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Application of Smart Surveillance System in National Security

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Abstract

Surveillance has been considered essential in maintaining order and discipline since the dawn of time. This paper explores various domains revolving around the Smart surveillance system ranging from the primitive definition, and how it deviates from traditional surveillance to how we can implement the system on a fundamental level which can be scaled up to work on national-level systems. With the rising criminal activity in today's world, there is a need for a proposed solution in surveillance applications that can examine human behavior and recognize people with criminal pasts and detect abnormal activities. This article focuses on proposing advancements in Surveillance Systems in Nepal such that Artificial Intelligence (AI) systems will be able to recognize people with criminal pasts and also keep track of a person's behaviour to predict if any acts of violence are about to take place or not. The research aims to explore the potential for such a system in Nepal and other places around the world, including questions such as: what specific types of AI Surveillance are the governments deploying and "The feasibility and challenges of adopting a Smart Surveillance System in Nepal". The research methodology consists of secondary sources of data to collect the information. A comparative document study, a quick survey with ICT experts, journal articles, and research on current technologies, found that Nepal is not far behind in technological advancements though it lacks policy-level intervention on AI which shows Nepal can enhance its national security by adopting an AI-powered Surveillance System.

Keywords: surveillance, artificial intelligence, human behavior, national security, information technology

Introduction

The history of surveillance begins from the German's invention of the cameras during the 1940s. The Germans used the earliest CCTV cameras to observe the launch of V2 rockets and the USA for the testing of the atomic bomb. In today's age, when everything is moving at a superfast pace, it is difficult to follow and monitor everything and everyone in crowded areas.

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Criminal activities in the modern world are a major problem that unfortunately has become common. Terrorist attacks, murders, kidnappings, and drug smuggling are some common terms that even a child knows about. There are people out there whose sole motive has been to create chaos and harm others. What if we can stop any criminal activities before they can occur just by tracking the criminals? That would be great, won't it? Suppose a person with a criminal record, whom the cops are looking for, is seen around a shopping mall or an airport. Let's assume he/she is there to do any illicit activity and the cameras track him/her and inform the police, they can monitor or arrest the suspect before he/she can do anything bad.

Even with huge manpower, it will be difficult to monitor 24/7 hence the concept of Smart Surveillance Systems has been established where a system with the capability to recognize faces and objects will keep track automatically 24/7 and warn of unwanted objects and unwanted people in an area before any incident take place. The Smart Surveillance system automatically tracks suspicious behaviours, recognizes unwanted objects, detects gunshots, and provides real-time alerts. This system should also be capable to get insights from various behaviour to alert the authorities about possible criminal activity or antisocial activity.

In recent years, there has been a rapid surge in the deployment of AI for security purposes. Artificial intelligence for video surveillance makes use of computer software tools that examine the images and sounds from security cameras in order to identify people, cars, objects, traits, and events. Manual monitoring by a human operator is an inefficient solution or even unpractical because human resource is expensive and has limited ability. Extensive studies have been conducted to automatically analyze data (image or video) from the surveillance camera (Ibrahim, 2016, p.7). Human operators were frequently used in previous surveillance systems. Chinese police analyze human behaviours to ensure facial recognition cameras capture as much activity as possible. They are also collecting voice prints using sound recorders attached to their facial recognition cameras (Qian, Xiao, Mozur & Cardia, 2022 paras, 6-15). Recently, the government of Nepal was also impacted by the Western practice of citizen surveillance. Nihure identifies that many missions to eradicate crime and terrorism were successful in the past using this method of online surveillance, and the mission to assassinate Osama Bin Laden also had online surveillance as a key step. With increasing criminal activities in the country, the government has granted special authority and technologies to the Nepal Police for online civil surveillance (Nihure, 2021, paras. 5-9). The report presented in "All The Research" shows that Artificial Intelligence (AI) for the surveillance and security market is expanding at a faster rate to a wider range of countries and at least 43% of 176 countries are actively using Artificial Intelligence (AI) for surveillance and security. This includes smart city/safe city platforms, facial recognition systems, and smart policing (Artificial Intelligence (AI) for Surveillance and Security Market Ecosystem Trend, Revenue and Growth Rate Analysis along with Decision Intelligence, 2020). Surveillance is nothing, but countries are exploring the potential of predicting crime by analyzing real-time surveillance data to increase security.

Many of the countries with advanced information technology, such as the US, the UK, Switzerland, France, India, Australia, Russia, and China use mass surveillance systems for public security and monitoring. However, in a country like Nepal, there are still some ethical and moral issues and the most crucial of which is the government's policy on information

technology and related fields regarding the advancement and application of Automated Surveillance systems. The number of CCTV cameras is increasing in many places in Nepal developing a surveillance network. The majority of the cameras are monitored in Kathmandu, Bhaktapur, and Lalitpur along with the valley entry and exit points. This research article discusses the role of smart surveillance systems for security (traffic monitoring, border and checkpoints, crowded areas monitoring, healthcare, roadways, and so on) with its trends in Nepal. The domains involved in this article can be summed up as Facial recognition systems, behavior tracking systems, and Object Detection systems. Tacking the three different domains individually and integrating them into a single system, this system makes a nation with a smart city and smart policing (cams connected to intelligent command centers).

Literature Review

To give a comprehensive overview of the state-of-the-art of smart surveillance system different states of research include different journal papers, e-newspapers, reports, and various google scholars. The majority of journals and papers came from international writers and few publications were from Nepal.

First video surveillance systems (1960–80) used multiple analog video cameras (sensor level) to monitor indoor or outdoor environments by transmitting and displaying analog visual signals in a remote control room (Foresti et al., 2009, p. 2254). The article by WSI technologies (2016), describes Surveillance as "Surveillance is another word for monitoring of the behaviour and activities of people, normally aimed at influencing, managing or protecting. In other words, surveillance is an ambiguous practice, which may create either positive or negative effects." In the developed world, Electronic surveillance is a common phenomenon these days with invisible, visible, semi-concealed cameras and sensors embedded everywhere in all corners of society (Odoemelam, 2015, p. 572). According to new research, the concepts underpinning surveillance and the number of different surveillance systems in use have expanded rapidly in recent years (Calba, C, 2015, p. 1). The CJS publication in Criminal Justice Section presents some general principles regarding Electronic Surveillance which shows that "Technologically-assisted physical surveillance can be an important law enforcement tool and It can facilitate the detection, investigation, prevention, and deterrence of crime, the safety of citizens and officers, the apprehension and prosecution of criminals, and the protection of the innocent" (American Bar, Technological-Assisted Physical Surveillance, 2019, para. 1). Video surveillance cameras can now offer facial recognition, smart cameras – like PTZ cameras with smart tracking that enables them to ID and follow people or vehicles until they are out of range – thermal cameras, night vision, high-def full colour, and a variety of smart technologies that allow cameras to send immediate notifications regarding specific types of activities (Security, 2022, para 31).

Face detection is done using skin colour-based methods. YCbCr colour model is used to detect skin regions as it represents intensity and colour information separately (Tathe, 2013, p. 1). Ahmed and Echi explore AI-powered threat detectors for smart surveillance cameras in which the system could transform surveillance cameras from passive sentries into active observers which would help in preventing a possible mass shooting in a school, stadium, or mall. Upadhyay talks about different provisions under different statutes which allow the government to conduct surveillance, various governmental bodies doing surveillance, and the

right to privacy of the individual in India. Research from Jha & Yadav (2022, para. 13), AI has been making progress in Nepal, and possibly changes will be seen at a time when the government and non-government sectors digitize their official business and set aside paperwork. Ritosh Roy, Sub-Inspector at the Metropolitan City HQ of Kathmandu, told us that surveillance cameras have also "largely contributed as evidence, especially to road and traffic management cases, and help solve investigations and track down the culprits too," including in cases of robbery or mugging (Shahi, 2019, para. 6). King (2022, p. 1) explores the development of military-specific capabilities in the context of artificial intelligence (AI) and machine learning. AI may be able to provide such an assessment. Using the array of data sources described, we may be able to make more accurate predictions about where the problems may actually lie (Gyawali, 2019)**.** There are researchers who show how economic growth will rise in developed countries with the increased use of AI. Research conducted by The Accenture Institute for High Performance shows that by 2035 A.D. the US will have an annual growth rate of 4.6% compared to the present 2.6%. Similarly, the UK will have an annual growth rate of 3.9% compared to the present 2.9% (Timsina, 2022, para. 5).

From the above review of literature, it can be seen that video surveillance is changing with the change in era and many developed countries, including China, US, and India have already adopted such a system which shows that practical implementation is absolutely possible.

Methodology

This research article is mainly prepared based on the analysis of reports, newspapers, research papers, and various working prototypes working on small and large scales. The methodology followed for this research article is based on the qualitative approach. Both primary and secondary sources of data are studied and analyzed. The primary data includes interviews and observations with national and international experts. For better understanding, the information is gathered through a comparative document study, and a quick survey with ICT experts to explore a few questions. Furthermore, websites, corporate documents, academic articles ports, journals, published books, and online reliable videos available are taken into consideration to quantify the article's content. An inductive approach to research has been used to form a proper analysis and conclusion. Also, phenomenology research was conducted for precise data collection where a small working prototype named "Cubic S" prepared by college students which was presented in an exhibition was studied along with their interviews and personal opinions were included. And a comparative study was conducted to better understand how established and emerging civilized nations experience using AI in surveillance.

Conceptual Design of a Smart Surveillance Syustem

The smart surveillance system utilizes the already-existing CCTV infrastructure in public spaces, including parks, roadways, retail centers, hospitals, national territories, and airports. The system was meant for detecting suspicious activity by means of powerful computer vision algorithms.

A proposed surveillance system should have two distinct phases:Training and Testing. As the name suggests, training is the phase where the system will learn about different ticks, behavioural patterns of violence, and faces of criminals. For the purpose of training, different

photos and videos as data consisting of various behaviour patterns shown by anti-social personnel and their faces as well should be used. These independent variables, such as, face, expressions, weapons, activities, movements and vehicle speed when combined with moderate variables of Machine Learning and Deep Learning algorithms, yield an AI Model that can be used as a moderate variable on the real-time footage from various Closed Circuit Cameras. As such, they provide us with all the possibilities and results (face detection, weapons detection, face recognition, unusual activities, and alerts to the control office).

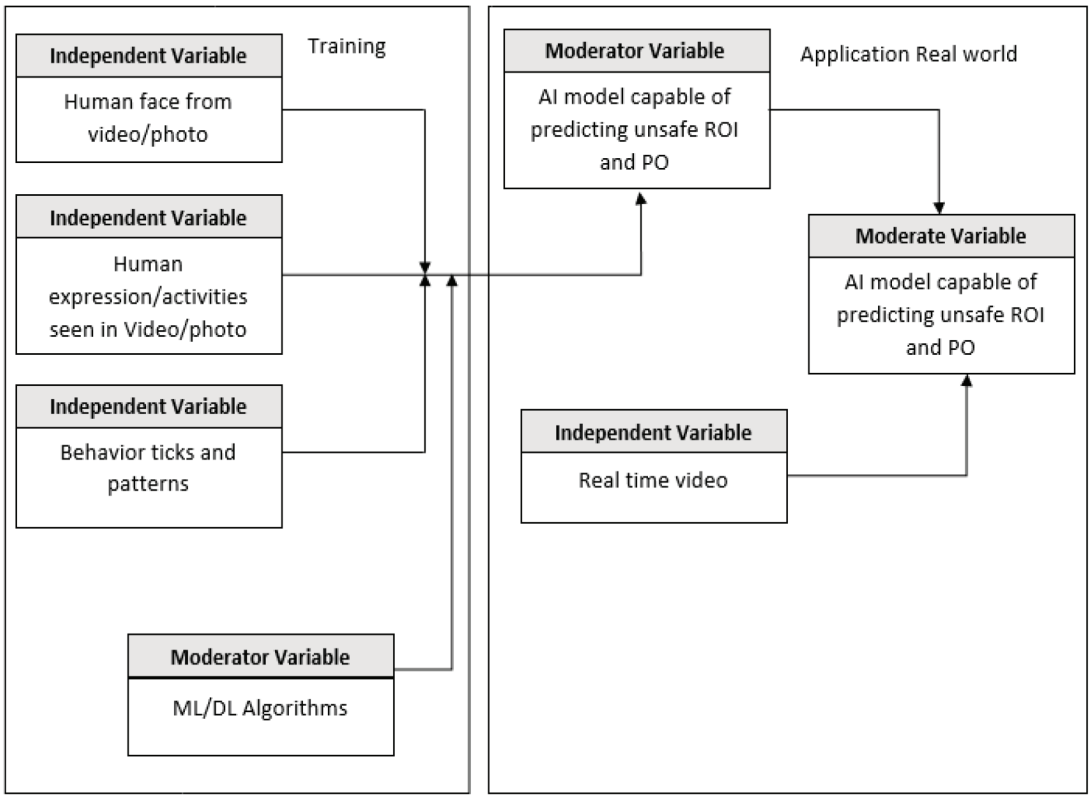


Fig.1. Conceptual Diagram of Smart Surveillance System

Understanding Behaviour Tracking and Threat Detection

Though unpredictable human beings have some basic patterns for various behaviours like clenching our fists and frowning our eyes when it comes to rage. Since there are such subtle hints that help us read human's behaviour, we can collect a huge chunk of videos and photos of various people with different behaviour patterns with facial expressions to body language. This data can be now used as a dataset which is used to train huge Neural Networks that will be able to learn from all the data by repeatedly rewatching the same data. This might sound complicated but with various available resources provided by big tech companies like Google's Mediapipe Tensorflow and Keras one can train the AI to be able to identify different behaviour patterns and in case of any violent behaviour it can be flagged as a high threat level. Additionally, in terms of threat detection, training the same AI to learn about various objects

and weapons, such as, knife, nail cutters, hammers helps track behavior by assigning a threat level for each person. For instance, if a person has eyebrows frowned, shows drunk body language and is carrying gun, such a person can be classified as a high-level threat. At the same time, a person who looks calm also shows calm body language and is carrying a hammer we can assume he/she is working on something and hence can be assigned a low threat level. It is capable of identifying if a person has ever had a criminal record, a criminal who is now on the run, and also a person who does not have any kind of record by doing facial recognition of the respective people by observing images of all of the people which can be found through various databases and platform. This detection helps us mobilize manpower in proper places, which also reducing crime by a 30% to 40% and reduce response times for emergency services by 20% to 35%.

Scope of Smart Surveillance System in Nepal

The smart surveillance system covers several domains where it can be used. Security is a basic need to survive and this article presents every possible way where AI-powered Surveillance can be installed for high efficiency, reliability, and security, relevant to cities and citizens of Nepal. AI could be much more reliable and accurate than the human eye, ensuring that no data or information is lost. For Better reflect the scenario, this article describes various different sectors where Smart Surveillance plays a vital role in high efficiency and high security.

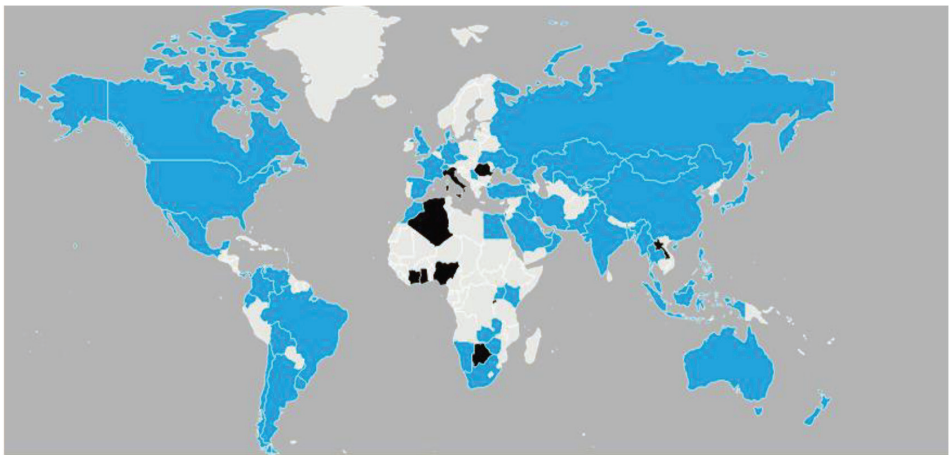
Crowd Detection and Recognition

In smart surveillance system and security, crowd detection is basically done by the bounding box theory where the area of interest is detected in a particular location. Bounding boxes can be used to track individuals in pedestrian detection systems, weapons in object detection systems, and faces in facial recognition systems. This concept is capable to generate an alarm signal if there founds any suspicious fellow or unusual activity in the crowded areas for public safety or quality of service (Singh et al., 2020, p. 350). The solution is most appropriate for congestion on city streets, in public spaces, in the subway, and at transit hubs. And alerts the authorized personnel or police about potentially dangerous crowds and tracks the target of interest's location in real-time.

The sooner crowds are taken into consideration (such as when violent or destructive crowds are identified and spread), the less probable it is that there will be extensive damage or injuries. So it can help the government of Nepal and related agencies in Nepal to evaluate staffing levels or help cities decide how many police officers or inspectors to dispatch to control a crowd or violent activities.

Countries like US, China, India, Pakistan, Russia, etc. have already been using facial recognition systems for public peace and security. The figure shown below shows the countries using facial recognition systems.

Fig.2. The blue parts in the map show countries with a Facial recognition system

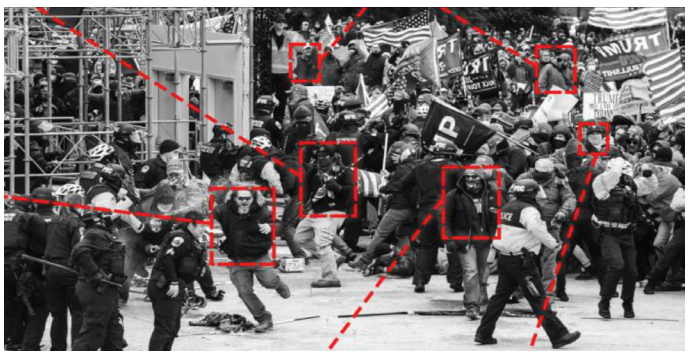


Note: Photo taken from AI Global Surveillance (AIGS) Index

Fig.3. Person with gun detection

Source: Arcarithm, LinkedIn

Fig.4. Weapons and person detection while trump supporters clash with police and security forces as they storm the US Capital in Washington on Jan 6,2021



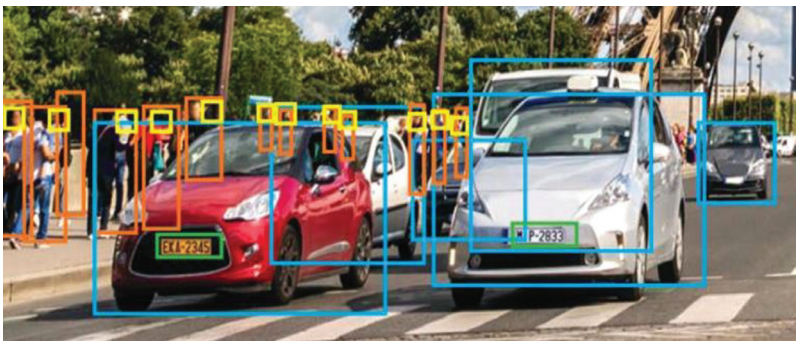
Note: [Photo:Roberto Schmidt/AFP via Getty Images]

Smart Traffic

In smart surveillance and security system, the 3D cuboid annotation method is used for traffic monitoring and control for smart cities. The AI-based traffic video platform improves transportation infrastructure, enables a quicker reaction to accidents, reduces traffic and pollution, scan for accidents, and help keep the streets safe overall.

AI and smart surveillance video analytics enable authorities, traffic planners, and highway operators to systematically track the behaviours of road users. Along with this smart security cameras will be able to photograph moving vehicles at high speeds and then use computer vision algorithms to automatically identify the vehicle's license plate, vehicle type, and color which boosts security and work efficiency. And such systems in Nepal facilitate service delivery, city management, and public safety that ensure national security along with its development.

Fig.5. AI-enabled surveillance cameras tracking individual objects and each of their attributes in extremely busy locations



Source: https://www.hanwha.com

Fig.6. Traffic modeling empowered by AI Video Analytics

Source: azena.com, GoodVision LTD

Facial recognition and unusual activity monitoring

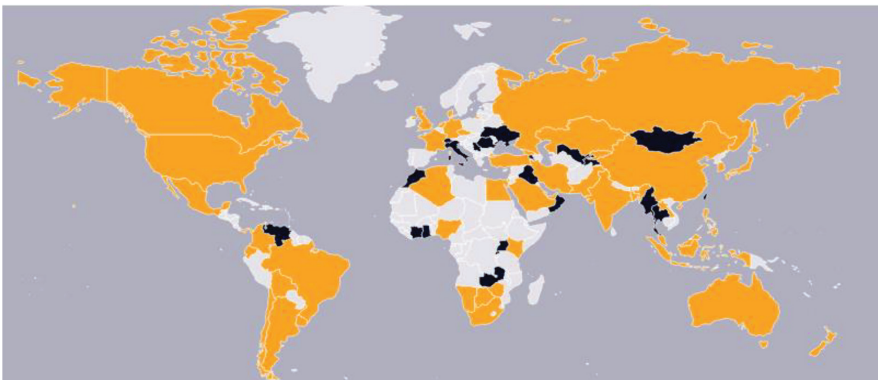
It is seen that one of the most difficult responsibilities for security personnel and systems is tracking and identifying suspicious activity. If a security system fails in a place like an airport, hospital or bank, or other public place, criminals can easily commit antisocial activities resulting in lots of casualties. Such criminal acts are expected to decrease dramatically if a smart camera will be installed in those places that could spot any suspicious activity and automatically call the authorities. Anything you do is fair game for public humiliation and punishment when facial recognition technology is ubiquitous. AI models can also derive patterns associated with certain poses of a person which can be used to estimate whether a particular pose is going to result in something violent or not. If the AI Detects 2 people who are talking to each other and can detect various patterns like clenching fists, frowning forehead, and detect angry facial expressions it can predict up to a great extent that the communication between the 2 people will probably end up in a fist fight.

Furthermore, it detects guns in public places and sends alert messages to all the admin and police stations nearby to get the situation under control. Also in the healthcare sector, security specialists can monitor activities outside the facility as well, such as neighbouring streets, parking, entrances, ambulance bays, or waiting areas for suspicious activity, in addition to keeping an eye on the patients, visitors, staff, and other items inside the facility. Other than that it can be used to assist various enforcement actions like Drug busts by detecting drugs and identifying the drug dealers as well. Addition with facial recognition helps in dealing with heinous crimes, terrorist threats, and human trafficking easily by alerting the authorized person immediately and making predictions about the future crime which is called as smart policing.

Fig.7. Unusual activity monitoring

Source: https://www.anolytics.ai/blog/ai-in-security-cameras-surveillance-solutions/

Fig.8. The yellow parts showing countries having smart policing system



Note: Photo taken from AI Global Surveillance (AIGS) Index

Global Landscape

Since artificial intelligence has become more prevalent, the surveillance and security industry has become a new trend in technology advancement throughout many industry verticals. According to the research, the global AI-powered Surveillance system has been expanding at a faster rate to a wider range of countries. Out of 176, nearly 75 countries globally are using AI surveillance for safe city purposes which includes: smart city/safe city platforms (fifty-six countries), facial recognition systems (sixty-four countries), and smart policing (fifty-two countries) (Feldstein, 2019a). The countries like Brazil, China, India, Mexico, Russia, and United State are actively using AI surveillance for "Smart city". Similarly, highly industrialized countries like Australia, China, and the United States are using smart policing. Furthermore, countries like South Africa, the United States are using facial recognition systems.

Some of the famous surveillance systems used by many countries are Frenchelon, Project 6, PRISM, Titan traffic database, X-Keyscore, SORM, Central Monitoring System, and Skynet.

Fig.9. Artificial intelligence Surveillance system globe

Note: This map shows AI tech surveillance falling between 2017 and 2019. Copyright AIGS index

China plays an important role in global AI surveillance. Chinese police analyze human behaviours to ensure facial recognition cameras capture as much activity as possible. Skynet is the Chinese government's video surveillance system, which it claims is for tracking criminals. Under the project, more than 20 million cameras have been set up in public spaces across the country. It is said to be able to catch a fugitive within minutes. According to state media The "Skynet Project", China's national surveillance system, has more than 20 million cameras deployed in public spaces across the country. Chinese state-run media has claimed Skynet can scan the entire Chinese population in one second with 99.8 percent accuracy, yet such claims ignore glaring technical limitations (Gershgorn, 2021, paras. 11-12). Particularly Huawei, Hikvision, Dahua, and ZTE -- supply AI surveillance technology in 63 countries, 36 of which

have signed onto China's Belt and Road Initiative (Kharpal, 2019, para 4). Developed countries, like the UK, Canada, the UAE, Singapore, Japan, South Korea, and China have introduced their national AI strategy. In China, AI is a Mission Mode Project with clear targets and PPP partnerships. China is aiming to become the world leader in AI by 2030 with the aim of making the industry worth one trillion Yuan (Yavad, 2022, paras 19-20).

However, China is not only the nation on the globe supplying cutting-edge surveillance technology. In 2021, India was ranked 142 out of 180 nations according to the Reporters without borders in World Press Freedom Index. The US, Russia, and, Saudi Arabia are also using AI for surveillance purposes. A total of 32 countries use AI surveillance technology that is provided by US companies. "PRISM": a code name for a program under which the United States National Security Agency collects internet communications from various U.S. internet companies. PRISM gathers saved online communications in response to requests made to internet service providers such as Google LLC. Along with this the "XKeyscore (XKEYSCORE or XKS)": is a formerly classified computer system that was first utilized by the National Security Agency (NSA) of the United States to search and analyze data that it continuously collects from the Internet. The NSA has shared XKeyscore with other intelligence agencies, including the Australian Signals Directorate, Canada's Communications Security Establishment, New Zealand's Government Communications Security Bureau, Britain's Government communications headquarters, Defense Intelligence Headquarters in Japan, and Germany's Bundesnachrichtendienst**.** AIGS index shows that 51% of advanced democracies deploy AI surveillance systems and Out of 65 countries, 47 now have access to Chinese artificial intelligence (AI) surveillance technology as of 2019. Chinese technologies and US technologies have been spreading in many parts of the world at a greater pace. US technology giant Microsoft has teamed up with a Chinese military university to develop artificial intelligence systems that could potentially enhance government surveillance and censorship capabilities (Feldstein, 2019b). AI technology has been enthusiastically adopted by the American police.

Recently, India bagged a couple of top ranks in the Forbes best-of list of shrivelled cities in the globe, where Delhi stood at rank one with about 1,826.6 cameras per square mile beating Chinese cities like Beijing, Wuhan, Xiamen, etc., and London; Chennai at rank three with 609.9 cameras per square miles and Mumbai at rank 18 with 157.4 cameras per square miles. The Delhi government has restarted phase 2 of its CCTV project to install 140,000 CCTVs **(**Goswami**,** 2021, para 2**)**. South Korea already has an aggressive, high-tech contact tracing system that harvests credit card records, cell phone location data, and CCTV footage, among other personal information (Cha, 2021, para 6).

When it comes to Nepal, since it is still in the early stages of development, it has not made such significant progress in implementing an AI Surveillance system but it has been making great progress in installing CCTV for surveillance in many parts of the country along with street sides, traffic monitoring and other public places to identify and capture criminals and litterbug. Authorities have focused on those areas where accidents frequently take place and those in crowded areas as well. According to the 2019 data, there are already more than 3,000 CCTV cameras deployed around the nation, 1,249 of which are in the Valley. It is found that Nepal Police has solved about 18,000 road accident cases through CCTV in Kathmandu.

Furthermore, cases like road accidents, reckless driving, theft, missing persons, sexual or physical abuse, harassment, street brawls, and others are being solved with the help of CCTV. So, we can say that Nepal is just a step behind to make national security and monitoring more reliable and efficient which can be done by implementing Smart Surveillance System. According to Statista.com, the development of AI from 2017 to 2025 is predicted to be 175 percent, with a forecast size of 2.4 billion US dollars. This is regarded as one of the primary driving factors for the worldwide Artificial Intelligence industry.

System Limitation

Although the system overall has plenty of proper advantages over traditional surveillance, there should be a couple of things that should be considered:

- This will hinder the privacy of the people as there will be cameras present everywhere so there might be privacy and human right concern as many of which fall into a murky middle ground.
- In case of false positive alerts (Cases where the machines predict someone as criminal and that zerson turns out to be innocent), a Great number of resources can be wasted on that result.
- If the system itself is not secure enough such that malicious viruses and hackers can hack it then they might do drastic changes to the system and hence cause more harm than good (like removing all the videos incriminating criminals, using deepfake to alter video footage to track our system, convert images of an innocent person to criminal, etc.)
- Need a lot of data for AI to be able to process the faces or objects and so on.
- It requires a huge deal of money and can incur further costs for repair and ongoing maintenance.

Conclusion

The study was designed to map out AI in Surveillance for national peace, security, and development. While doing so, every scope of AI surveillance in security and nation-building was analyzed. It shows how new surveillance capabilities are transforming the ability of governments to monitor and track individuals or systems. The study found out the detail of the Smart Surveillance System that has been powered around the whole world and the system of surveillance practicing in Nepal. It is found that the adaptation of the Smart Surveillance system in Nepal is a bit challenging because of its political, cultural, sociological, and regulatory issues, as well as potential ethical and legal implications and safety constraints along with this collecting a huge volume of data for AI to process the system, create technical difficulties.

Despite of some limitations and challenges in Nepal and other places, the future of safety and security of a nation in the Surveillance sector appears to be a Smart Surveillance System.

Recommendation

So what can be seen from the study is that it is indeed possible to have such a system to even work on country-level scales. The government, security, and Investigation department

should start with something small that may be the security of super important places such as parliament buildings, Airports, and Bus Stations. Recommendations would be explicitly for the government relating to national initiatives, programs, and policies to control AI-powered surveillance systems. There is also a need of explicit rules to address AI misuse, identity theft, infringement of intellectual property rights, and other abuse or impermissible uses of the technology. In the modern age, it is also necessary to redefine the term privacy because the development of the IT sector and the surveillance industry has changed its meaning and the laws controlling it.

The Nepalese government should couple digitalization with a cultural shift. Similarly, the government needs to establish institutional review boards that include ethics, privacy, and technology, policymakers, civil servants, and community representatives and legislators should enact laws and regulations that address how agencies operate, who has the authority to conduct surveillance, how that data is protected and destroyed, and how well personal privacy is protected and. And most importantly there should be a balance between the security interest and civil liberties (freedom, privacy, security). With proper regulation and implementation, the use of a Smart Surveillance System can be a boon for the surveillance and security sector. And this innovation surely provides a new direction for Nepal along with its development.

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