Smartphone Based Autopilot for Robotic Systems
TrackBot

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INTRODUCTION

The wide availability of smartphones with high performance processors and sophisticated sensor suites is the main motivation behind this work. For more than 10 years, a lot of expensive equipment used in robotics can be found within smartphones.[1]
The aim of this project is to exploit said equipment and produce a highly capable foundation that can autonomously control a robotic system while maintaining a user-friendly environment.

METHODOLOGY

The smartphone utilizes its internal IMU, GPS, light intensity and proximity sensors along with its cameras and external LiDAR sensor support while communicating through WiFi in order to achieve remote control, feature tracking and GPS & LiDAR based autonomous driving.
By leveraging the on-device cameras one can detect features on camera, apply control via the capability of the device CPU and keep awareness of its position & orientation by utilizing the IMU and highly accurate GPS within.

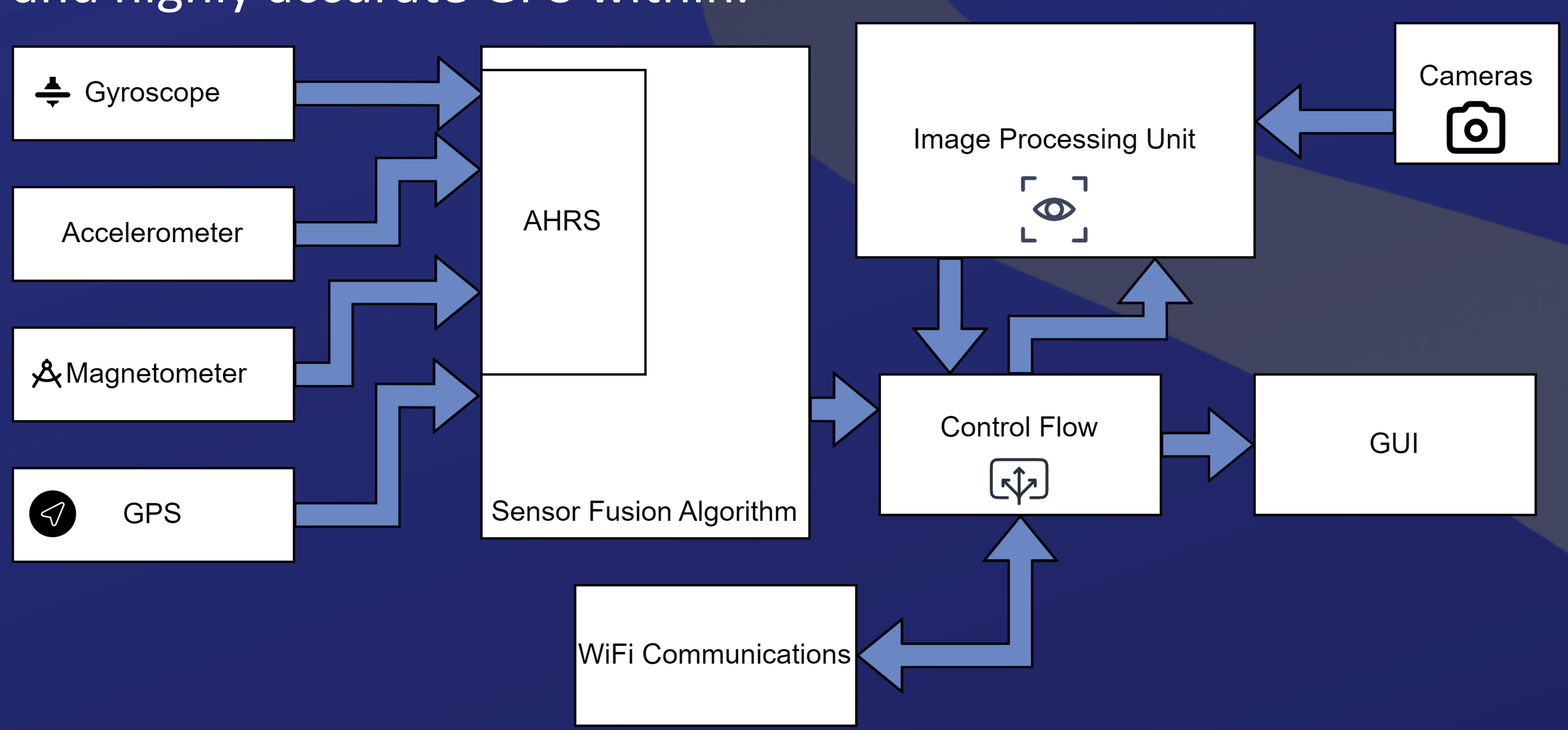

Figure 1: Smartphone Software Architecture

With such capabilities the older devices can gain a new meaning as robot controllers and newer devices become cutting edge robotic development platforms that can be used in exploration, search and rescue or autonomous food delivery systems.

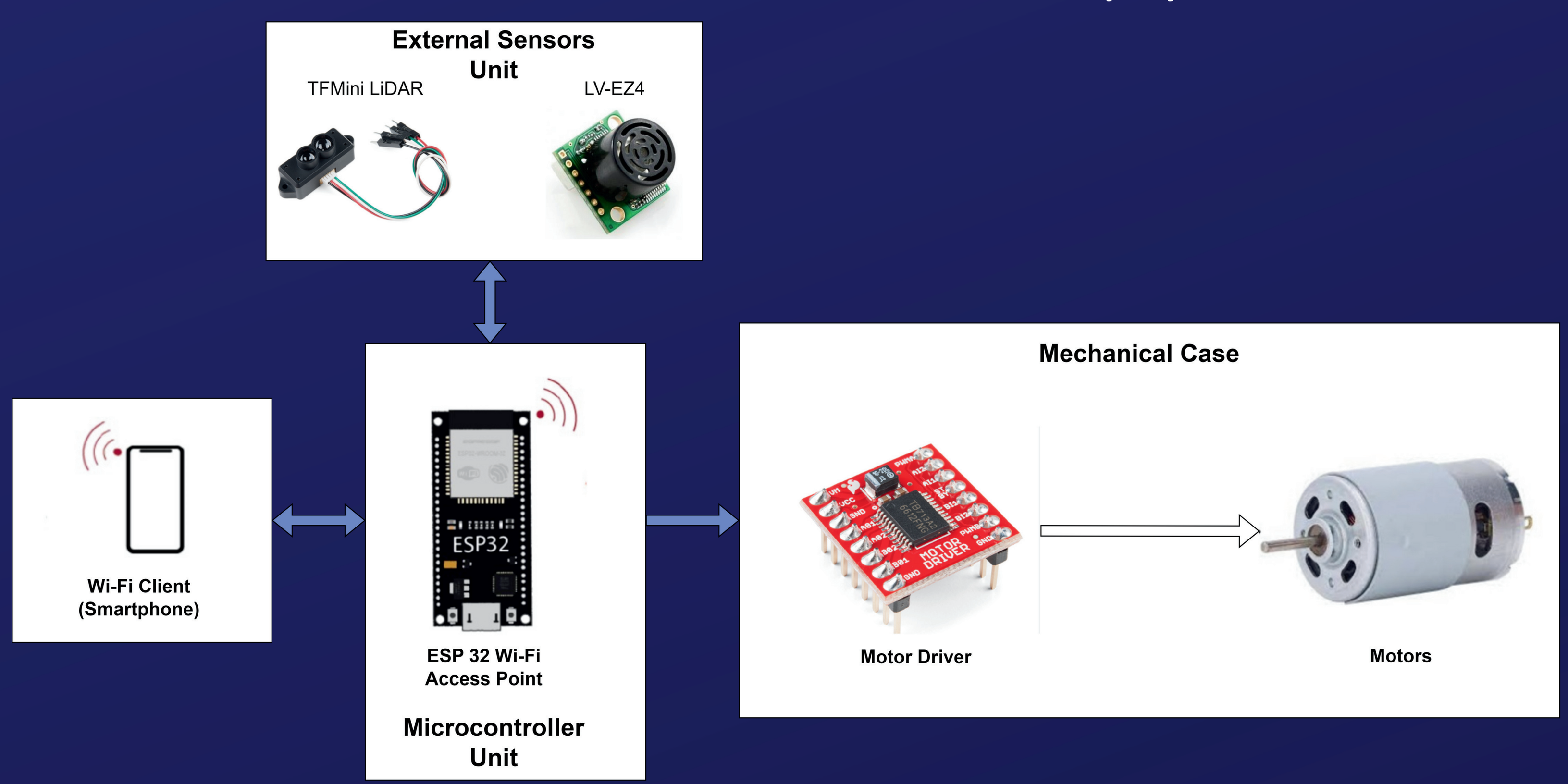

Figure 2: Hardware Architecture

DESIGN AND RESULTS

In our design process, smartphone subsystems of sensor management, image processing, wireless communication, controller unit and GUI are developed using Android Studio and its API.
User sets the driving mode from a range of feature tracking, GPS & LiDAR based autopilot and remote controlling. Feature tracking uses the custom-written camera reader and image processor which utilizes Tensorflow Lite models that can be configured.

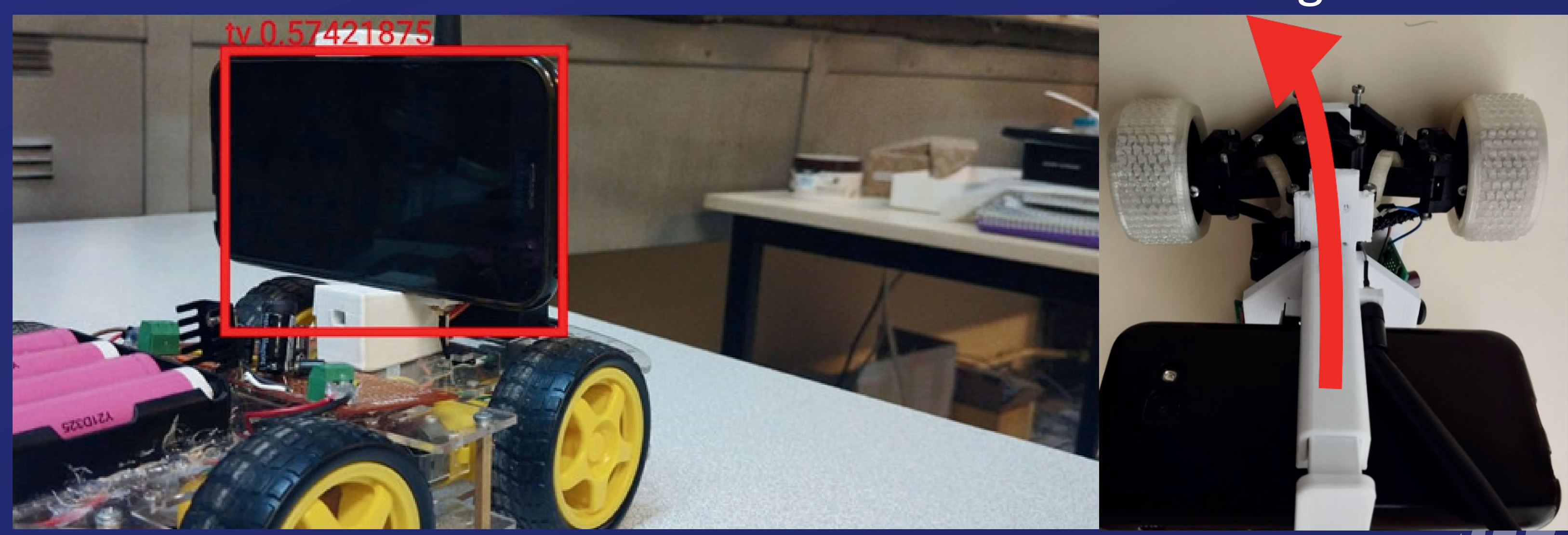

Figure 3: Tracking Mode Inference

GPS & LiDAR based driving uses the mapping created by using the external LiDAR module and needed bearing and distance to reach the target location.

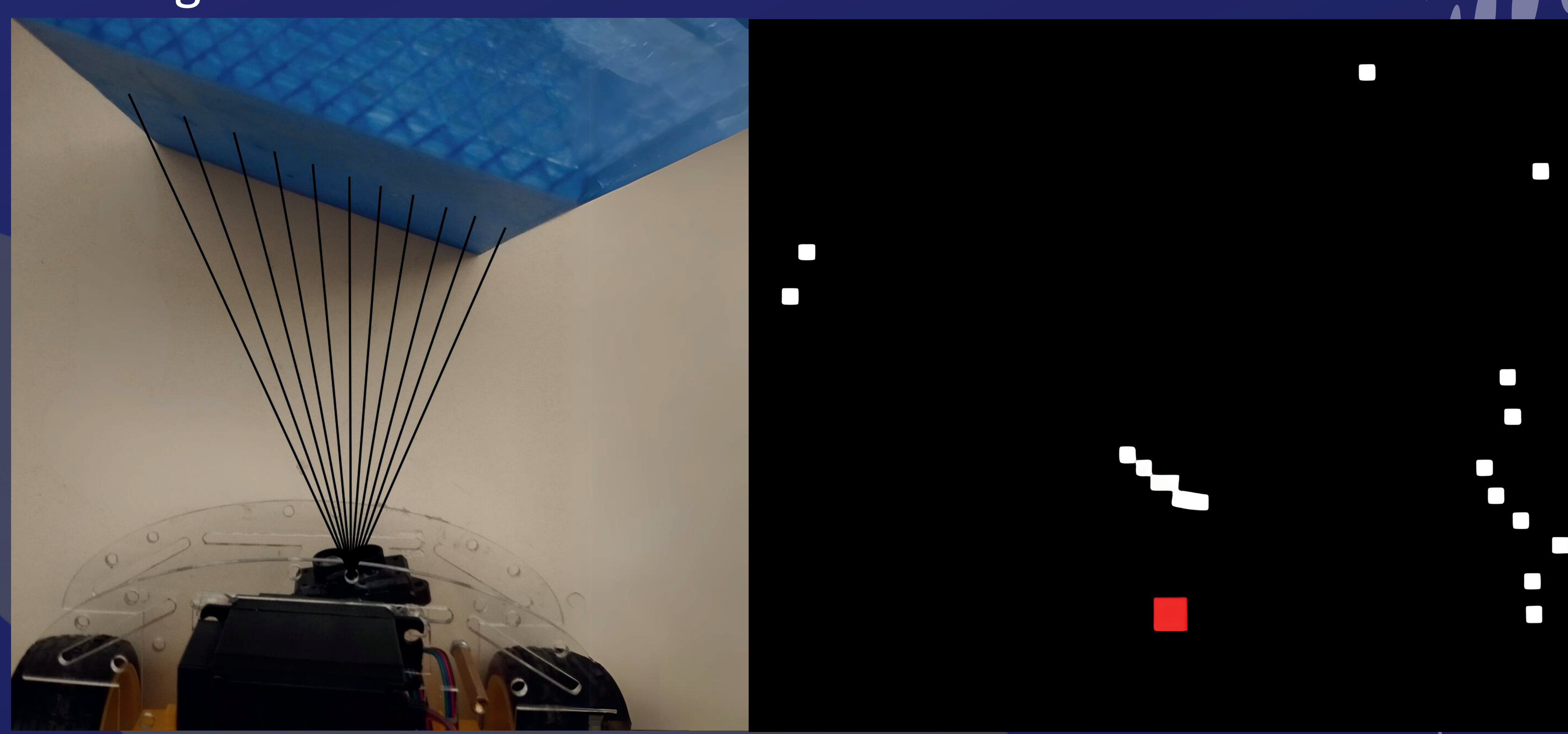

Figure 4: LiDAR Mapping

In the graphical interface, user is given the ability to change operation modes, robotic platform Wi-Fi message formats and used cameras while providing subsystems to remote control and visualize LiDAR mapping.
One of the most significant features of the design is the inference made from the LiDAR map such that the slope angle seen by the sensor is computed and robot accounts for the direction of the faced obstacle.

REFERENCES

[1] N. D. Lane, E. Miluzzo, H. Lu, D. Peebles, T. Choudhury and A. T. Campbell, "A survey of mobile phone sensing," in IEEE Communications Magazine, vol. 48, no. 9, pp. 140-150, Sept. 2010
[2] M. Müller and V. Koltun, "OpenBot: Turning Smartphones into Robots," 2021 IEEE International Conference on Robotics and Automation (ICRA), Xi'an, China, 2021