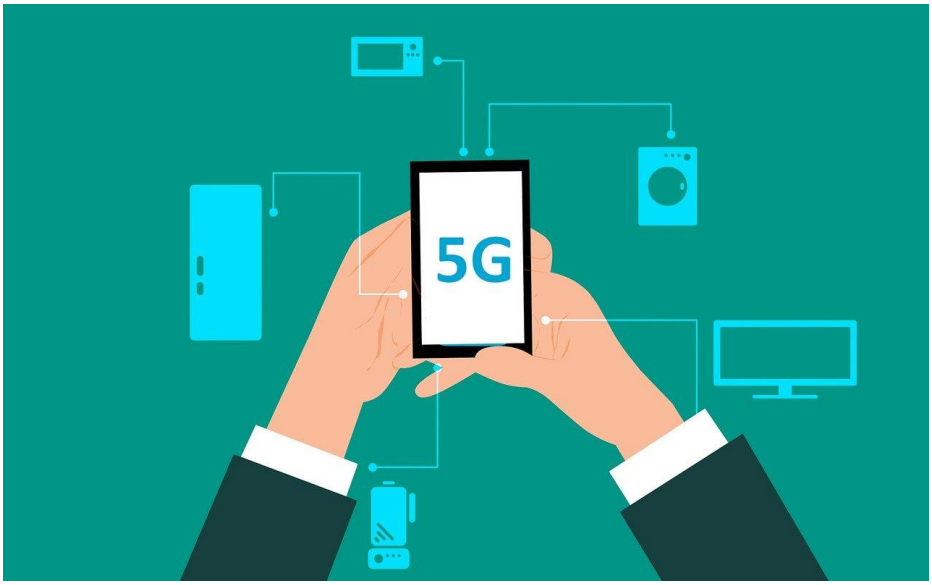
TECHNOLOGIE 5G

Bulletin de veille scientifique : Août 2024



Objectifs : réaliser une veille scientifique sur la technologie 5G

La validation des informations fournies (exactitude, fiabilité, pertinence par rapport aux principes de prévention, etc.) est du ressort des auteurs des articles signalés dans la veille. Les informations ne sont pas le reflet de la position de l'INRS. Les éléments issus de cette veille sont founis sans garantie d'exhaustivité. Les liens mentionnés dans le bulletin donnent accès aux documents sous réserve d'un abonnement à la ressource.

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Généralités

Commentary: Understanding the public voices and researchers speaking into the 5G narrative.

de Vocht F, Albers P. *Front Public Health*. 2024;12:1461515.

Lien vers l'article

Performances et sécurité

Aucun article dans ce bulletin.

Antennes

Aucun article dans ce bulletin.

Architecture réseau

LLM-Twin: mini-giant model-driven beyond 5G digital twin networking framework with semantic secure communication and computation.

Hong Y, Wu J, Morello R. *Sci Rep*. 2024 Aug 17;14(1):19065.

Beyond 5G networks provide solutions for next-generation communications, especially digital twins networks (DTNs) have gained increasing popularity for bridging physical and digital space. However, current DTNs pose some challenges, especially when applied to scenarios that require efficient and multimodal data processing. Firstly, current DTNs are limited in communication and computational efficiency, since they require to transmit large amounts of raw data collected from physical sensors, as well as to ensure model synchronization through high-frequency computation. Second, current models of DTNs are domain-specific (e.g. E-health), making it difficult to handle DT scenarios with multimodal data processing requirements. Finally, current security schemes for DTNs introduce additional overheads that impair the efficiency. Against the above challenges, we propose a large language model (LLM) empowered DTNs framework, LLM-Twin. First, based on LLM, we propose digital twin semantic networks (DTSNs), which enable more efficient communication and computation. Second, we design a mini-giant model collaboration scheme, which enables efficient deployment of LLM in DTNs and is adapted to handle multimodal data. Then, we designed a native security policy for LLM-twin without compromising efficiency. Numerical experiments and case studies demonstrate the feasibility of LLM-Twin. To our knowledge, this is the first to propose an LLM-based semantic-level DTNs.

Lien vers l'article

Slice-aware 5G network orchestration framework based on dual-slice isolation and management strategy (D-SIMS).

Venkatapathy S, Srinivasan T, Lee OS, Jayaraman R, Jo HG, Ra IH. *Sci Rep*. 2024 Aug 11;14(1):18623.

Network slicing is crucial to the 5G architecture because it enables the virtualization of network resources into a logical network. Network slices are created, isolated, and managed using software-defined networking (SDN) and network function virtualization (NFV). The virtual network function

(VNF) manager must devise strategies for all stages of network slicing to ensure optimal allocation of physical infrastructure (PI) resources to high-acceptance virtual service requests (VSRs). This paper investigates two independent network slicing frameworks named as dual-slice isolation and management strategy (D-SIMS) and recommends the best of the two based on performance measurements. D-SIMS places VNFs for network slicing using self-sustained resource reservation (SSRR) and master-sliced resource reservation (MSRR), with some flexibility for the VNF manager to choose between them based on the degree to which the underlying physical infrastructure has been sliced. The present research work consists of two phases: the first deals with the creation of slices, and the second with determining the most efficient way to distribute resources among them. A deep neural network (DNN) technique is used in the first stage to generate slices for both PI and VSR. Then, in the second stage, we propose D-SIMS for resource allocation, which uses both the fuzzy-PROMETHEE method for node mapping and Dijkstra's algorithm for link mapping. During the slice creation phase, the proposed DNN training method's classification performance is evaluated using accuracy, precision, recall, and F1 score measures. To assess the success of resource allocation, metrics such as acceptance rate and resource effectiveness are used. The performance benefit is investigated under various network conditions and VSRs. Finally, to demonstrate the importance of the proposed work, we compare the simulation results to those in the academic literature.

Lien vers l'article

Handover for V2V communication in 5G using convolutional neural networks.

Alhammad SM, Khafaga DS, Elsayed MM, Khashaba MM, Hosny KM. *Heliyon*. 2024 Aug 15;10(15):e35269.

Vehicle communication is one of the most vital aspects of modern transportation systems because it enables real-time data transmission between vehicles and infrastructure to improve traffic flow and road safety. The next generation of mobile technology, 5G, was created to address earlier generations' growing need for high data rates and quality of service issues. 5G cellular technology aims to eliminate penetration loss by segregating outside and inside settings and allowing extremely high transmission speeds, achieved by installing hundreds of dispersed antenna arrays using a distributed antenna system (DAS). Huge multiple-input multiple-output (MIMO) systems are accomplished via DASs and huge MIMO systems, where hundreds of dispersed antenna arrays are built. Because deep learning (DL) techniques employ artificial neural networks with at least one hidden layer, they are used in this study for vehicle recognition. They can swiftly process vast quantities of labeled training data to identify features. Therefore, this paper employed the VGG19 DL model through transfer learning to address the task of vehicle detection and obstacle identification. It also proposes a novel horizontal handover prediction method based on channel characteristics. The suggested techniques are designed for heterogeneous networks or horizontal handovers using DL. In the designated surrounding regions of 5G environments, the suggested detection and handover algorithms identified vehicles with a success rate of 97 % and predicted the next station for handover.

Lien vers l'article

Efficacité énergétique

Aucun article dans ce bulletin.

Autres équipements

Aucun article dans ce bulletin.

Applications médicales et industrielles de la 5G

Applications industrielles

Aucun article dans ce bulletin.

Applications médicales

Remote Monitoring, AI, Machine Learning and Mobile Ultrasound Integration upon 5G Internet in the Prehospital Care to Support the Golden Hour Principle and Optimize Outcomes in Severe Trauma and Emergency Surgery.

Mammas CS, Mamma AS. *Stud Health Technol Inform*. 2024 Aug 22;316:1807-11.

AIM: Feasibility and reliability evaluation of 5G internet networks (5G IN) upon Artificial Intelligence (AI)/Machine Learning (ML), of telemonitoring and mobile ultrasound (m u/s) in an ambulance car (AC)- integrated in the pre-hospital setting (PS)- to support the Golden Hour Principle (GHP) and optimize outcomes in severe trauma (TRS). MATERIAL AND METHODS: (PS) organization and care upon (5G IN) high bandwidths (10 GB/s) mobile tele-communication (mTC) experimentation by using the experimental Cobot PROMETHEUS III, pn:100016 by simulation upon six severe trauma clinical cases by ten (N1=10) experts: Four professional rescuers (n1=4), three trauma surgeons (n2=3), a radiologist (n3=1) and two information technology specialists (n4=2) to evaluate feasibility, reliability and clinical usability for instant risk, prognosis and triage computation, decision support and treatment planning by (AI)/(ML) computations in (PS) of (TRS) as well as by performing (PS) (m u/s). RESULTS: A. Trauma severity scales instant computations by the Cobot PROMETHEUS III, pn 100016)) based on AI and ML complex algorithms and Cloud Computing, telemonitoring and r showed very high feasibility and reliability upon (5GIN) under specific, technological, training and ergonomic prerequisites B. Measured be-directional (m u/s) images data sharing between (AC) and (ED/TC) showed very high feasibility and reliability upon (5G IN) under specific, technological and ergonomic conditions in (TRS). CONCLUSION: Integration of (PS) tele-monitoring with (AI)/(ML) and (PS) (m u/s) upon (5GIN) via the Cobot PROMETHEUS III, (pn 100016) in severe (TRS/ES), seems feasible and under specific prerequisites reliable to support the (GHP) and optimize outcomes in adult and pediatric (TRS/ES).

Lien vers l'article

5G Key Technologies for Helicopter Aviation Medical Rescue.

Han W, Sr., Li Nd Y, Chen Rd C, Huang D, Wang J, Li X, et al. *J Med Internet Res*. 2024 Aug 1;26:e50355.

Rapid global population growth and urbanization have heightened the demand for emergency medical rescue, with helicopter medical rescue emerging as an effective solution. The advent of 5G communication technology, characterized by large bandwidth, low latency, and high reliability, offers substantial promise in enhancing the efficiency and quality of helicopter rescue operations. However, the full integration of 5G technology into helicopter emergency medical services is still in its nascent stages and requires further development. In this viewpoint, we present our experience from the Shenzhen University General Hospital of the application of 5G low-altitude network communication

technology, body area network disease sensing technology, and 5G air-ground collaborative rapid diagnosis and treatment technology in aeromedical rescue. We consider that the 5G air-to-ground collaborative rapid diagnosis and treatment technology enables high-quality remote consultation, enhancing emergency medical rescue and providing strong support for future rescue operations.

Lien vers l'article

Evaluation (Mesure des niveaux d'exposition)

Méthodes d'évaluation

Aucun article dans ce bulletin.

Evaluation population générale

Aucun article dans ce bulletin.

Risques professionnels

Aucun article dans ce bulletin.

In silico

Aucun article dans ce bulletin.

In vitro

Study of genotoxic and cytotoxic effects induced in human fibroblasts by exposure to pulsed and continuous 1.6 GHz radiofrequency.

Massaro L, De Sanctis S, Franchini V, Regalbuto E, Alfano G, Focaccetti C, et al. *Front Public Health*. 2024;12:1419525.

BACKGROUND: The widespread use of radiofrequency (RF) sources, ranging from household appliances to telecommunications devices and military equipment, raises concerns among people and regulatory agencies about the potential health risks of RF exposure. Consequently, several in vitro and in vivo studies have been done to investigate the biological effects, in particular non-thermal, of this non-ionizing radiation. To date, this issue is still being debated due to the controversial results that have been reported. Furthermore, the impact of different RF signal modulations on biological systems remains poorly investigated. The present in vitro study aims to evaluate the cytotoxicity and genotoxicity of continuous or pulsed 1.6 GHz RF in human dermal fibroblasts (HDF). METHODS: HDF cultures were exposed to continuous and pulsed 1.6 GHz RF, for 2 h, with Specific Absorption Rate (SAR) of 0.4 W/kg. The potential biological effects of 1.6 GHz RF on HDF were assessed with a multi-methodological approach, analyzing the effects on cell cycle, ultrastructure, protein expression, mitotic spindle, CREST stained micronuclei, chromosome segregation and γ-H2AX/53BP1 foci. RESULTS: 1.6 GHz RF exposure modified proteins expression and morphology of HDF. Specifically, the expression of different heat-shock proteins (HSP) (i.e., HSP-90, HSP-60, and HSP-25) and phospho-AKT were affected. In addition, both continuous and pulsed RF modified the cytoskeletal organization in HDF and increased the number of lysosomes, while the formation of autophagosomes was observed only after pulsed RF exposure. Mitotic spindle anomalies were also found after exposure. However, no significant effect was observed on cell cycle, chromosome segregation, CREST-stained micronuclei and γ-H2AX/53BP1 foci. CONCLUSION: The results of the present study show the absence of genotoxic damage in 1.6 GHz RF exposed HDF and, although mitotic spindle alterations were observed, they did not have an aneugenic effect. On the other hand, changes in some proteins expression and cell ultrastructure in exposed HDF suggest that RF can potentially induce cell alterations at the morphological and molecular levels.

Lien vers l'article

Thermal and Nonthermal Effects of 5 G Radio-Waves on Human's Tissue.

Jazyah YH. *ScientificWorldJournal*. 2024;2024:3801604.

The deployment of 5 G wireless technology has generated considerable interest and debate regarding its potential effects on human health. This work provides a comprehensive overview of the current

scientific understanding of the potential health implications associated with 5 G technology. Drawing upon a wide range of research studies, reviews, and expert opinions, we explore the implications through which 5 G signals interact with the human body. This work presents a balanced perspective, summarizing both the potential benefits of 5 G technology, such as improved data transfer speeds, reduced latency, and enhanced connectivity, as well as concerns that have been raised about its effects on human's tissues. We discuss various aspects of health impacts, including thermal and nonthermal effects, focusing on the existing research on radiofrequency electromagnetic fields and their potential to cause adverse health outcomes. Simulation results show the negative effect of radio waves on human's tissues.

Lien vers l'article

Sur l'animal

Aucun article dans ce bulletin.

Sur l'homme

Aucun article dans ce bulletin.

Reproduction

The effects of radiofrequency exposure on male fertility: A systematic review of human observational studies with dose-response meta-analysis.

Pw Kenny R, Evelynne Johnson E, Adesanya AM, Richmond C, Beyer F, Calderon C, et al. *Environ Int*. 2024 Aug;190:108817.

BACKGROUND: The World Health Organization (WHO) is bringing together evidence on radiofrequency electromagnetic field (RF-EMF) exposure in relation to health outcomes, previously identified as priorities for research and evaluation by experts in the field, to inform exposure guidelines. A suite of systematic reviews have been undertaken by a network of topic experts and methodologists to collect, assess and synthesise data relevant to these guidelines. Following the WHO handbook for guideline development and the COSTER conduct guidelines, we systematically reviewed the evidence on the potential effects of RF-EMF exposure on male fertility in human observational studies. METHODS: We conducted a broad and sensitive search for potentially relevant records within the following bibliographic databases: MEDLINE; Embase; Web of Science and EMF Portal. We also conducted searches of grey literature through relevant databases including OpenGrey, and organisational websites and consulted RF-EMF experts. We hand searched reference lists of included study records and for citations of these studies. We included quantitative human observational studies on the effect of RF-EMF exposure in adult male participants on infertility: sperm concentration; sperm morphology; sperm total motility; sperm progressive motility; total sperm count; and time to pregnancy. Titles and abstracts followed by full texts were screened in blinded duplicate against pre-set eligibility criteria with consensus input from a third reviewer as required. Data extraction from included studies was completed by two reviewers, as was risk of bias assessment using the Office of Health Assessment and Translation (OHAT) tool. We conducted a dose-response meta-analysis as possible and appropriate. Certainty of the evidence was assessed by two reviewers using the OHAT GRADE tool with input from a third reviewer as required. RESULTS: We identified nine studies in this review; seven were general public studies (with the general public as the population of interest) and two were occupational studies (with specific workers/workforces as the population of interest). General public studies. Duration of phone use: The evidence is very uncertain surrounding the effects of RF-EMF on sperm concentration (10/6 mL) (MD (mean difference) per hour of daily phone use 1.6 10(6)/mL, 95 % CI -1.7 to 4.9; 3 studies), sperm morphology (MD 0.15 percentage points of deviation of normal forms per hour, 95 % CI -0.21 to 0.51; 3 studies), sperm progressive motility (MD -0.46 percentage points per hour, 95 % CI -1.04 to 0.13; 2 studies) and total sperm count (MD per hour -0.44 10(6)/ejaculate, 95 % CI -2.59 to 1.7; 2 studies) due to very low-certainty evidence. Four additional studies reported on the effect of mobile phone use on sperm motility but were unsuitable for pooling; only one of these studies identified a statistically significant effect. All four studies were at risk of exposure characterisation and selection bias; two of confounding, selective reporting and attrition bias; three of outcome assessment bias and one used an inappropriate statistical method. Position of phone: There may be no or little effect of carrying a mobile phone in the front pocket on sperm concentration, total count, morphology, progressive motility or on time to pregnancy. Of three studies reporting on the effect of mobile phone location on sperm total motility and, or, total motile count, one showed a statistically significant effect. All three studies were at risk of exposure characterisation and selection bias; two of confounding, selective reporting and attrition bias; three of outcome assessment bias and one used inappropriate statistical method. RF-EMF Source: One study indicates there may be little or no effect of computer or other electric device use on sperm concentration, total motility or total count. This study is at probably high risk of exposure characterisation bias and outcome assessment bias. Occupational studies. With only two studies of occupational exposure to RF-EMF and heterogeneity in the population and exposure source (technicians exposed to microwaves or seamen exposed to radar equipment), it was not plausible to statistically pool findings. One study was at probably or definitely high risk of bias

across all domains, the other across domains for exposure characterisation bias, outcome assessment bias and confounding. DISCUSSION: The majority of evidence identified was assessing localised RF-EMF exposure from mobile phone use on male fertility with few studies assessing the impact of phone position. Overall, the evidence identified is very uncertain about the effect of RF-EMF exposure from mobile phones on sperm outcomes. One study assessed the impact of other RF-EMF sources on male fertility amongst the general public and two studies assessed the impact of RF-EMF exposure in occupational cohorts from different sources (radar or microwave) on male fertility. Further prospective studies conducted with greater rigour (in particular, improved accuracy of exposure measurement and appropriate statistical method use) would build the existing evidence base and are required to have greater certainty in any potential effects of RF-EMF on male reproductive outcomes. Prospero Registration: CRD42021265401 (SR3A).

Lien vers l'article

The effects of radiofrequency exposure on adverse female reproductive outcomes: A systematic review of human observational studies with dose-response meta-analysis.

Johnson EE, Kenny RPW, Adesanya AM, Richmond C, Beyer F, Calderon C, et al. *Environ Int*. 2024 Aug;190:108816.

BACKGROUND: To inform radiofrequency electromagnetic field (RF-EMF) exposure guidelines the World Health Organization (WHO) is bringing together evidence on RF-EMF in relation to health outcomes prioritised for evaluation by experts in this field. Given this, a network of topic experts and methodologists have conducted a series of systematic reviews collecting, assessing, and synthesising data of relevance to these guidelines. Here we present a systematic review of the effect of RF-EMF exposure on adverse pregnancy outcomes in human observational studies which follows the WHO handbook for guideline development and the COSTER conduct guidelines. METHODS: We conducted a broad, sensitive search for potentially relevant records within the following bibliographic databases: MEDLINE; Embase; and the EMF Portal. Grey literature searches were also conducted through relevant databases (including OpenGrey), organisational websites and via consultation of RF-EMF experts. We included quantitative human observational studies on the effect of RF-EMF exposure in adults' preconception or pregnant women on pre-term birth, small for gestational age (SGA; associated with intrauterine growth restriction), miscarriage, stillbirth, low birth weight (LBW) and congenital anomalies. In blinded duplicate, titles and abstracts then full texts were screened against eligibility criteria. A third reviewer gave input when consensus was not reached. Citation chaining of included studies was completed. Two reviewers' data extracted and assessed included studies for risk of bias using the Office of Health Assessment and Translation (OHAT) tool. Random effects meta-analyses of the highest versus the lowest exposures and dose-response meta-analysis were conducted as appropriate and plausible. Two reviewers assessed the certainty in each body of evidence using the OHAT GRADE tool. RESULTS: We identified 18 studies in this review; eight were general public studies (with the general public as the population of interest) and 10 were occupational studies (with the population of interest specific workers/workforces). General public studies. From pairwise meta-analyses of general public studies, the evidence is very uncertain about the effects of RF-EMF from mobile phone exposure on preterm birth risk (relative risk (RR) 1.14, 95% confidence interval (CI): 0.97-1.34, 95% prediction interval (PI): 0.83-1.57; 4 studies), LBW (RR 1.14, 95% CI: 0.96-1.36, 95% PI: 0.84-1.57; 4 studies) or SGA (RR 1.13, 95% CI: 1.02-1.24, 95% PI: 0.99-1.28; 2 studies) due to very low-certainty evidence. It was not feasible to meta-analyse studies reporting on the effect of RF-EMF from mobile phone exposure on congenital anomalies or miscarriage risk. The reported effects from the studies assessing these outcomes varied and the studies were at some risk of bias. No studies of the general public assessed the impact of RF-EMF exposure on stillbirth. Occupational studies. In occupational studies, based on dose-response meta-analyses, the evidence is very uncertain about the

effects of RF-EMF amongst female physiotherapists using shortwave diathermy on miscarriage due to very low-certainty evidence (OR 1.02 95% CI 0.94-1.1; 2 studies). Amongst offspring of female physiotherapists using shortwave diathermy, the evidence is very uncertain about the effects of RF-EMF on the risk of congenital malformations due to very low-certainty evidence (OR 1.4, 95% CI 0.85 to 2.32; 2 studies). From pairwise meta-analyses, the evidence is very uncertain about the effects of RF-EMF on the risk of miscarriage (RR 1.06, 95% CI 0.96 to 1.18; very low-certainty evidence), pre-term births (RR 1.19, 95% CI 0.32 to 4.37; 3 studies; very low-certainty evidence), and low birth weight (RR 2.90, 95% CI: 0.69 to 12.23; 3 studies; very low-certainty evidence). Results for stillbirth and SGA could not be pooled in meta-analyses. The results from the studies reporting these outcomes were inconsistent and the studies were at some risk of bias. DISCUSSION: Most of the evidence identified in this review was from general public studies assessing localised RF-EMF exposure from mobile phone use on female reproductive outcomes. In occupational settings, each study was of heterogenous whole-body RF-EMF exposure from radar, short or microwave diathermy, surveillance and welding equipment and its effect on female reproductive outcomes. Overall, the body of evidence is very uncertain about the effect of RF-EMF exposure on female reproductive outcomes. Further prospective studies conducted with greater rigour (particularly improved accuracy of exposure measurement and using appropriate statistical methods) are required to identify any potential effects of RF-EMF exposure on female reproductive outcomes of interest.

https://doi.org/10.1016/j.envint.2024.108816

Dispositifs médicaux implantables

Aucun article dans ce bulletin.