ABSTRACTS (MASTER THESIS)

Study on high efficiency wireless power transfer method for the In-Line Inspection robot

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Gas pipelines are important infrastructures, and it is necessary to conduct inspection of the pipes. In-Line Inspection (ILI) robots had been invented for this inspection. These robots are currently driven with batteries, and thus the robots cannot move more than 1km. This limitation can be removed with wireless power transfer system using microwave (Fig.1). Since gas pipes are made of steel, pipes can be regarded as circular waveguide, and microwave can propagate through the pipe with less attenuation. At first, we conducted power transmission experiments in a gas pipe using a microstrip antenna as a transmitting antenna and a dipole antenna as a receiving antenna (Fig.2). Our attempt to calculate attenuation rate from decrease of receiving power failed because of mixed mode. Therefore, we designed a transmitting antenna which only generates TE_{01} mode. Receiving antenna with high receiving efficiency for all propagation mode including TE_{01} mode was also designed. Using these antennas, we achieved 55 % transmission efficiency in experiments (Fig.3). From the experiment, attenuation rate of TE_{01} mode was calculated as 11.9dB/km. Furthermore, we estimated conductivity of the pipe from the attenuation rate. We assumed the conductivity as 1.0×10^7 S/m. However, the actual conductivity is 1.9×10^6 S/m, which is lower than we assumed, and this is due to rust and scratches on the pipe. Next we designed a receiving antenna which fits the ILI robot. When designing this antenna, we considered degradation of antenna characteristics when placed in a gas pipe. Transmission efficiency with this antenna was 48%. Decrease in the efficiency was due to the antenna being tilted. With attenuation rate and receiving efficiency that we obtained from our experiments, we can calculate transmission efficiency at any distance. For further research, we have to design rectifier circuit to convert microwave power to DC power.

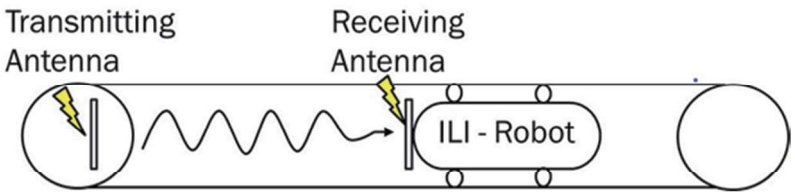

Fig.1. Microwave power transfer system for robot in gas pipe

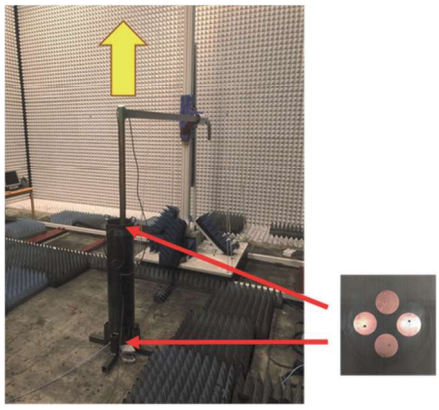

Fig.2. Experimental setup of MPT in gas pipe

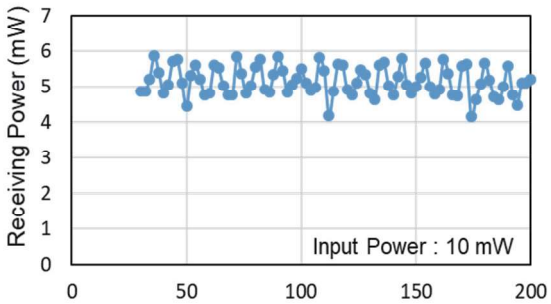

Fig.3. Measured data of microwave propagation in gas pipe