Data Set Information Sheet: On the Reduction of Uplink Electromagnetic Field Exposure Using Reflecting Intelligent Surfaces: An Experimental Validation

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GENERAL INFORMATION

Title of Dataset

On the Reduction of Uplink Electromagnetic Field Exposure Using Reflecting Intelligent Surfaces: An Experimental Validation

Author Information

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Date of data collection:

The data was collected over first two weeks of July 2022.

Geographic location of data collection:

MAST Lab, James Watt South Building, Glasgow, G12 8QQ, United Kingdom

Information about funding sources that supported the collection of the data:

This work was supported in parts by Engineering and Physical Sciences Research Council (EPSRC) grants: EP/T021020/1 and EP/T021063/1, and ICRG PAK-UK Education Gateway (2020) funded Project No. 310366.SHARING/ACCESS INFORMATION

Licenses/restrictions placed on the data:

NA

Links to other publicly accessible locations of the data:

NA

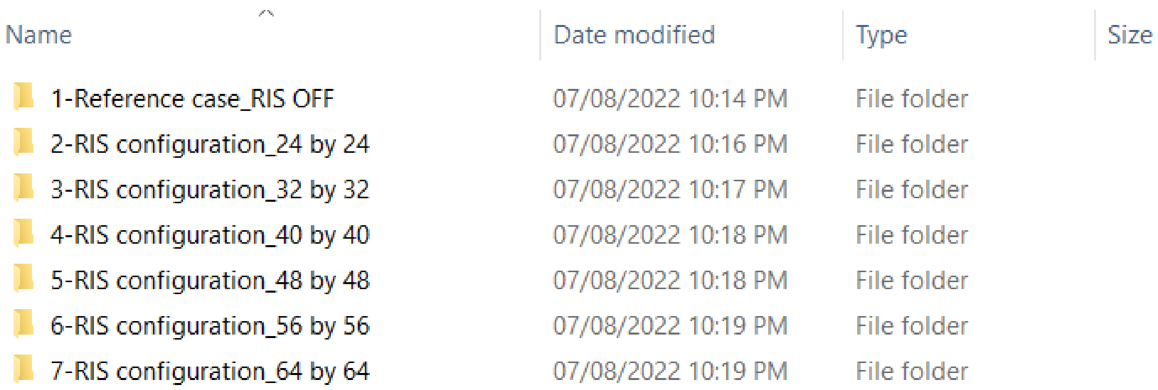
Was data derived from another source?

No

DATA & FILE OVERVIEW

Details of Data Folders and Files

The main data folder is subdivided into 7 folders, corresponding to the data for different RIS configurations, each configuration with 120 samples (see Figure 1 and Table 1).



Name	Date modified	Type	Size
1-Reference case_RIS OFF	07/08/2022 10:14 PM	File folder	
2-RIS configuration_24 by 24	07/08/2022 10:16 PM	File folder	
3-RIS configuration_32 by 32	07/08/2022 10:17 PM	File folder	
4-RIS configuration_40 by 40	07/08/2022 10:18 PM	File folder	
5-RIS configuration_48 by 48	07/08/2022 10:18 PM	File folder	
6-RIS configuration_56 by 56	07/08/2022 10:19 PM	File folder	
7-RIS configuration_64 by 64	07/08/2022 10:19 PM	File folder	

Figure 1 Data folder Structure

Table 1 Details of the Data Set (Folders, Files, Description, and Number of Samples)

No. of Subjects	Folder Name	Class/File Name	Description	Number of Samples per Class
1	1-Reference case RIS OFF	RIS off reference power	Reference sensed power when RIS is off	120
2	2-RIS configuration_24 × 24	RIS 24 × 24 Configuration	Power sensed for 24×24 RIS size	120
3	3-RIS configuration_32 × 32	RIS 32 × 32 configuration	Power sensed for 32×32 RIS size	120
4	4- RIS configuration_40 × 40	RIS 40 × 40 configuration	Power sensed for 40×40 RIS size	120
5	5- RIS configuration_48 × 48	RIS 48 × 48 configuration	Power sensed for 48×48 RIS size	120
6	6- RIS configuration_56 × 56	RIS 56 × 56 configuration	Power sensed for 56×56 RIS size	120
7	7- RIS configuration_64 × 64	RIS 64 × 64 configuration	Power sensed for 64×64 RIS size	120

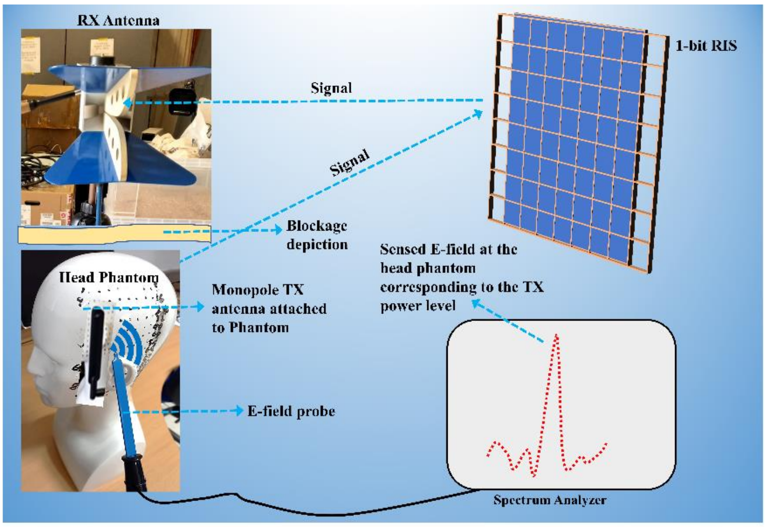


Figure 2. *Conceptual schematic figure of the proposed methodology.*

METHODOLOGICAL INFORMATION

Description of methods used for collection/generation of data:

The dataset represents the measured values of power captured during uplink transmission by an E-field probe near a head phantom model to evaluate Specific Absorption Rate (SAR) in the presence of a Reconfigurable Intelligent Surface (RIS). A combination of different configurations (effective unit cells which are switched on) of RIS. The head phantom was marked with 120 different positions. For each RIS configuration, 120 measurements were recorded to measure sensed power at a head phantom model using an E-field probe. TEKBOX electromagnetic compatibility (EMC) near field probe (Model TBPS01) was used to perform SAR/EMF exposure measurements. This model consists of three H-field probes and an E-field probe. In this work, only an E-field probe is used to measure the near-field effects in transmission mode. The probes work like wide-band antennas, picking up radiated emissions from the proximity of the phantom. A conceptual block diagram of the measurement setup on the transmitter side is depicted in Figure 2. The measurements were taken with the antenna connected to the phantom in transmission mode. The setup comprises a head phantom model, E-field probe, SMB to SMA cable, spectrum analyzer, transmitter (Tx) and receiver (Rx) antenna, USRP, and a 1-bit RIS operating at 3.85 GHz.

A standard monopole antenna was attached to the head side of Phantom. The E-field probe was positioned in close proximity to the phantom. The output of the probe was attached to a spectrum analyzer to detect the resultant power. When the probe is scanned near the phantom, it detects the magnitude of the E-field at 3.85 GHz. The E-field was sampled in a grid of 120 points, arranged over an area of 9 cm $\times$ 16 cm, and positioned such that the monopole is at the centre of the grid. The Tx consists of a laptop computer and a USRP X300 software radio connected to a monopole antenna attached to the phantom at the ear, emulating the uplink of a mobile user. The Rx consists of a standard gain horn antenna connected to a USRP X300 and laptop computer. The RIS is positioned such that it is 6 meters broadside from the receiver and 8 meters, 45 degrees relative to the transmitter at the phantom. The combination of the directivity of the Rx horn antenna and the adjacent partition wall forms a significant blockage of the line-of-sight (LoS) link between the two end terminals. On the optimization of the reflection response of the RIS, a virtual LoS link is established, thus greatly improving the reception.

Methods for processing the data:

Firstly, transmitter and receiver antennas were placed in a position as shown in Figure 3. The RIS was switched off, and the reference received power level was recorded. Then, when the whole RIS is switched on, the resulting baseband received power for the 64 $\times$ 64 case with a transmit gain of 5 dB

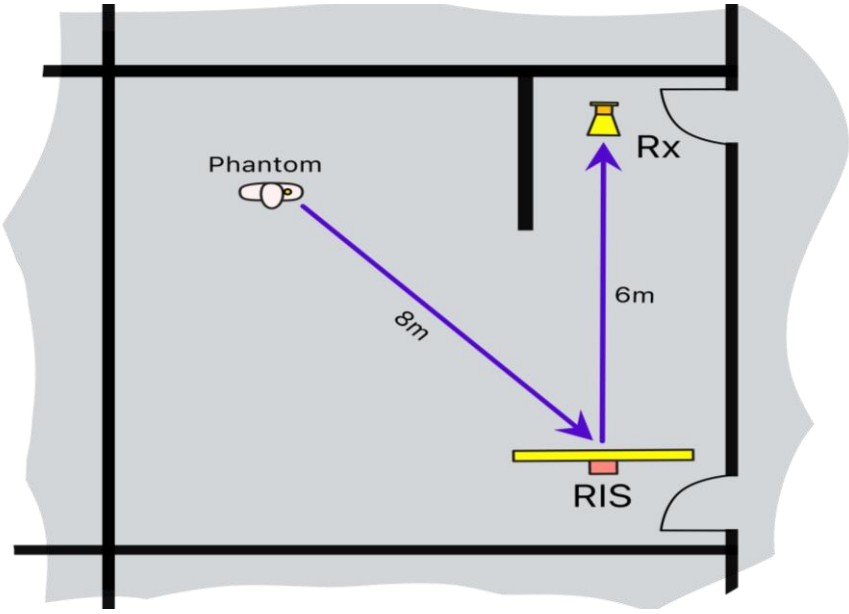


Figure 3. Schematic diagram showing the setting to obtain received power level using RIS.

was -60.7 dBm. Without the RIS, it was necessary to increase the transmitter gain by 14.2 dB to achieve this same power level. Since practically the gain of a transmitter or receiver antenna is fixed, thus this higher value of gain (in the absence of RIS) has to be compensated by increasing the transmit power, which would in turn directly increase the SAR and EM exposure. It is this ability for the RIS deployment to enable a lower transmit power to achieve the same received power, that is explored here. For each RIS effective size, the RIS was optimised, whilst the transmit gain setting was kept at 5 dB. The transmitter gain was increased such that the -60.7 dBm power level was achieved. This was followed by measuring the E-field magnitude on the surface of the phantom for the given transmit power level.

After the received powers were obtained (Figure 4), the uplink transmission was made for different RIS configurations and the E-field value ($|E|^2$=power) was measured using the probe on the head

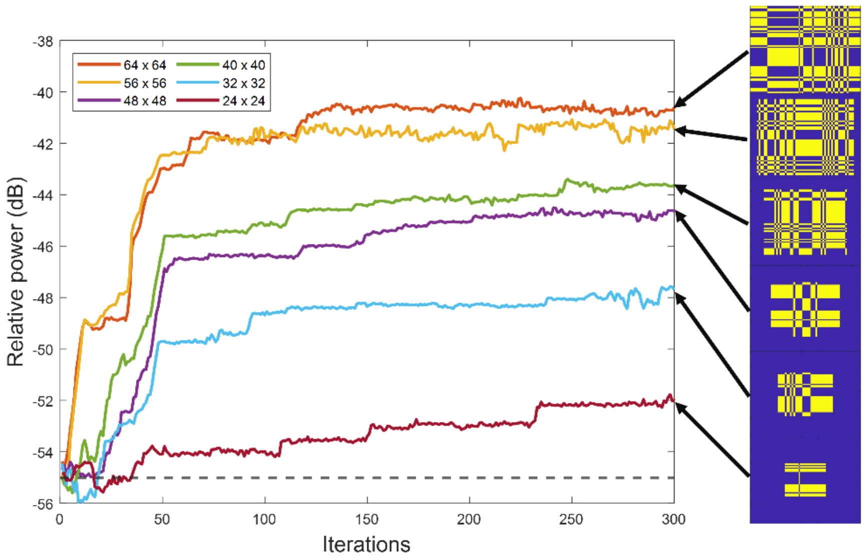


***Figure 4**. Received power levels obtained for various RIS configurations as well as the reference case.*

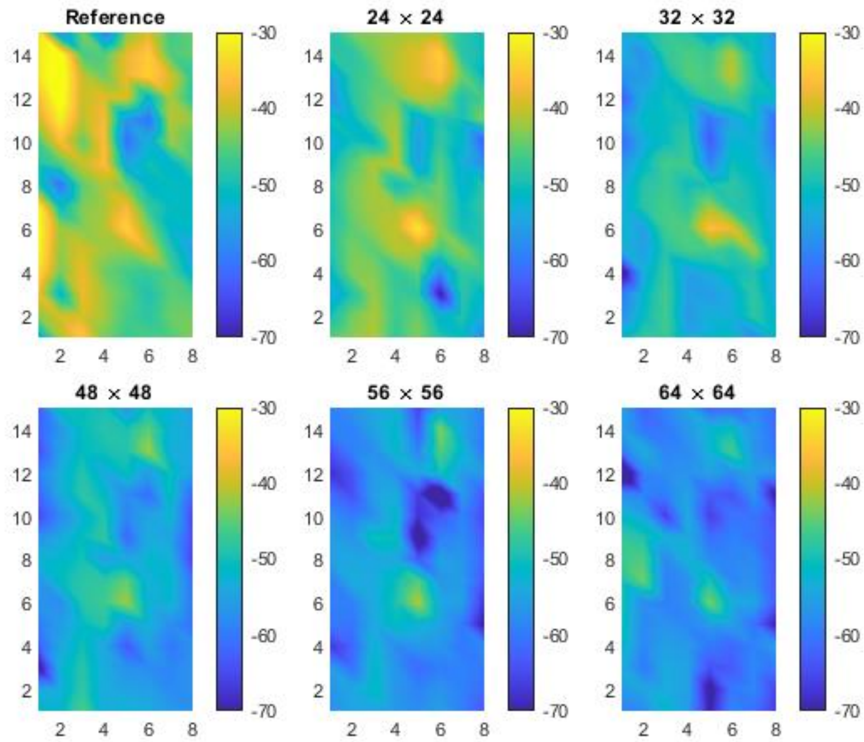


Figure 5. *Heat map showing power levels experienced at head phantom during uplink RIS-aided communication.*

phantom. The resultant sensed power levels were recorded in the form of heat maps as shown in Figure 5. In the case of full RIS configuration, the analyzed power level and thus the SAR was found to be the lowest.

Instrument- or software-specific information needed to interpret the data:

Data files are all in ".csv" format which could be opened using Microsoft Excel and further processed using Matlab.