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ADVANCEMENT OF SPACE TECHNOLOGY IN THE REALM OF GLOBAL HEALTH

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Abstract:

Space science with the development of technology has led to innovation of various space-based applications. The outer space is a key domain to space-based applications such as remote sensing, global navigation satellite system and satellite communication. Space technology is the future aspect to address global health issues which can provide vital data and information to improve human health on earth. The United Nations Conference on the Exploration and Peaceful Uses of Outer Space has recognised the use of space technology for improving public health service. Space technology is regarded as a means to achieve Sustainable Development Goal 3 which ensures good health and well-being at every stage of life for all. The World Health Organisation has supported the concern for "Space and Global Health", a resolution adopted by the General Assembly. The paper takes into account the steps undertaken by United Nations to facilitate collaboration of space and global health. It also provides an insight of the various applications of space technology for benefit of global health. The study of this paper is based on secondary sources mainly on United Nations resolutions adopted by General Assembly and reports of United Nations Office for Outer Space Affairs, United Nations Conference on the Exploration and Peaceful Uses of Outer Space, World Health Organisation along with articles relating to space and global health applications. The outcome of the paper is to provide an overview of application of space technology to global health and the prospect to bridge space technology and global health.

Keywords: Space Technology, Global Health, UNISPACE, Remote Sensing, Navigation Satellite System, Satellite Communication.

Introduction:

Space science and technology both are part of science and technology an aspect essential for economic and social development of a nation in the era of globalisation. The dawn of space race marked the evolution of space technology with the establishment of the National Aeronautics and Space Administration by United States in 1958. Space technology itself is an overarching term defined as technology related to the exploration of and activity in space, referring to satellites infrastructure and aerospace industry (Lexico, 2020). The application of space technology paved way into various domains providing vital data and information relating to space exploration, earth observation, weather forecasting, navigation, disaster management, communication and broadcasting. The emerging space race amongst nations led United Nations to establish space-based organisations namely Committee on the Peaceful Uses of Outer Space (COPUOS) and United Nations Office for Outer Space Affairs (UNOOSA) to regulate outer space activities.

The United Nations for the first time in 1960s used space technology to tackle health systems in the field of medical sciences. The United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE) has recognised the use of space technology for improving public health service. The use of space technologies such as remote sensing, global navigation satellite system and satellite communication has been recognised by the Expert Group on Space and Global Health of the United Nations Office for Outer Space Affairs (UNOOSA) as key technological domains in outer space to address issues relating to global health. The application of space technology to global health also assumes importance in the context of the United Nations 2030 Agenda for Sustainable Development Goal 3 which emphasize on Good Health and Well Being.

At the very outset, an overview of the declarations and resolutions taken by the United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE) and other organisations of United Nations with regard to space and global health is given. Thereafter, the key domains of space technologies and its applications to address global health is analysed. It then discussed th the fields of global health benefited by the use of space technology. Finally, it provides an overview of the Space and Global Health Network before proving a conclusion regarding the scope and prospect of the study of this research paper.

Overview of United Nations Manoeuvre for Global Health:

The United Nations Conference on the Exploration and Peaceful Uses of Outer Space, 1962 (UNISPACE) for the first time highlighted the application of space technology to tackle health systems by the United States in 1960s and laid emphasis on the impact of cosmic research on the field of biology and medicine in its session. The UNISPACE II Conference held in 1982 highlighted the application of space technology to assist in providing specialists consultation of medical services in rural areas through satellite and showed the demonstration use of Canadian Anik-B satellite in this regard. The application of space technology in the field of global health again gained importance in the UNISPACE III Conference held in 1999 in its Resolution 1 relating to The Space Millennium: Vienna Declaration on Space and Human Development wherein a declaration was taken to take action for improving public health services through use of space-based applications with the help of telemedicine and for control of infectious diseases.

In 2001, the Action Team on Public Health (Action Team 6) was established by the Committee on the Peaceful Uses of Outer Space (COPUOS) to implement the recommendations of the United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III) held in Vienna from 19th to 30th July, 1999. The Action Team 6 was entrusted the task to implement tele-health in developing countries and for application of space technologies by providing early warning of infectious diseases in order to improve public health services. The Action Team 6 submitted its final report in 2011 to the Scientific and Technical Subcommittee of the Committee on the Peaceful Uses of Outer Space (COPUOS) underlying the significant role of space technology to aid public health services through early warning systems for infectious diseases and health surveillance programmes. The Committee on the Peaceful Uses of Outer Space (COPUOS) in 2014 on the basis of the recommendation of the Scientific and Technical Subcommittee set-up a space and global health expert group to address issues

relating to use of space technology for public health. The Expert Group on Space and Global Health in its first meeting held on 5th February, 2015 proposed a work plan for the next three years along with some of the following recommendations:

- Create a pool of experts in the space and global health interface known as "community of practice"
- Engage international health organisations to discuss global health needs
- Active engagement of the World Health Organization (WHO) to align space solution to global health needs
- Active engagement of the United Nations Office of Outer Space Affairs to guide and support co-operation to foster space benefits for global health
- Linked social issues such as social-psychological acceptance, social value and ethical considerations to determine space solutions for global health
- Other technical considerations for implementing projects relating to space and health

The United Nations Member States in 2015 adopted the 2030 Agenda for Sustainable Development which provided for 17 Sustainable Development Goals (SDGs) out of which SDG 3 laid emphasis for "ensuring health and well being for all, at every stage of life". The application of space technology is the key to achieve this goal by emphasizing on research and development to identify factors responsible for health issues through surveillance and provide health support.

In 2017, the third meeting of the Expert Group on Space and Global Health laid emphasis the fifth thematic priority of the UNISPACE+50 agenda regarding "Strengthened space cooperation for global health" and assigned a Task Group to prepare a road map of space activities related to global health. The fourth meeting of the Expert Group on Space and Global Health held in 2018 recognised the ambit of applications of space technologies and science to global health and the need for single framework "One Health" amongst organisation and actors for promoting awareness and engagement of space science and technology.

The Space2030 Agenda submitted by the Committee on the Peaceful Uses of Outer Space (COPUOS) which was adopted by the General Assembly in 2021 vide Resolution No. 76/3 provided a blue print regarding the use of space activities and space technology as a major tool for achievement of the Sustainable Development Goals which includes Goal 3: Good Health and Well Being. Objective 2.6 of the Space2030 Agenda emphasise upon:

"Strengthen space-related cooperation in support of global health; improve the use and application of space medicine, science and technology, innovations in the global health domain, cooperation and the sharing of information and tools to improve the timeliness and effectiveness of public health and health-care interventions; and enhance capacity-building in space medicine, science and technology."

Applications of Space Technology to access Global Health:

The application of space technology to access vital inputs and data relating to global health has been identified under the following domains:

- Remote Sensing

- Global Navigation Satellite System
- Satellite Communication

Remote Sensing

Remote sensing implies collection of data from a distance with the help of sensors through space-based platforms such as satellites or spacecraft. Remote sensing is defined as gathering information from a distance without making contact with the object observed, similar to how human eyes or camera lens work (Dietrich et al., 2018). Remote sensing involves two methods – passive remote sensing and active remote sensing. Space technology based on remote sensing is equipped with sensors to detect electromagnetic waves which are emitted, reflected or diffracted by the sensed objects which are further studied for mapping (Dunk and Tronchetti, 2015). The use of remote sensing as domain of space technology to assess global health takes into consideration other technologies such as artificial intelligence or Bluetooth to yield more convenient results.

Remote sensing in the field of healthcare is used to monitor and identify the determinants of infectious diseases. Satellite imagery using remote sensing was used in sub-Saharan Africa to track malaria transmission throughout the African regions (Ford et al., 2009). A study of the health geographic information systems (GIS) literature in 2014 revealed that infectious diseases mapping through remote sensing became the focus of 248 out of 865 papers reviewed (Lyseen et al., 2014). The remote sensing technology was applied by Bangladesh to address the outbreak of cholera in order to predict the actual cholera incident rate for constructing an environmental model (Christaki, 2015). Remote sensing was also used to monitor air pollutants and link them to non-communicable diseases such as respiratory diseases, coronary artery diseases, premature birth and low birth weight. Similarly, satellite imagery at the time of pandemic COVID-19 was used for tracking its spread by analysing the interaction of humans with other humans and animals.

Global Navigation Satellite System

A global navigation satellite system (GNSS) is a network of satellites which orbits around the Earth surface transmitting signals to broadcast timing and orbital information used for navigation and positioning measurements. A global navigation satellite system (GNSS) has three primary functions namely position, navigation and timing (PNT). Global navigation satellite system (GNSS) receivers receive and decode signals simultaneously from more than one satellite constellation. The geographic data provided is mapped before transforming it to interactive visual information providing vital data.

Global navigation satellite system (GNSS) plays an important role in tracking and surveillance through spatial analysis by identifying those factors responsible for spreading vector borne diseases and to monitor disease pattern. Global navigation satellite system (GNSS) is often used in epidemiological studies along with geographic information system (GIS) and remote sensing. Global navigation satellite system (GNSS) is the basis for providing data and information relating to communicable diseases and zoonoses. The use of global navigation satellite system (GNSS) to construct random sampling frames for surveys, mapping households and determining population estimates has been reported in various articles. Further, an article

titled "Impacts for medicine of global monitoring" by David Pager has highlighted the future impacts of global positioning system (GPS) devices one type of global navigation satellite system in the field of medicine. Global positioning system (GPS) devices were used in northern Nigeria to track movements of teams of polio vaccination thereby identifying the coverage of low vaccine areas.

The United States developed HealthMap, a healthcare application which uses online informal sources to search data for monitoring outbreaks of disease and performs surveillance in real time by identifying emerging threats to public health (Boulos and Geraghty, 2020). Similarly, BlueDot a firm in Canada also uses global navigation satellite system (GNSS) to surveillance the outbreak of infectious diseases. The technology of global navigation satellite system (GNSS) was also used to report the outbreak of COVID-19 and analyse its impact.

Satellite Communication

Satellite communication is the use of satellites orbiting around the Earth for transferring radio frequency signals from one place to another for the purpose of communication at distant place. The signals are sent via transponder to create a source of communication between transmitter and receiver globally at any place of the Earth. Satellite communication performs its function primarily from Geostationary Earth Orbit (GEO), Medium Earth Orbit (MEO) and Low Earth Orbit (LEO).

Telemedicine technology is the mean through which satellite communication access global healthcare. Telemedicine implies the use of satellite communication in the field of health care where it is not possible to provide onsite medical expertise for varied reasons. Telemedicine is considered as a key source to provide health services in developing countries. Telemedicine through the medium of satellite communication helps to facilitate virtual interactions in real time between medical experts and patients providing access to healthcare services.

Thailand was the first to use telemedicine through its first communication satellite THAICOM in 1993 which connected health care providers (HCPs) in rural areas to medical specialists in urban areas facilitating consultations through videoconferencing. Telemedicine also plays an important role regarding emergency patient transportation regarding transmission of medical history of the patient, vital signs and laboratory examinations which provides crucial information to medical expert for proper treatment. Another aspect of telemedicine is Satellites for Epidemiology (SAFE) which provides health related early warnings to identify and respond to post disaster outbreak of a disease. Medical tele-education is an important component of telemedicine to provide medical education through distance learning. An application of tele-education was reported in Japan where a joint radiology conference connected through satellite was attended by 39 different universities and institutes. The Houston Fire Department in 2014 implemented a project named Emergency Telehealth and Navigation (ETHAN) for efficient emergency care system through the medium of telehealth, social services and alternative transportation for navigating primary care to patients (Langabeer et al., 2016). The application of satellite communication is being experimented through the use of Spot's sensor code for collecting vital information regarding body temperature, respiratory rate, pulse and oxygen levels from a patient which can be a major achievement in the field of global health (Simon,

2020 and Mack, 2020). Telemedicine is a key to health services through the use of 4G and 5G high resolution signals globally.

Discussion:

The role of space technology in the field of medical science can be traced to the early 1960s when activities relating to exploration of outer space was in its initial phase. The United Nations assigned to maintain international peace and security play an important role for formation of the Committee on the Peaceful Uses of Outer Space (COPUOS) and United Nations Office for Outer Space Affairs (UNOOSA) in order to regulate activities of nations relating to outer space exploration. The United Nations Office for Outer Space Affairs (UNOOSA) recognising the potential of space technology with the advancement of science and technology organised various global conferences of which three United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE) amongst others also focused the potential benefits of space technology for mankind in the field of global health. The resolutions and recommendations at the three United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE) relating to use of space technology for global health were implemented by the Committee on the Peaceful Uses of Outer Space (COPUOS) after reviewing the same. It led to workout of action plan with the aegis of World Health Organization (WHO) along with various space agencies worldwide. The role of space technology for advancement of global health also assumes importance in 2030 Agenda for Sustainable Development Goals relating to Good Health and Well Being and also subsequently in the Space2030 Agenda.

The application of space technology to address issues of global health can be access through domain of remote sensing, global navigation satellite system and satellite communication. Remote sensing assumes importance in the context of mapping to study parameters of disease epidemiology and identify determinants of infectious diseases. The geographic information system (GIS) helps to analyse, visual and detect the patterns of infectious diseases to combat outbreak along with planning for disease control. Global Navigation Satellite System provides tracking and surveillance of various communicable diseases though use of global positioning system (GPS). It also helps to locate 'hot spots' and assist to contaminate the spread of vector borne diseases. Satellite communication through the medium of telemedicine and tele education has assisted health cares to provide health services in remote areas by facilitating real-time interactions between medical experts and patients globally. Satellite communication is regarded as key access for exchange of heath care in cases of emergency situations. The ambit of space technology to global health has already been stated in foregoing paragraphs.

Conclusion:

Space science and technology is a boon to access global health. It has been accorded due importance by the United Nations, Committee on the Peaceful Uses of Outer Space (COPUOS), World Health Organization (WHO) and other international bodies. The use of space technology to address global heath issues has been the subject of importance in various international conferences. The matter assumes importance in light of achievement of 2030 Agenda for Sustainable Development Goals.

The innovative research of space science combine with technology has foster overall development of health care which is essential for betterment of global health. Space technology has led to innovative research to facilitate surveillance and monitor of outbreak of diseases by providing early warnings. It has assisted in the field of epidemic disaster management. Space technology has provided the platform for mapping, geospatial information, telemedicine and tele education which are essential for betterment of mankind in terms of global health.

The innovation of space technology has no bounds as what at one point of time was unpredictable or imaginary has become the fruits of human exploration. There is a long way forward and steps be taken to build a system of network taking new ventures of space policy, science and technology for development of global health. Further, there is a need to bridge the technological aspect of space science and medical science into one domain for better knowledge and management of global health. To conclude, there is further scope of research in the field of space technology and global health.

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Conflict of Interest:

No.

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