e-Yantra Ideas Competition 2019-20

Project Name: Amphibious Autonomous Surveillance UGV

Introduction/Motivation:

Traditional security arrangements have proven to be ineffective, unreliable and exhausting. This causes a burden on the limited manpower who then put in extra hours of work in minimum wages causing them to tire out at night missing a security breach or be in on it for the money. Lack of proper training makes them unequipped to handle such type of situations. Cameras that are installed in place for surveillance are the first once to go out because these can be easily broken or shutdown. This leads to the loss of life and property due to the negligence of the security personal or due to the harsh environment and terrain. The idea proposed increases the efficiency of the system at the same or even decreased cost.

Robots that use ML are emerging as a way for businesses to integrate existing security measures and provide greater situational awareness. Security robots can bring substantial benefits to businesses:

- Patrolling of perimeter of corporate campuses or critical infrastructure sites to identify potential trouble/ issues.
- Remove traditional guards from dangerous situations.
- Detect individuals or vehicles in unauthorised areas;
- Integrates with existing sensors and systems to allow operators to gain new levels of intelligence and insight into situations.

Market Research / Literature Survey:

Systems have already been developed to autonomously analyse video feed in environments such as transportation networks and public spaces. while other works are focused on a four wheeled robot for Surveillance. Mobile Robotic System for Surveillance of Indoor Environments robot can be used to interact with the environment, with humans. Using robots for security is still a budding and untouched market in India and has a huge potential for growth in the coming years. Currently, there is no private company in India that manufactures security surveillance robots.

This product provides the following features over the existing ones:

- It has a minimalistic design that aids in its mobility.
- It is suitable for both indoors and outdoors.
- It is suitable for any kind of terrain and is amphibious.

- We match the features at a lower cost.
- It has the capability to climb steps aiding its manoeuvrability. Its wheels allow the robot to absorb impact and act as a cushion.

Hardware requirements:

- Jetson Nano
- 2D RP lidar
- Intel real sense (embedded IMU)
- BLDC motors
- Microphone
- Webcam
- DC motors
- BLDC motor drivers
- Smoke detector

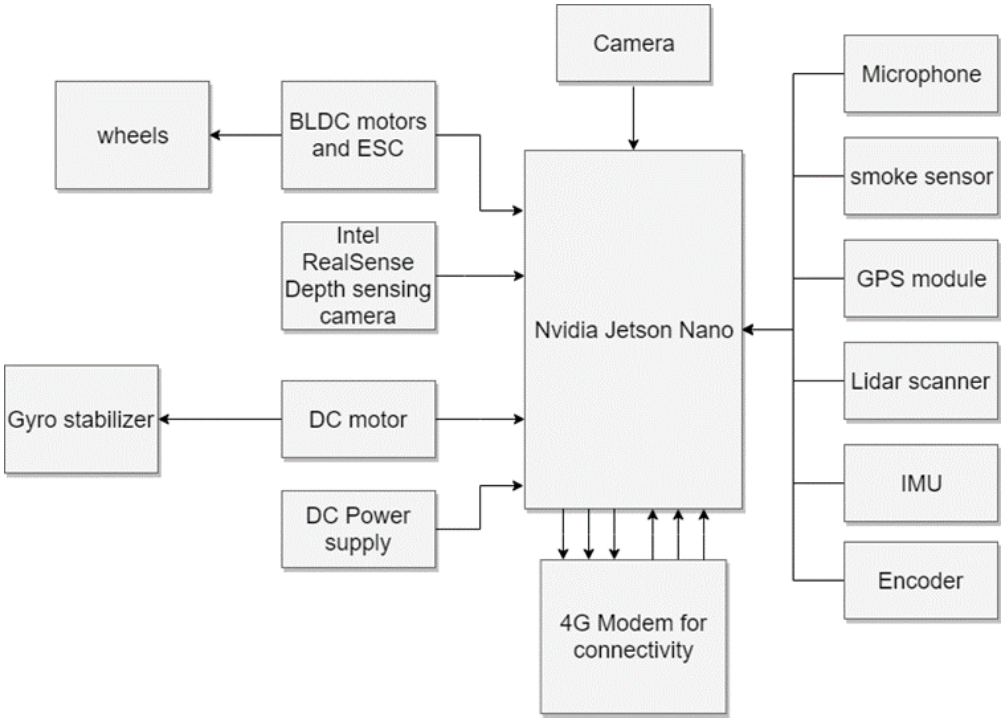
Software requirements:

- MATLAB
- ROS
- Python
- Gazebo
- VREP

Implementation:

Mechanical Aspects:

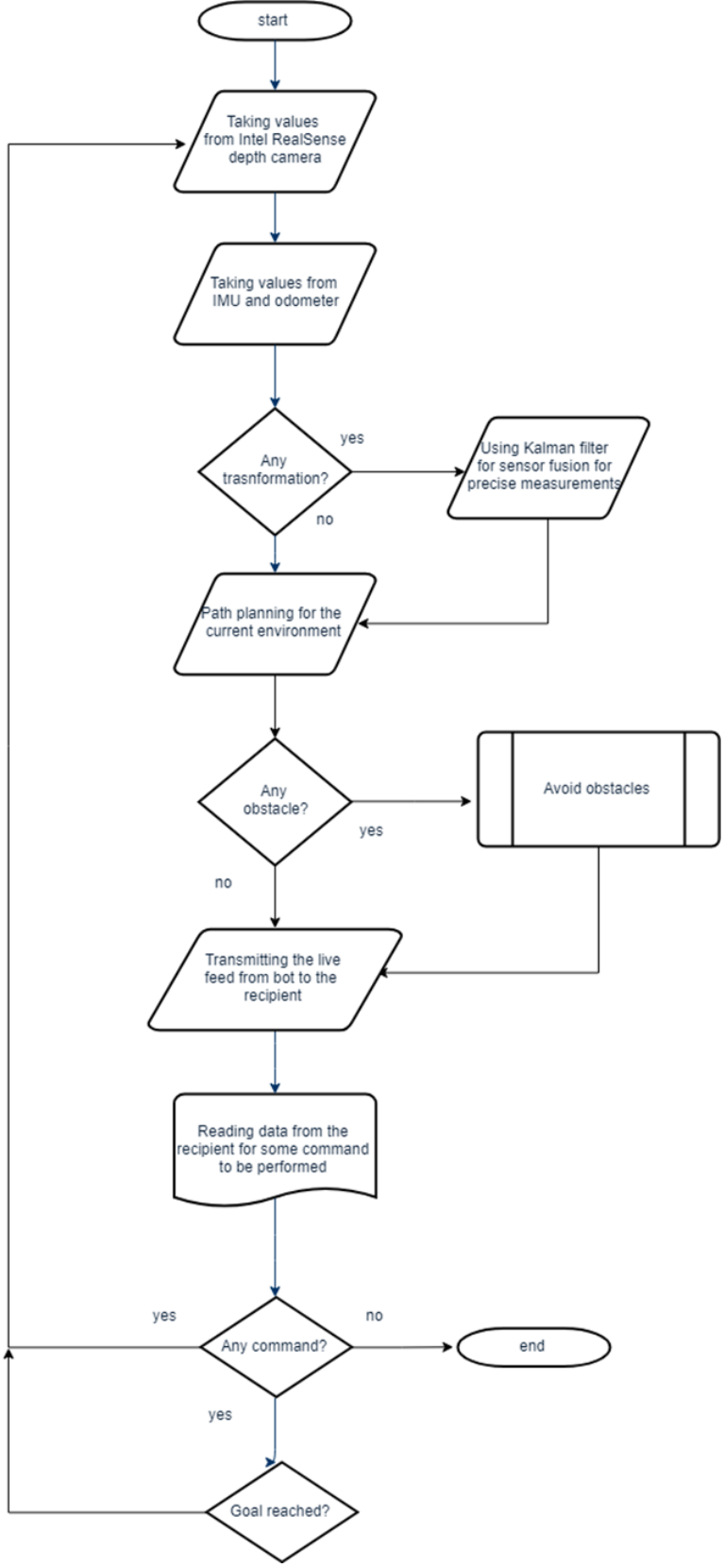
The robot consists of a two-wheel self-balancing robot. Due to the unique structure and material of the wheels the robot can accommodate itself on rough terrain and climb stair by balancing its centre of gravity. The wheels also absorb any impact that occur due to the robot falling from a height making it a robust system. The wheel design is such that the robot can traverse on diverse terrain and float on water. It consists of BLDC motors that form a combination to give a planetary gearhead reduction. It is the comparatively small make of the robot that helps it interact with the environment better.



- Intel RealSense camera is used to localize the robot using monocular visual odometry (position of the robot i.e. rotation and translation in 2D space). For accurate measurement of these values an Inertial Measurement Unit (IMU). Cameras at the rear alternate source for monocular visual odometry as well as make the system reliable and robust.
- Cameras are also used to detect people, objects and alert the security personal about the same. These cameras provide a 360-degree field of view and are also equipped with night vision to be able to see in the dark.
- Lidar rangefinder is used for mapping of the environment for more precise localisation information of the robot. Kalman filter with sensor fusion is used for accurate measurements and also used different types of filtering techniques on sensors raw measurements. Particle filter is used for localisation in known environments.
- GPS is used for location tracking.

- YOLO algorithm is used for detection of suspicious objects or individuals (e.g.: detecting guns, terrorists, etc.).
- 4G modem/dongle is used to transmit feed data i.e. video/audio as we as link the robot with other patrol robots in the framework.
- The control of the robot is done using LQR Feedback controller by using various sensors like IMU, Camera, and Lidar.
- DC Motors are used to drive the gyro stabilizer for changing its roll, pitch, and yaw.
- Gyrostabilizer works on the principle of gyroscopic effect to balance the robot on uneven terrain or on surfaces where the balance of the robot can be affected. This is also used to provide the necessary balance during step climbing.
- Smoke Sensor is used to detect the level of co2 and predict if there is a fire nearby.
- Microphone is used to get a two-way audio transfer that can transmit as well as receive, another is a one-way audio transfer from robot to the user. The microphone is also used to do footsteps detection.

Flowchart:



Feasibility:

The design of the robot is minimalistic that helps it to blend into the background making it unnoticeable by people. This makes it so that people do not feel out of place or pressured that they are constantly being watched. It also gives the robot an element of surprise over the hostiles as it can then sneak up on them and notify the authorities beforehand. The robot can detect and classify hostiles/threats/weapons using a camera. One can instruct this robot to go to a specific sector of the facility or

the region or it can navigate autonomously throughout the compound making this a mobile security unit. This robot can give consistent results and is less prone to sabotage when compared to security cameras that are fixed at a place and do not cover much ground. In case something goes wrong or the module breaks down it immediately sends a signal to the security personal along with its location and immediately notifies the authorities.
This device aids the functioning of traditional security framework thereby increasing the efficiency and lessening the burden put on the resources thus proving very cost effective.

References:

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