A HIGH SPEED INFRARED CAMERA ARRAY BASED POSITIONING AND ITS APPLICATION TO INDOOR ROBOTICS STEM EDUCATION

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INTRODUCTION

This study presented an accurate indoor positioning system utilizing a high speed infrared camera array, designed as an accessible educational tool for emerging robotics applications. To enable accurate spatial tracking, a volumetric capture environment measuring 2m x 2m x 3.5 m was established, instrumented with 10 infrared cameras. The cameras featured a 2.2 megapixel resolution (2048 x 1088) and a maximum frame rate of 330 Hz at this resolution. A 50 cm long robotic unit, equipped with 15 mm diameter retroreflective markers, served as the target object within this calibrated space. A controller designed in the MATLAB achieved positioning accuracy within the sub-centimeter range.

METHOD

This interactive STEM demo is to demonstrate how the motion capture system works. When holding a stick as a robot arm simulator with a reflective marker on the track of the pattern letter “UM” on the ground, we can observe the track we walk and compare it with the original track.

INFRARED CAMERA

REFLECTIVE MARKER

Light based indoor positioning setup for RiE

Simulated robotic arm with markers

INDOOR POSITIONING CHALLENGES FOR ROBOTICS STEM EDUCATION

Human-Robot Interaction is a welcoming approach for the latest STEM education. Recent development of Robotics in Education (RiE) shows positive impact on learning-based education. RiE education is mainly about the indoor teaching and; its positioning is still a challenge because of the denied GNSS positioning signal for indoor navigation.

GNSS
USA:GPS
China: BDS
Russia: GLONASS
Europe: GALILEO

Complex topology

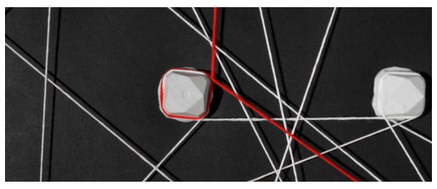
Complex radio environment

Complex human motion patterns

EXISTING SOLUTIONS

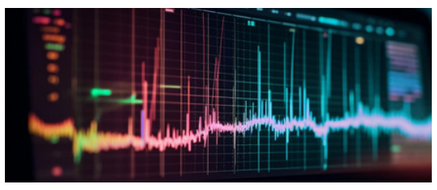
1. Magnetic (m)

2. Acoustic (m)



3. Light Signal (cm)

4. WiFi (m)



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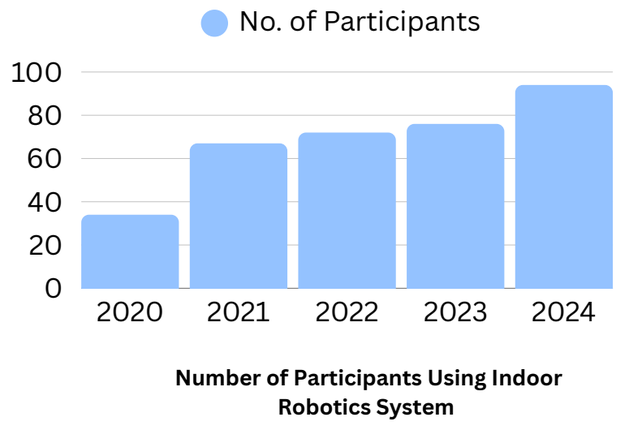
RESULTS AND CONCLUSION



Number of Participants Using Indoor Robotics System

System performance was evaluated through in-situ demonstrations involving 340 student participants with 90% of positive feedback on the positioning functionality in RiE of the STEM education.

In the past 5-year study, the data shows that RiE based on light positioning for indoor STEM education and demonstrations is an effective approach for student STEM motivation. A gradually increasing motivation of STEM study is observed in the number of participants in the light based positioning setup. There is 176% increase from 2020 to 2024.