**Localization and Visual Navigation of a   
Scalable Robot Swarm using ArUco Markers**

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*A comprehensive project report has been submitted in partial fulfillment of the requirements for the degree of*

**Bachelor of Technology**

*in*

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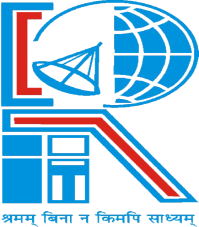
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**TO WHOM IT MAY CONCERN**

I hereby recommend that the project entitled “**Localization and Visual Navigation of a Scalable Robot Swarm using ArUco Markers**” prepared under my supervision by Swarnendu Sardar (11700116026), Sounak Mondal (11700116035), Soumik Dhar (11700116039) and Arindam Samanta (11700116098) may be accepted in partial fulfillment of the requirements for B.Tech degree in **Computer Science** **& Engineering** from **Maulana Abul Kalam Azad University of Technology, West Bengal.**

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**CERTIFICATE OF APPROVAL**

The foregoing Project is hereby accepted as a credible study of an engineering subject carried out and presented in a manner satisfactory to warrant its acceptance as a prerequisite to the degree for which it has been submitted. It is understood that by this approval the undersigned do not necessarily endorse or approve any statement made, opinion expressed or conclusion drawn therein, but approve the project only for the purpose for which it is submitted.

FINAL EXAMINATION FOR

EVALUATION OF PROJECT

1. .…………………………………………….

2. .…………………………………………….

3. .…………………………………….………

(Signature of Examiners)

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***Abstract:*** This project deals with one of the most interesting problem in the field of robotics - localization and navigation of a mobile robot. The ability of a robot to find its location in the form of x and y coordinates in the 3D space or effectively in the 2D space and then finding its way to reach the destination is a very common problem and is also a very computation intensive and complex task. It has to take into account not just its own position relative to a reference point in the 2D space but also calculate the distance between the destination and its current position, as well as do the same for any obstacles that might come in its way. Not to mention the great applications that they provide, autonomous robot navigation can be used from regular household works to heavy duty industrial work.

***Keywords:*** Localization, Navigation, Indoor Navigation Systems, Fiducial Markers, ArUco, Swarm Robotics

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**LIST OF ABBREVIATIONS**

ArUco: Augmented Reality University of Cordoba

Bot: Robot

Nav: Navigation

OpenCV: Open Source Computer Vision library

VBL: Vision Based Localization

MQTT: Message Queuing Telemetry Transport

GPS: Global Positioning System

TCP: Transport Control Protocol

PID: Proportional, Integral, Derivative

Contrib: Contributor

2WD: 2-wheel drive

IoT: Internet of Things

BO-motors: Battery Operation motors

Li-ion: Lithium-ion

Json: JavaScript Object Notation

Lib: Library

Rad: Radian

AR-marker: ArUco Marker

px: Pixel

rvec: Rotation vector

tvec: Translation vector