A Survey on Detection of Cyberbullying in Social Media Using Machine Learning Techniques

Nida Shakeel and Rajendra Kumar Dwivedi

Abstract Nowadays, in this technologically sound world, the use of social media is very popular. Along with the advantages of social media, there are many terrible influences as well. Cyberbullying is a crucial difficulty that needs to be addressed here. Cyberbullying influences both men and women victims. Harassment by way of cyberbullies is a big issue on social media. Cyberbullying affects both in terms of the mental and expressive manner of someone. So there's a need to plan a technique to locate and inhibit cyberbullying in social networks. To conquer this condition of cyberbullying, numerous methods have been developed using Machine Learning techniques. This paper presents a brief survey on such methods and finds that Support Vector Machine (SVM) is a very efficient method of cyberbullying detection that provides the highest accuracy.

Keywords Cyberbullying · Social networks · Machine learning · Twitter · Victims

1 Introduction

Due to the large improvement of Internet technology, social media websites which include Twitter and Facebook have to turn out to be famous and play a massive function in transforming human life. Millions of youths are spending their time on social media devotedly and exchanging records online. Social media has the potential to attach and proportion facts with everyone at any time with many humans concurrently. Cyberbullying exists via the internet where cell phones, video game packages, or other mediums ship or put up textual content, photos, or movies to hurt or embarrass some other character deliberately. Cyberbullying can happen at any time throughout the day, in a week, and outreach a person everywhere via the internet. Cyberbullying texts, pix, or motion pictures may be published in an undisclosed way a disbursed immediately to a very huge target market. Twitter is the furthermost regularly used social networking software that permits humans to micro-weblog around

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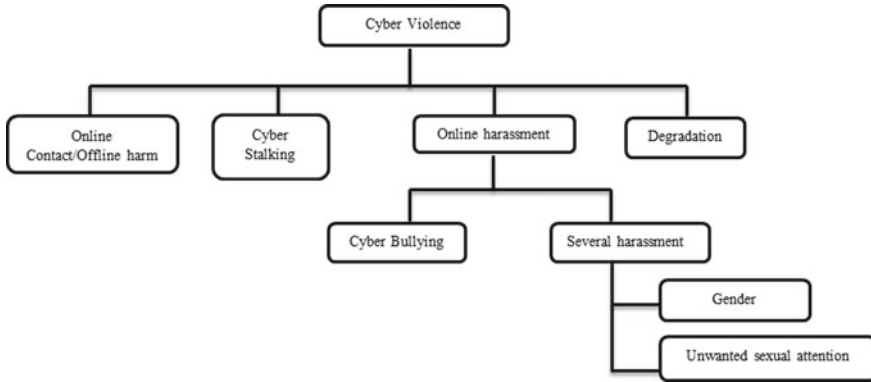e-mail: nidashakeel251@gmail.com

Fig. 1 Overview of cyberbullying

an intensive variety of areas. It is a community stage for verbal exchange, creativity, and public contribution with nearly 330 million vigorous monthly customers, greater than one hundred billion day by day lively customers, and about 500 billion tweets are produced on ordinary every day. Conversely, with Twitter turning into a high-quality as well as a real communication network, one having a look has stated that Twitter exists as a "cyberbullying playground".

Cyber violence is defined as online behaviors that criminally or non-criminally attack, or can cause an attack, on a person's physical, mental, or emotional properly-being. It can be achieved or experienced by way of a character or organization and occur online, through smartphones, at some stage in Internet video games, and so forth. Figure 1 shows that there are numerous kinds of cyber violence's several of which are online contacts or offline damage, cyberstalking, online harassment, and degradation. Online harassment is similarly divided into two categories which are cyberbullying and several harassments like gender harassment and unwanted sexual interest. Further cyberbullying deals that how humans can get burdened, annoyed, and depressed because of a few implied feedbacks. Nowadays humans without problems fall in line with the evaluations of different humans. Very vulnerable-minded humans with no backbone get affected by a lot of these shits taking place on a social platform.

1.1 Motivation

Today, social media has grown to be part of anyone's life. Which makes it clear for bullies to pressurize them as many human beings take it very seriously? Many instances had been pronounced within the past few years but the rates of cyberbullying were elevated in the ultimate 4–5 years. As the rate increases, many humans dedicated suicide due to the fact they get pissed off by way of bullies' hate messages and they

do not get every other way to overcome it. By noticing all the increments in those cases it is very vital to take action against bullies.

1.2 Organization

The rest of the paper is organized as follows. Section 2 presents the background. Section 3 presents related work. Section 4 presents the conclusion and the future work.

2 Background

Social media platforms have a huge worldwide attain and its target audience cover increases 12 months after 12 months, with YouTube boasting more than 1 billion users in line with month. Similarly, Twitter has on average 500 million tweets in line with the day, even as Facebook remains the biggest social media network with a million energetic users and plenty of million people sending updates. As this shows, cybercrime criminals had been the usage of each system which has attracted lots of perspectives, feedback, forums, and posts. For example, thru using motion pictures, snapshots posted on YouTube, Facebook, and Instagram they try to bully humans. The videos and pix attract accompanied by taglines make bullying simpler to cause harm to people.

Bullying is commonly described as repeated antagonistic behavior. Bullying has covered especially bodily acts, verbal abuse, and social exclusion. The boom of electronic communications technology causes teens and children to undergo a brand new manner of bullying. There are many exceptional kinds of cyberbullying along with Harassment, Flaming, Exclusion, Outing, and Masquerading. Reducing cyber harassment is vital due to the fact numerous negative health outcomes were determined among people who had been stricken by cyberbullying, along with depression, tension, loneliness, suicidal conduct.

Cyberbullying is "bullying for the twenty-first century, using e-mail, textual content messages, and the internet" (Richard Aedy, ABC Radio National). Investigation indicates that nearly one in 4 kids among the whole of 11 and 19 has been the victim of cyberbullying. Cyberbullying is bullying that proceeds area over digital gadgets like mobile phones, computers, and capsules. Cyberbullying can happen through SMS, Script, and apps, or virtual in community media, media, or gaming wherein folks can sight, take part in, or share gratified. Cyberbullying consists of sending, posting, or distributing poor, dangerous, untrue, or suggestive pleases nearby a person else.

Figure 2 shows the most common locations where cyberbullying happens are:

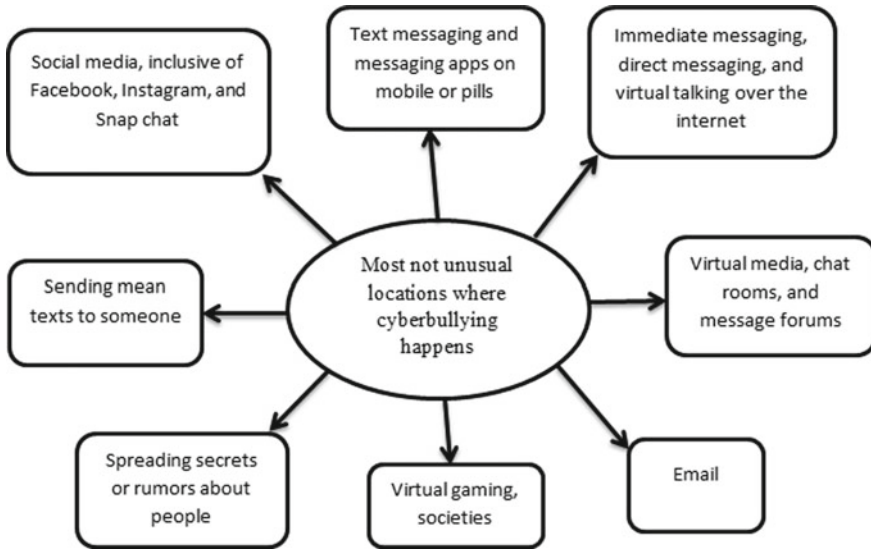- Social Media, inclusive of Facebook, Instagram, Snap Chat, and Tik-Tok.

Fig. 2 Most common locations where cyberbullying happens

- Text messaging and messaging apps on mobile or pill devices.
- Immediate messaging, direct messaging, and virtual talking over the internet.
- Virtual media, chat rooms, and message forums, including Reddit
- Email
- Virtual gaming societies.

Cyberbullying can be well-defined as violent or deliberately achieved annoyance with the aid of an institution or character via digital means repeatedly in opposition to a sufferer who's not able to guard them. This sort of intimidation contains dangers, offensive or sexual feedback, rumors, and hate speech. Cyberbullying is a moral difficulty observed on the internet and the proportion of sufferers is also distressing. The major participants in cyberbullying are social networking websites. The societal media system offers us high-quality communication stage chances in addition they boom the liability of younger human beings to intimidating circumstances virtual.

Cyberbullying on a community media community is a worldwide occurrence due to its vast volumes of active users. The style suggests that cyberbullying in a social community is developing hastily every day. The vigorous nature of these websites helps inside the boom of virtual competitive behavior. The nameless function of person profiles grows the complication to discover the intimidator. Community media is generally owed to its connectivity in the shape of systems. But then this could be dangerous while rumors or intimidation posts are extended into the community which can't be simply managed. Twitter and Facebook may be occupied as instances that might be general among numerous community media websites.

According to Facebook customers must extra than one hundred fifty billion links which offer the clue approximately how intimidation content can be extended inside

the community in a portion of the period. To physically perceive these intimidation messages over this massive system is hard. There has to be an automatic machine anywhere such varieties of things may be identified routinely thus taking suitable motion. The sufferers specifically include girls and young adults. The intense effect on the intellectual and bodily fitness of the sufferers in such sort of events betters the danger of despair prominent to desperate instances. Consequently, to manipulate cyberbullying there may be a want for computerized detection or tracking structures.

It has been recognized that because of cyberbullying victims grow to be dangerously timid and may get violent minds of revenge or even suicidal thoughts. They suffer from despair, low self-worth, and anxiety. It is worse than bodily bullying because cyberbullying is "behind-the-scenes" and "24/7". Even the bully's tweets or remarks don't vanish; they stay for a long period and constantly impact the sufferer mentally. It's nearly like ragging besides it occurs in the front of heaps of mutual buddies, and the scars live for all time because the messages live forever on the net. The hurtful and tormenting messages embarrass the sufferers to a degree that cannot be imagined. The outcomes are even worse and more excessive. In most instances, this is 9 out of 10 instances the younger victims do now not inform their dad and mom or guardian out of embarrassment and get into depression or worse suicide. The hidden scourge of cyberbullying is something that no one likes to speak approximately, and those have been disregarding it for the reason that a long term now, however, what humans don't understand is this issue is as extreme as any case of homicide or other heinous crimes, the sufferers in those instances are in most cases young and they may be likely to enter depression or drop-out of faculty or get into alcoholism, get into pills which ruin their whole existence and certainly ruin the destiny of the kingdom as it's the kids that have the strength to make the country rise or fall.

2.1 Impact of Cyberbullying

Bullying depicts an intention to harm a person, it miles described as an action while a person has the power to smash a person's intellectual fitness, bodily health, etc. It can grow to be a supply of trauma for youngsters, young, adults and stay with them their complete lives. Figure 3 shows the impact of cyberbullying on society, mental health, youth, and teenager's life.

The impacts of cyberbullying are:

- Impact of cyberbullying on society
- Impact of cyberbullying on youth
- Impact of cyberbullying on students
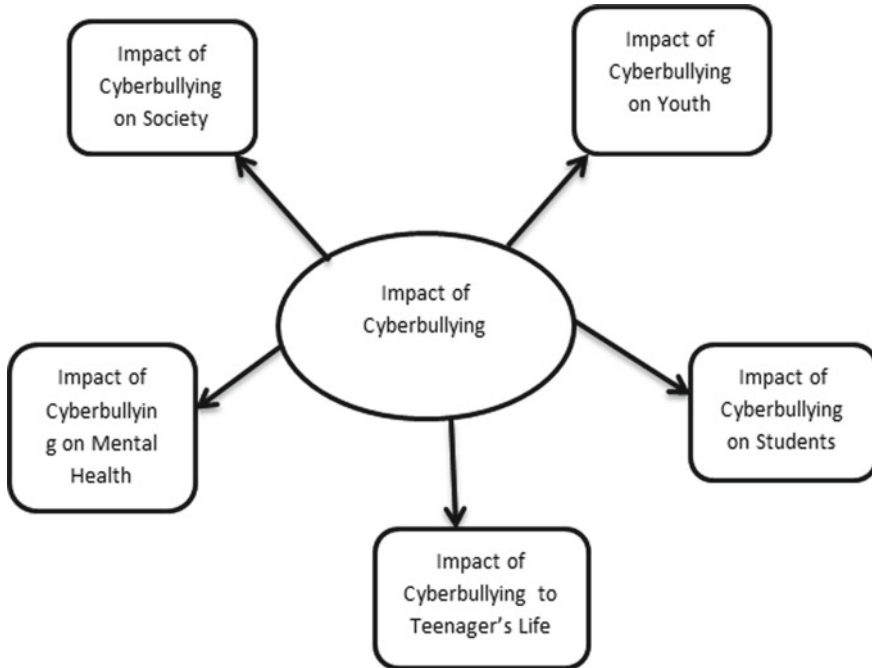- Impact of cyberbullying on teenagers.

Fig. 3 Impact of cyberbullying

A. Impact of Cyberbullying on Society

Cyberbullying influences numerous humans in society. The victims of cyberbullying will possibly by no means view the internet in an equal manner again, as their digital identities could be probably broken by using an aggressive online attack. In ultra-modern international, it can be very challenging to prevent cyberbullying from having bodily results on victims.

B. Impact of Cyberbullying on Youth

The impact of cyberbullying on children can lead to severe long-lasting troubles. The stress of being in a steady country of disenchanted of the 12 months can result in problems like moods, energy level, sleep, and so forth. It can also make a person sense jumpy, demanding, or unhappy. If the youngsters are already depressed or demanding, cyberbullying could make matters a whole lot worse.

C. Impact of Cyberbullying on Mental Health

Cyberbullying precedes numerous forms—sending, posting, or sharing unaffected and malicious content material approximately a person privately or in public groups, sending threads, leaking figuring out facts, or sharing embarrassing content. Those folks who were already depressed or stricken by mental health troubles have been more likely to be bullied online than people who did now not suffer from intellectual health problems.
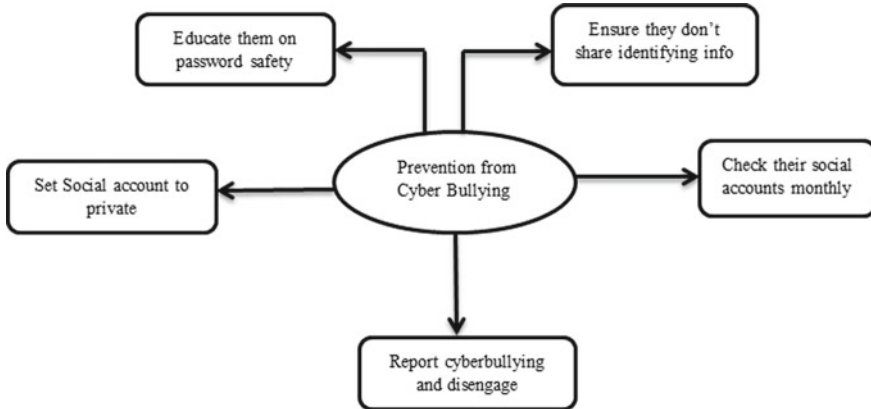
Fig. 4 Prevention from cyberbullying

D. Impact of Cyberbullying on Teenagers Life
Cyberbullying influences young adults in many ways like this could boom strain and tension, feelings of worry, negative attention on the study, depression, decreased shallowness and self-belief and even this will cause suicide.

2.2 How to Prevent Cyberbullying

While there is no secure manner to save your youth from always being cyberbullied, there are things you could do together to lessen the chance they may be battered. This consists of applying security methods in addition to having enduring discussions approximately cyberbullying. It's additionally vital to speak to your tweens as well as young adults about the way to use social media correctly and responsibly and what they must do if they're bullied online. Figure 4 shows the ways to prevent cyberbullying.

Following are the ways to prevent Cyberbullying, these are as follow:

- Educate them on password safety.
- Set social accounts to private.
- Ensure they do not share their location.
- Logout when using public devices.
- Refuse to respond to cyberbullies.
- Report cyberbullies and disengage.

A. Educate Them on Password Safety
When it involves stopping cyberbullying, and similar behaviors like catfishing, it's critical that your infant use passwords on everything. Passwords are one of the most effective methods to shield debts and gadgets. Emphasize that your baby has to in

no way percentage their passwords with all and sundry, including their high-quality friend. Even though they'll believe that pal implicitly, the fact is that pals come and cross and there may be no guarantee they may be going to be friends for all time.

B. Set Social Accounts to Private

No count number what your teenager does online, ensure they are privy to the privateer's settings and equipment offered using the business enterprise. Almost every social media platform such as Instagram, Twitter, Snap Chat, etc. has privacy settings. Go thru every account together with your infant and assist them to set their privateers settings to the maximum comfy settings. This way making bills personal, preventing humans from tagging them, requiring different humans to get permission before sharing considered one of their images, and so on.

C. Ensure They Do not Share Their Location

Some smartphones permit users to share their location with pals. This means that if they percentage their location with human beings, these human beings will always realize where they may be. Have a discussion together with your child approximately who they could share their region with or if they could proportion it at all.

D. Logout When Using Public Devices

Remind your tween or teenager that when they're using public computers or laptops at college or the library, they ought to log off of any account they use. This consists of logging out of e-mail, social media bills, their faculty account, Amazon account, and another account they'll open. Simply closing the tab isn't enough. If someone gets at the laptop/computer at once after they are accomplished, they will nevertheless be able to get into your child's account. And once they have access, they can take control of that account using changing passwords. Once they have got manipulated, they could impersonate your infant online via making faux posts and remarks that make your toddler's appearance bad. Plus, after you lose access to an account, it could be difficult and time-consuming to regain manage.

E. Refuse to Respond to Cyberbullies

If your child does experience cyberbullying, they have to refrain from responding. In this method, they have to no longer argue, attempt to explain, or have interaction in any way with cyberbullies. Cyberbullies are seeking out an emotional response, however, if your infant refuses to give them anything head-on, they're left with one-sided communications.

F. Report Cyberbullies and Disengage

Make sure your child knows that they should always report cyberbullying. This includes not only telling you what is happening, but also letting the social media platform, internet service provider, and any other necessary parties know what is going on. You may even need to contact the school or the police to put an end to the harassment. Once all the reports have been filed, take the appropriate steps to block the person or account responsible for the cyberbullying. Doing so doesn't prevent them from using a different account or a public space to continue to cyberbully your tween or teen, but it will slow them down.

3 Related Work

Different cyberbullying detection techniques have been invented over the latter few years. All techniques had proven their better effort on certain unique datasets. There are several strategies for figuring out cyberbullying. This segment offers a short survey on such strategies.

Nurrahmi et al. [1] described that cyberbullying is a repetitive action that annoys, disgraces, hovers, or bothers different human beings via digital gadgets and virtual communal interacting websites. Cyberbullying via the internet is riskier than outdated victimization, as it may probably increase the disgrace to vast virtual target spectators. The authors aimed to hit upon cyberbullying performers created on scripts and the sincerity evaluation of customers and inform them around the damage of cyberbullying. They pragmatic SVM and KNN to study plus stumble on cyberbullying texts. Prasanna Kumar et al. [2] describe the fast growth of the net and the development of verbal exchange technology. Due to the upward thrust of the popularity of social networking the offensive behaviors taking birth that's one of the critical problems referred to as cyberbullying. Further, the authors mentioned that cyberbullying has emerged as a menace in social networks and it calls for extensive research for identification and detection over web customers. The authors used some technologies such as Semi-Supervised Targeted Event Detection (STED), Twitter-based Event Detection and Analysis System (TEDAS).

Pradheep et al. [3] The Social networking platform has emerged as very famous inside the last few years. Therefore, there is essential to conceive a technique toward stumbling on and inhibiting cyberbullying in communal networks. The cyberbullying image can be detected by the use of the pc imaginative and prescient set of rules which incorporates methods like Image Similarity and Optical Character Recognition (OCR). The cyberbullying video could be detected using the Shot Boundary detection algorithm where the video could be broken into frames and analyzed the use of numerous strategies in it. Mangaonkar et al. [4] explained the usage of Twitter statistics is growing day-with the aid of-day, hence are unwanted deeds of its workers. The solitary of the unwanted conduct is cyberbullying which might also even result in a suicidal attempt. Different collaborative paradigms are recommended and discussed in this paper. They used the strategies like Naive Bayes (NB). Al-Ajlan et al. [5] explained that tools are ruling our survives now we trust upon a generation to perform a maximum of our everyday deeds. In this paper, we advocate boosted Twitter cyberbullying discovery founded totally on deep getting to know (OCDD), As per the cataloging segment, deep learning may be recycled, at the side of a metaheuristic optimization algorithm for parameter tuning.

Agrawal et al. [6] described that internet devices affected each aspect of humanoid existence, getting easiness in linking human beings about the sphere and has made records to be had to massive levels of the civilization with a click on of a button. Harassment by way of cyberbullies is an enormous phenomenon on social media. In this paper, Deep Neural Network (DNN) technique has been used. Meliana et al. [7] explained that nowadays community media is actual crucial on behalf of certain

human beings for the reason that it is the nature of community media that can create humans waste to the use of societal media, this takes extensively validated in phrases of healing, community interplay has been abridged because of community media, kits linked to the somatic to be decreased, social media may be fine and terrible, fantastic uncertainty recycled to deal hoary associates who do not encounter for lengthy, however poor matters may be used to crime or matters that are not suitable. Keni et al. [8] described that state-of-the-art youngsters have grown in an era that is ruled by new technologies where communications have typically been accomplished through the use of social media. The rapidly growing use of social networking sites by a few young adults has made them susceptible to getting uncovered to bullying.

Wade et al. [9] explained that within the latest years social networking sites have been used as a platform of leisure, task opportunity, advertising however it has additionally caused cyberbullying. Generally, cyberbullying is an era used as a medium to bully someone. Cyberbullying includes insulting, humiliating, and making a laugh at human beings on social media that could purpose intellectual breakdown, it could affect one bodily in addition to the extent that can also lead to a suicidal try. Nirmal et al. [10] defined the growth within the use of the Internet and facilitating get admission to online communities which includes social media have brought about the emergence of cybercrime. Cyberbullying may be very not unusual nowadays. Patidar et al. [11] defined the speedy increase of social networking websites. Firstly, the authors cited the nice aspect of social networking sites after that they cited some of its downside which is using social media human beings can be humiliated, insulted, bullied, and pressured using nameless customers, outsiders, or else friends. Cyberbullying rises to use tools to embarrassing social media customers.

Ingle et al. [12] described in the current year's Twitter has appeared to be a high-quality basis for customers to show their day-by-day events, thoughts, and emotions via scripts and snapshots. Because of the rapid use of social networking websites like Twitter the case of Cyberbullying has been also been boomed. Cyberbullying is an aggravation that takes conspicuously ensues in community networking websites wherever cyberbullies goal inclined sufferers and it has essential mental and bodily effects on the victims. Desai et al. [13] describe that the use of internet plus community media credentials tend within the consumption of distribution, receiving, and posting of poor, dangerous, fake, or else suggest gratified material approximately any other man or woman which therefore manner Cyberbullying. Mistreatment over community media additionally works similar to intimidating, defamation, and punishing the character. Cyberbullying has caused an intense growth in intellectual health problems, mainly many of the younger technology. It has led to lower vanity, multiplied desperate ideation. Except for certain degrees besides cyberbullying is occupied, self-regard and spiritual fitness concerns will affect a partial technology of young adults. Khokale et al. [14] defined as internet having affected each phase of social lifestyles, fetching easiness in linking human beings about the sphere and has made facts to be had to large sections of the civilization on a click on of a knob. Cyberbullying is a practice of automatic verbal exchange, which evils the popularity or confidentiality of a discrete or hovers, or teases, exit a protracted-—eternal effect.

Mukhopadhyay et al. [15] defined social media as the usage of a digital stage for linking, interrelating, distributing content, and opinions nearby the sphere. The quickening of various community media stages has altered the technique folk's link with everyone it has additionally preceded in the upward push of cyberbullying gears on community media that has contrary results on a person's health. Shah et al. [16] described that in a cutting-edge technologically sound world using social media is inevitable. Along with the blessings of social media, there are serious terrible influences as properly. A crucial problem that desires to be addressed here is cyberbullying. Dwivedi et al. [17] explained that nowadays IoT-based structures are developing very rapidly which have a diverse form of wireless sensor networks. Further, the authors defined anomaly or outlier detection in this paper. Singh et al. [18] defined human identity as a part of supplying security to societies. In this paper, the writer labored at the techniques to find which methodology has better overall performance so that you can provide human identification protection. Zhang et al. [19] explained Cyberbullying can ensure a deep and durable effect on its sufferers, who are frequently youth. Precisely detecting cyberbullying aids prevent it. Conversely, the sound and faults in community media posts and messages mark identifying cyberbullying exactly hard.

Shakeel et al. [20] explained that social media plays an important role in today's world. Further, the author described influence maximization as a problem and how to conquer this problem if you want to find the maximum influential node on social media. Sahay et al. [21] defined that cyberbullying impacts greater than 1/2 of younger social media users' global, laid low with extended and/or coordinated digital harassment. Cyberbullying and cyber aggression are serious and massive problems affecting increasingly more Internet users. Dwivedi et al. [22] defined a system studying-based scheme for outlier detection in smart healthcare sensor cloud. The authors used numerous performance metrics to evaluate the proposed work. Malpe et al. [23] depicted that Cyberbullying is a movement where someone or else a collection of folk's usages societal networking websites happening the internet through smartphones, processors, as well as pills toward misfortune, depression, injured, or damage an alternative person. Cyberbullying happens with the aid of transfer, military posting, or distribution of violent or hurtful texts, images, or else motion pictures. Chatzakou et al. [24] defined Cyberbullying and cyber-aggression as more and more worrisome phenomena affecting human beings across all demographics. The authors similarly referred to that more than half of younger face cyberbullying and cyber aggression because of using social media.

Reynolds et al. [25] explained these days social media is used as a medium to bully someone. Social networking sites provide a fertile medium for bullies and young adults, and adults who used those web sites are susceptible to attack. Dwivedi et al. [26] defined how a smart information system is based totally on sensors to generate a massive amount of records. This generated record may be stored in the cloud for additional processing. Further, in this paper, the authors defined healthcare monitoring sensor cloud and integration of numerous frame sensors of various patients and cloud. Rai et al. [27] defined that many technologies have made credit cards common for both online and offline purchases. So, protection is expected to save you

fraud transactions. Therefore, the authors worked on it using different methodologies and thus find the accuracies of every methodology. Shakeel et al. [28] explained how social media turns into part of every person's life and its bad effect like cyberbullying. Further, the authors worked on the accuracy to find which algorithm is best suited to find the cyberbullying comments or contents. Chen et al. [29, 30] explained how the usage of the net, numerous enterprises including the economic industry has been exponentially extended.

Tripathi et al. [31] explained the lack of physical reference to each other due to COVID 19 lockdown which ends up in an increase in the social media verbal exchange. Some social media like Twitter come to be the most famous region for the people to specific their opinion and also to communicate with every other. Kottursamy et al. [32, 33] defined how facial expression recognition gets hold of loads of people's interest. Nowadays many humans use facial expression recognition to depict their emotion or opinion toward a selected mind. Further, the authors explained the technologies which have been utilized in facial expression popularity. A. Pandian et al. [34, 35] defined some commonplace programs of deep gaining knowledge of like sentiment evaluation which possess a higher appearing and green automatic feature extraction techniques in comparison to conventional methodologies like surface approach and so forth.

Table 1 presents a comparative study of related work. Based on the survey, inside the comparative table of related work, we've got referred to the author's name, years of the paper, name of the paper, and methodology used. And Table 2 constitutes the kinds of models and datasets used in related work.

4   Conclusion and Future Work

Although social media platform has come to be an essential entity for all of us, cyberbullying has numerous negative influences on a person's lifestyle which contain sadness, nervousness, irritation, worry, consider concerns, small shallowness, prohibiting from social activities, and occasionally desperate behavior also. Cyberbullying occurrences are not the simplest taking region via texts, however moreover audio and video capabilities play an essential function in dispersal cyberbullying. The existing work of this paper is that the accuracy of SVM is lowest as compared to that of the voting classifier. This study has discussed a designated and comprehensive review of the preceding research completed within the subject of cyberbullying. The future may be prolonged to examine distinctive social media or network pages to perceive every unfamiliar or violent post using the societies in opposition to authorities' businesses or others.

Table 1 Comparative study of related work

S. No.	Author's name	Year	Title	Algorithm used	Limitations
1	Nurrahmi et al. [1]	2016	Indonesian Twitter Cyberbullying Detection using Text Classification and User Trustworthiness	SVM and KNN	There are some wrong tags in the Indonesian POS tagger
2	Prasanna Kumar et al. [2]	2017	A Survey on Cyberbullying	Semi-supervised Targeted Event Detection (STED), Twitter-based Event Detection and Analysis System (TEDAS)	Not any
3	Pradheep et al. [3]	2017	Automatic Multimodel Cyberbullying Detection From Social Networks	Naïve Bayes	Sometimes a proposed model is not able to control the stop words
4	Mangaonkar et al. [4]	2018	Collaborative Detection of Cyberbullying Behavior in Twitter Data	Naive Bayes (NB), Logistic Regression, and Support Vector Machine (SVM)	When the true negatives increase then the models are not working
5	Al-Ajlan et al. [5]	2018	Improved Twitter Cyberbullying Detection based on Deep Learning	convolutional neural network (CNN)	The metaheuristic optimization algorithm is incorporated to find the optimal or near-optimal value
6	Agrawal et al. [6]	2018	Deep Learning for Detecting Cyberbullying Across Multiple Social Media Platforms	Deep Neural Network (DNN)	Some models do not work properly
7	Meliana et al. [7]	2019	Identification of Cyberbullying by using Clustering Approaches on Social Media Twitter	Naïve Bayes and Decision Tree	Naïve Bayes wasn't able to find the hate comments as compared to that of Decision Tree J48
8	Keni et al. [8]	2020	Cyberbullying Detection using Machine Learning Algorithms	Principle Component Analysis (PCA) and Latent Semantic Analysis (LSA), Support Vector Machine (SVM)	The performance of other classifications is not good

Table 1 (continued)

S. No.	Author's name	Year	Title	Algorithm used	Limitations
9	Wade et al. [9]	2020	Cyberbullying Detection on Twitter Mining	Convolutional Neural Network (CNN) and Long Short-Term Memory (LSTM)	CNN-based models do not have better performance as compared to that DNN models
10	Nirmal et al. [10]	2020	Automated Detection of Cyberbullying Using Machine Learning	Naïve Bayes Model, SVM Model, DNN Model	Difficult to detect some hate words because of specific code
11	Ingle et al. [12]	2021	Cyberbullying monitoring system for Twitter	Gradient boosting	Naïve Bayes, Logistic Regression does not possess good results
12	Desai et al. [13]	2021	Cyberbullying Detection on Social Media using Machine Learning	BERT	The accuracy of SVM and NB is not good as compared to that of pre-trained BERT
13	Khokale et al. [14]	2021	Review on Detection of Cyberbullying using Machine Learning	Support vector machine (SVM) classifier, Logistic Regression, Naïve Bayes algorithm and XGboost classifier	The authors didn't find the use of K-folds across the techniques
14	Mukhopadhyay et al. [15]	2021	Cyberbullying Detection Based on Twitter Dataset	convolutional neural network (CNN)	Not good performance
15	Malpe et al. [23]	2020	A Comprehensive Study on Cyberbullying Detection Using Machine Learning Technique	Deep Neural Network (DNN)	Not any
16	Chatzakou et al. [24]	2019	Detecting Cyberbullying and Cyber- aggression in Social Media	LDA	Effective tools for detecting harmful actions are scarce, as this type of behavior is often ambiguous

Table 2 Types of models and datasets used in related work

S. No	Author's name	Classification taxonomy	Dataset used	Types of the model used (ML or DL)	Evaluation metrics used
1	Nurrahmi et al. [1]	SVM and KNN	Twitter	Machine learning	Precision, Recall, and F1 score
2	Prasanna Kumar et al. [2]	Semi-supervised Targeted Event Detection (STED), Twitter-based Event Detection and Analysis System (TEDAS)	Twitter	Deep learning	Not any
3	Pradheep et al. [3]	Naïve Bayes	Youtube, Facebook, Twitter, and Instagram	Machine learning	Social bullying, Verbal bullying, and Physical bullying
4	Mangaonkar et al. [4]	Naive Bayes (NB), Logistic Regression, and Support Vector Machine (SVM)	Twitter	Machine learning	Accuracy, Recall, and Precision
5	Al-Ajlan et al. [5]	convolutional neural network (CNN)	Twitter	Deep learning	Word embedding
6	Agrawal et al. [6]	Deep Neural Network (DNN)	Twitter, Wikipedia, and Form spring	Deep learning	Accuracy and F1 score
7	Meliana et al. [7]	Naïve Bayes and Decision Tree	Twitter	Machine learning	Accuracy
8	Keni et al. [8]	Principle Component Analysis (PCA) and Latent Semantic Analysis (LSA), Support Vector Machine (SVM)	Facebook and Twitter	Machine learning	Accuracy
9	Wade et al. [9]	Convolutional Neural Network (CNN)and Long Short-Term Memory (LSTM)	Twitter	Deep learning	Bullying and not bullying

(continued)

Table 2 (continued)

S. No	Author's name	Classification taxonomy	Dataset used	Types of the model used (ML or DL)	Evaluation metrics used
10	Nirmal et al. [10]	Naïve Bayes Model, SVM Model, DNN Model	Facebook	Machine and Deep learning	Not any
11	Ingle et al. [12]	Gradient boosting	Twitter	Machine learning	Accuracy
12	Desai et al. [13]	BERT	Snap chat, Instagram, Facebook, Youtube, and Wikipedia	Machine learning	Accuracy
13	Khokale et al. [14]	Support vector machine (SVM) classifier, Logistic Regression, Naïve Bayes algorithm, and XGboost classifier	Twitter, Reddit, Wikipedia, Youtube	Machine learning	Accuracy
14	Mukhopadhyay et al. [15]	convolutional neural network (CNN)	Twitter, Facebook, and Instagram	Deep learning	Matrix word embedding
15	Malpe et al. [23]	Deep Neural Network (DNN)	Twitter and Youtube	Machine and Deep learning	Not any
16	Chatzakou et al. [24]	LDA	Twitter	Machine learning	Accuracy of active, deleted, and suspended comments

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