vehicles is expected to grow by at least 10 times in the next decade.

II. Current Industry

Electric vehicles (EVs) have become popular in India in recent times due to a number of reasons, some of them being the government's constant focus on the promotion of the adoption of Eco-friendly initiatives. Most people in India view EVs as a way to reduce their carbon footprint and contribute to the country's efforts to diminish climate change. The Indian government has recently introduced various policies and incentives to encourage EV adoption, including EV purchase subsidies, tax breaks, and the construction of charging infrastructure. Overall, the perception of EVs in India is generally positive as they are seen as clean and efficient transportation options. As a result of these new laws and government efforts, the number of EVs on India's roads has increased significantly in recent years. According to the Society of Manufacturers of Electric Vehicles (SMEV), the number of electric vehicles sold in India increased from 48,179 electric cars sold in 2020–21, the numbers increased to 2,37,811 in 2021–22 and 4,42,901 in 2022–23. This trend is expected to continue in the coming years, with the Indian government aiming to sell 30 per cent of electric cars by 2030.

The availability of a wide variety of EV models at different price points has also helped EV adoption in India. Many major automakers, including Tata Motors and Mahindra, offer a variety of EV models in the Indian market. In addition, several new entrants, such as MG Motors, Nexa and Hyundai, have announced plans to introduce EVs in the Indian market in the coming years.

Despite the growth of the EV market in India, there are several challenges that lie ahead of us which is needed to be addressed in order for the EV market to reach its full potential. One of the severe challenges is the lack of charging infrastructure/stations. While the government has made numerous efforts to address this issue, the availability of charging stations is still limited, particularly in many rural areas. The high cost of EVs is a financial barrier for many of its consumers, as EVs are more expensive than comparable gasoline-powered vehicles.

Many major automakers in India, such as Tata Motors, Mahindra, and Hero Electric, offer a variety of EV models in the Indian market. These companies have a long history in the automotive industry in India since the beginning and have extensive manufacturing and supply chain capabilities which are at par with other automakers, it allowed them to quickly grow the production of EVs in response to the growing demand.

Furthermore, several new entrants have announced plans to introduce EVs in the Indian market in the coming years ahead. For example, MG Motors, a subsidiary of China's SAIC Motor Corporation, has announced plans to launch a range of EVs in India by the end of 2025. Hyundai also announced plans to enter the Indian EV market with a new model of the Ioniq 7 car. The company has already introduced Kona Electric, a popular EV model, in the Indian market and is reportedly working on a new EV model specifically for the Indian market.

There are several private companies that are active in the Indian EV charging market scene, including charging network operators and power utility operators. Tata Power, for example, has installed a number of charging stations in several Indian cities and plans to expand its charging network to rural India in the coming years.

In addition to charging network operators and power utilities, there are also several start-ups that have grown and still developing at an unimaginable pace. Overall, the EV

charging infrastructure in India is still in the early stages of development, but there has been significant progress in recent years. Private companies, such as charging network operators and power utilities, are playing a vital role in the development of charging infrastructure and are helping to make charging stations more widely available throughout the country.

III. Methodology

The main goal of this research paper is to analyze the sentiment toward electric vehicles in the Indian customer segment using two approaches:-

A. Using a Natural language processing algorithm

It is no longer difficult to understand what people think about a topic by analyzing the tweets shared by people. Sentiment analysis is one of the most popular use cases for NLP (Natural Language Processing). We have used Tweepy which is an API provided by Twitter for fetching tweets in real-time.

1) Data Collection:: To analyze Twitter data related to the EV sector in India, we need to collect relevant tweets. This is done using the Twitter API, which allows us to search for tweets based on keywords and hashtags. In this case, we can use keywords such as "electric vehicle," "EV," and "India" to search for relevant tweets. .

2) Data Preprocessing:: Before applying NLP techniques, we preprocessed the collected data. This involves cleaning the data by removing irrelevant information, such as URLs and special characters. We also tokenized the data by splitting it into individual words and phrases, and remove stop words such as "and," "the," and "is," which do not add much meaning to the text. Additionally, we performed stemming or lemmatization to reduce words to their base form and avoid redundancy.

3) Sentiment Analysis:: Once the data has been preprocessed, we applied NLP techniques such as sentiment analysis to classify tweets into positive, negative, or neutral sentiment categories. Sentiment analysis involves using algorithms and machine learning models to identify the tone and emotion of a text. In the case of the EV sector in India, we used sentiment analysis to determine how people feel about electric cars, charging infrastructure, government policies, and other related topics.

4) Analysis workflow: For the analysis, we gave different keywords as input so that all the keywords related to the electric vehicle industry in India are covered. Some of these keywords include:- 'EV industry India', 'electric vehicles India', 'EV India', etc. Using these keywords, we fetched around 7,000 tweets. Additionally, we also included keywords involving major EV manufacturing companies such as TATA, Mahindra, Ola, etc., to get a holistic overview of the whole industry both from the general perception point of view, and the EV manufacturing company's perception.

From the table below, it is very evident that social media engagement in the electric vehicle industry in India is pretty low at this moment. One more thing that can be derived from the above readings is that the majority of the conversation about the EV industry in India on Twitter has a very neutral sentiment around it and is not very polar. However, the tweets become quite polar in the case of Ather Energy and Statiq.

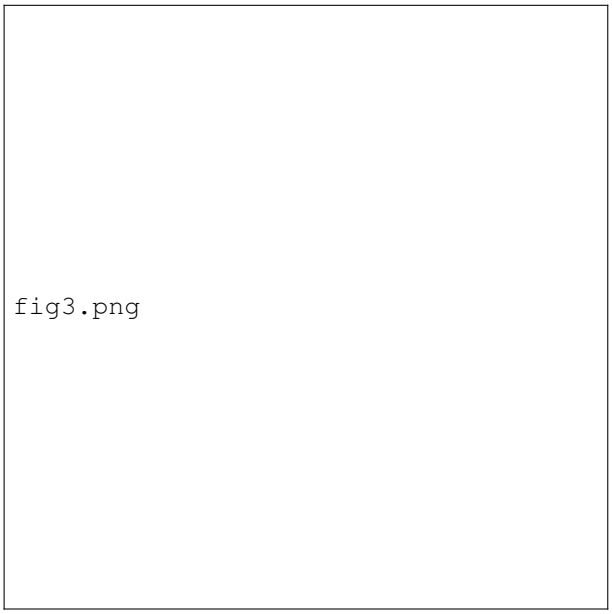
TABLE I
Sentiment Analysis Results

S. No	Keyword	No. of tweets analyzed	Positive sentiment (%)	Negative sentiment (%)	Neutral sentiment (%)
1	'Electric vehicle India'	1000	32.05	5.77	62.18
2	'EV India'	1.2k	47.72	8.50	43.78
3	'EV industry India'	110	58.97	11.54	29.49
4	'TATA EV'	1000	41.01	5.82	53.17
5	'OLA electric'	304	34.21	22.04	43.75
6	'TATA Nexon'	908	28.66	13.65	57.49
7	'TATA Tigor EV'	100	29.59	18.37	52.04
8	'Tesla India'	661	41.15	12.56	46.29
9	'TATA Tiago'	180	23.46	16.20	60.34
10	'Ola electric'	454	33.48	14.98	51.54
12	'Ather energy'	187	74.33	5.35	20.32
14	'Statiq'	982	52.12	17.58	30.3

fig2.png

B. Using analysis tools

We analyzed people's sentiments towards electric vehicles using different sentiment analytical tools.



For the relevance of this paper, we only focused on the targeted demographics of India. The results were quite similar when compared to the tweet analysis done about the tweets using ML algorithms.

The majority of the vehicles operating in the EV sector as of now in general have a slightly higher negative sentiment towards them as compared to the general sentiment towards the industry. Recent fires in EVs, lack of information, poor infrastructure, etc might be the reason behind these findings. The growing negative sentiment towards the vehicles can be solved through channelized correct information without any layering and also by swiftly revamping the whole charging infrastructure for EVs in India.

1) Positive Sentiment:: Positive sentiment towards the EV sector is apparent in Twitter discussions. Users often highlight the environmental benefits of electric cars, such as lower emissions and reduced dependence on fossil fuels. They also praise the technology and innovation behind EVs, as well as the performance and driving experience they offer. Positive sentiment is also driven by the increasing availability of charging infrastructure and government incentives to promote the adoption of electric cars.

2) Negative Sentiment:: However, negative sentiment towards the EV sector also exists on Twitter. Some users express concerns about the cost of electric cars, citing high upfront costs and maintenance expenses. Others are sceptical about the range and reliability of EVs, particularly in extreme weather conditions. There are also concerns about the environmental impact of producing batteries and the disposal of old batteries.

3) Neutral Sentiment:: In addition to positive and negative sentiments, a significant proportion of Twitter discussions about the EV sector are neutral. Many users share news and updates about the industry, without expressing a clear positive or negative opinion. Some users also express a neutral opinion due to a lack of knowledge or experience with electric cars.

Conclusion: Overall, sentiment analysis reveals a diverse range of opinions and attitudes towards the EV sector on Twitter. Positive sentiment is driven by environmental benefits, technology, and government incentives, while negative sentiment is driven by cost, range, and reliability concerns. Neutral sentiment is also significant, indicating that many users are still undecided or uninformed about electric cars. As the EV industry continues to grow and evolve, sentiment analysis can provide valuable insights into the public's perceptions and attitudes towards this sector.

WORD CLOUD ANALYSIS

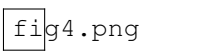


Fig. 1. Electric Vehicle India

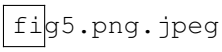


Fig. 2. EV India

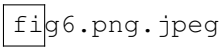


Fig. 3. Tata EV

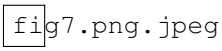


Fig. 4. Ola electric

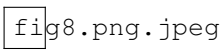


Fig. 5. Tata nexon

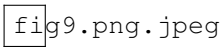


Fig. 6. Tata tiago

IV. WORD CLOUD ANALYSIS CONCLUSION

The above is the word cloud analysis which is done for all the keywords which were entered in the sentiment analysis section. The most prominent keywords that were visible in the keyword 'electric vehicle industry India' were mostly related to the major companies operating in the EV sector, startups, and keywords related to charging infrastructure. The word cloud analysis was done by dividing the keyword search into:

1) Positive Sentiment:

2) Negative Sentiment:

3) Neutral Sentiment: In our research, we found out that in the neutral sentiment word cloud, the deviation did not depend upon the keyword entered as almost all of the results were almost identical and contained the keywords related to the EV industry in India, major companies and startups in India, and keywords related to charging infrastructure. The same can be said about the positive sentiment word cloud analysis.

However, the negative sentiment of Wordcloud was majorly based upon the name of the prominent companies operating in the EV sector in India, their service, and customer reviews. Hence, the negative sentiment word cloud was much more polar and suggestive than the positive and neutral keywords word cloud.

V. CONCLUSION

As India seeks to move to a more sustainable transportation system, EVs are expected to play a crucial role in meeting its climate and air quality goals. Many governments around the world are implementing policies and incentives to encourage the adoption of EVs, including subsidies for electric vehicles and the deployment of charging infrastructure. One of the key roles in India has been played by private companies of India such as TATA, Mahindra, Ola, etc by investing in the development of electric vehicles and charging infrastructure. However, in order for the market to reach its full potential, it will be important for the government and private sector to address the challenges of charging infrastructure and high upfront costs. Overall, the future of the EV market in India looks bright, with the government's commitment to promoting the adoption of clean energy technologies and the increasing demand for environmentally-friendly transportation options. But, on the other hand, there are still a number of challenges that need to be addressed to increase the adoption of electric vehicles in India. One of the main challenges is the lack of consumer awareness and understanding of the benefits and capabilities of electric vehicles. Many Indian consumers still perceive electric vehicles as expensive and underperforming compared to gasoline vehicles.

Another problem is the country's lack of charging infrastructure, which limits the range of EVs and makes them less suitable for long-distance travel. In addition, the high cost of batteries is still a major obstacle for many consumers, as the purchase price of electric cars is significantly higher than that of gasoline vehicles.

Despite these challenges, Indian sentiment toward the electric vehicle industry is generally positive and optimistic. Awareness and understanding of the benefits of electric vehicles are increasing and government efforts to promote electric mobility are expected to continue in the coming years.

VI. FUTURE SCOPE

The current EV industry needs a lot of changes in terms of policies, infrastructure, engineering, etc, but what we fail to realise is that the most important thing which is to be kept in the prime focus is the sentiment of common people in India towards electric vehicles. The change of sentiment, or the positive motivation towards the EV industry in India, should come from the internal motivation of common people in India rather than external. This can be done in many ways, such as a change in government policies, increased incentives for both manufacturers and consumers, infrastructural expansion, raising awareness of EVs in the mass, etc. On a technological front, techniques other than NLP could also be used to gather the sentiment of the people in India towards the industry. But, the most important thing is to analyze the change in the sentiment of people in India towards electric vehicles in further studies and to take action accordingly. This can be done by incorporating qualitative and quantitative studies together at regular intervals of time, so as to depict and predict the current and the future state of the EV industry in India respectively.

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