УДК 004.8

ПОЗИЦІОНУВАННЯ ВСЕРЕДИНІ ПРИМІЩЕННЯ З ВИКОРИСТАННЯМ МОБІЛЬНОГО РОЗПІЗНАВАННЯ ЗОБРАЖЕНЬ І BLE

INDOOR POSITIONING WITH MOBILE IMAGE RECOGNITION AND BLE

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Abstract. *An experimental system is presented that allows for the recognition of objects in images using neural networks on microcomputers and the determination of the distance to objects using Bluetooth Low Energy signals. The advantages and disadvantages of the presented system are described.*

Indoor positioning systems (IPS) have become increasingly important for a wide range of applications, from navigation in large buildings to asset tracking in warehouses. Traditional GPS technology is often unreliable indoors due to signal attenuation and multipath effects caused by walls and other obstacles. As a result, alternative technologies and methods are required to achieve accurate indoor positioning.

In our work, we explore a hybrid approach that combines image recognition using neural networks and Bluetooth Low Energy (BLE) for distance estimation. This method leverages the computational capabilities of microcomputers, such as the Raspberry Pi, to recognize objects within an environment. Once an object is identified, BLE signals are used to calculate the distance to the object using the Received Signal Strength Indicator (RSSI).

Three types of Hardware-Software configurations is tested to provide best results on object detection task: CPU configuration (int8 post-training quantization); Accelerated CPU (using ARM NN delegate); Using external TPU (Google Coral Accelerator with Edge TPU model optimization, int8 quantized models). As the software framework for inference, Tensorflow and Tensorflow Lite are used.

For YOLOv5S models best option was ARM NN Delegate – average recognition time is 70ms, that represents realtime recognition. This option have 2.4x better recognition time than accelerated CPU option (170ms).

To improve the accuracy of RSSI-based distance estimation, a first-order Kalman filter employed. The Kalman filter somewhat smooths out the noise in our signal.

To calculate the distance, the initial approximation formula was used. Due to the sinusoidal nature of the signal, our distance calculation does not match the actual distance to the object but fluctuates around this true distance. improve the smoothing, higher-order Kalman filters can be used. On average, the error value is 14.5%.

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