Disaster Management Robot (DMR)

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Till date we have observed the development of various robots that are sent into the disaster affected area to record the condition there, collect samples, identify survivors and finally provide this data to the group of people who can carry out the rescue operations. All these robots are coined under the category- Post-Disaster Management Robots. DMR plays a role here, DMR is not only able to carry out the above given functions but also help during the disaster. It can be used by residential areas and not just professionals. Let us see how!

DMR can work in two ways, it can be a bunch of sensors always present in an area to detect any kind of unusual changes or it can be directly sent to the affected area to obtain samples. From providing pest control alerts to disaster alerts it can do it all.

During the rescue operations, with a confirmation from the user the bot is converted into a rover that records the condition of the affected area and sends that data. This data can be used to figure out, before the rescue professionals come, exactly where to send them. Presently, only humans and dogs are used to find out where to carry out the operation but with this data obtained by DMR we can target places, pre-define where to go and carry out efficient rescue operations.

Features of DMR

At this point we will be defining different states present around a disaster.

- No disaster state
  The rule that comes along with DMR is that you don't switch it off so that it is always alert and ready for an emergency. So, during the No disaster state – on the display screen of DMR it displays the temperature, humidity, weather, location of the DMR. At this state the user is expected to store all emergency contacts into the bot. The different types of sensors which will be mentioned shortly are continuously running and analysing data for any anomaly.

- Pre-disaster state
  DMR has various sensors attached to it – LPG gas sensor, temperature and humidity sensor, metal detection sensor, nuclear radiation sensor, GPS, touch sensor, infrared sensor. Each plays its role and sends notifications to the user's mobile phone according to the situation.

- During the disaster state

It contacts the emergency contact numbers after receiving confirmation from the user through the mobile app. All users associated with the app are sent alerts notifications immediately. An alarm is initiated to alert the people around the disaster affected area. The sensors data is collected and analysed with the help of pre-defined algorithms the probable disaster type, all on the app. It also using AI detects things like need for pest control, house cleaning, power wastage and informs the user about it.

- Post disaster state
  DMR is able to move around and capture images/videos of the affected place. If available it can obtain samples. It can live telecast the affected area it is looking at. This helps the rescue professionals to carry out the operation is an efficient manner.

Technology behind DMR

The technology behind DMR is – **NVIDIA JETSON TX1**.

The world's first supercomputer on a module, Jetson TX1 is capable of delivering the performance and power efficiency needed for the latest visual computing applications. It's built around the revolutionary NVIDIA Maxwell™ architecture with 256 CUDA cores delivering over 1 TeraFLOPs of performance. 64-bit CPUs, 4K video encode and decode capabilities, and a camera interface capable of 1400 MPix/s make this the best system for embedded deep learning, computer vision, graphics, and GPU computing.

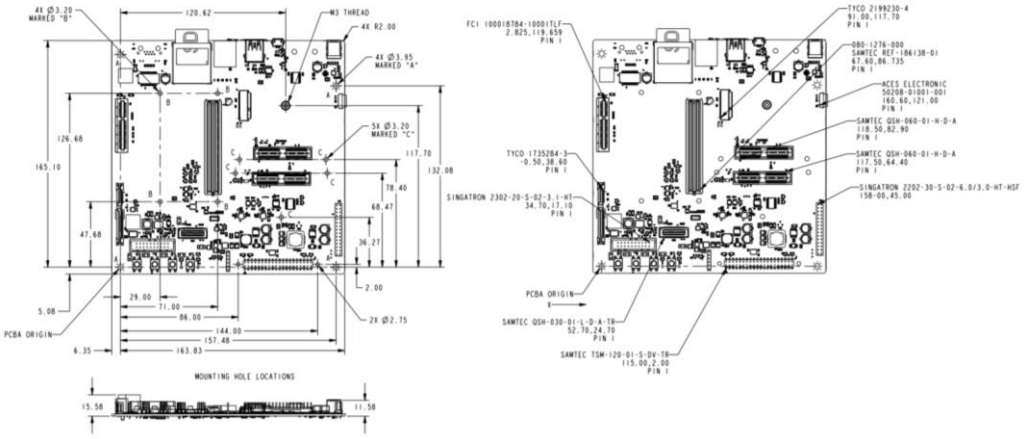
The main secondary features if summarized from the datasheet are-

- High computation in a low power envelope and a small size

  The size of the Jetson is as small as a credit card. Jetson TX1 draws as little as 1 watt of power or lower while idle, around 8-10 watts under typical CUDA load, and up to 15 watts TDP when the module is fully utilized, for example during most demanding vision routines. Jetson TX1 provides exceptional dynamic power scaling. With this power efficiency it allows the modern world needs of machine learning, deep

learning, image (depth) recognition, management of high amounts of data to be carried out.

For DMR: At least our processor would not take much of the space in the final bot. The bot can maintained to be as compact as possible. The videography and photography can be carried out without the demand of much power, a battery source can be provided to the bot that is rechargeable. The processing of this data will be carried out in a satisfactory way due to high computational powers of the module.



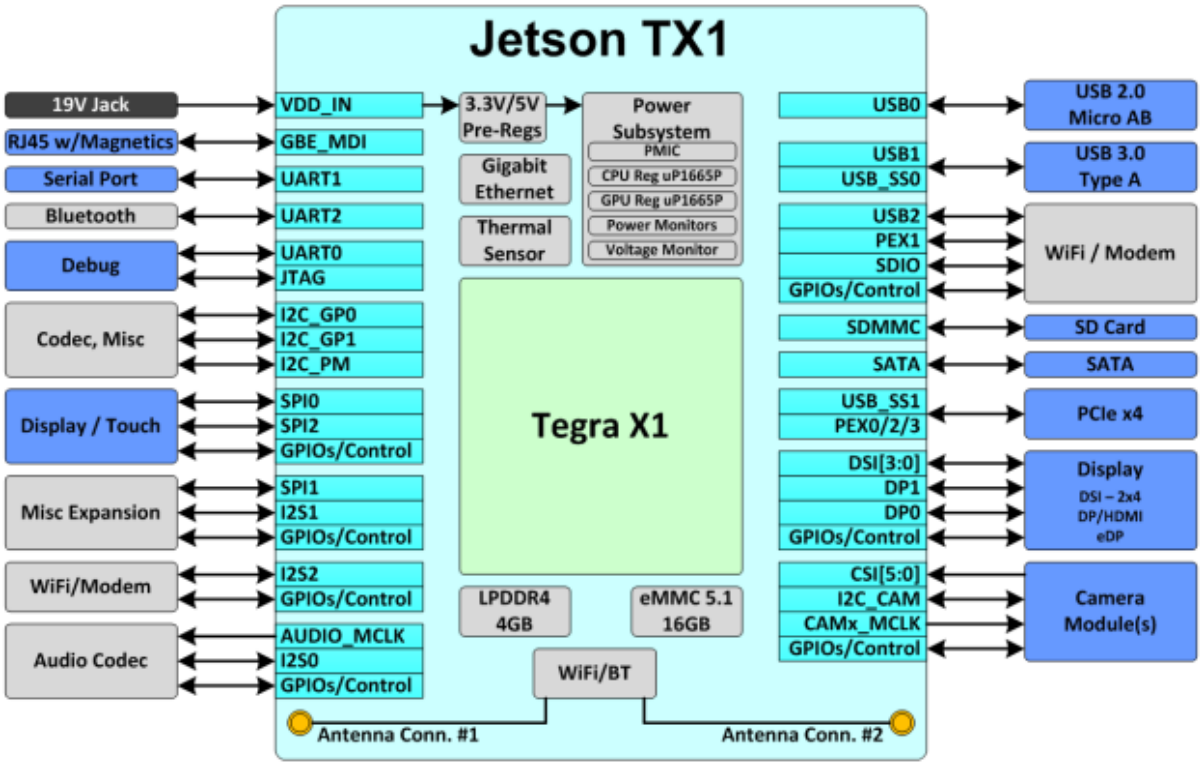
- <u>LPDDR4 RAM with 4 GB memory , 16GB eMMC flash memory</u>
  For DMR: As mentioned above the bot needs to manage high amounts of data, the LPDDR4 RAM comes handy. Its 4 GB memory proves to be well and enough for all applications of the bot. The 16 GB flash memory is non-volatile and programmable memory.

- <u>Thermal Transfer Plate</u>
  For DMR: It is ready to accept whatever passive or cooling solution that you wish to design for the bot. It can thus support the range of sensors attached to it, as it will avoid any kind of harm to the module. It is rated between -25 degrees Celsius to 80 degrees Celsius.

- <u>Connectivity with wireless LAN and Bluetooth enabled devices</u>

  For DMR: The module encompasses inbuilt WiFi and Bluetooth modules that can be connected to short range devices that will be able to automatically switch off electrical appliances. Through it all device that are ready to receive alerts are sent notifications about the emergency. The various communication protocols are

present to support it. For example UART enables the Bluetooth similarly I2C helps WiFi enabling. With SPI a proper display can be made that can also be upgraded to touchscreen.



- Jetson -Software
  With Jetson we get the Linux-Ubuntu duo that allows extensive programming that supports file system, AI. It has inbuilt Multimedia and graphics library (using it would be optional in DMR).

- CUDA 7 and cuDNN/Caffe
  Jetpack 2.0 includes the CUDA Toolkit version 7.0, with 16-bit floating-point support (FP16). CUDA 7.0 unleashes Jetson TX1's integrated Maxwell GPU. Maxwell, with Compute Capability 5.3, supports Dynamic Parallelism and higher performance FP16. The many uses for Dynamic Parallelism in embedded applications include point cloud processing & tree partitioning, parallel path planning & cost estimation, particle filtering, RANSAC, solvers, and many others.

  One of the highlights of the Jetson software ecosystem is an incredible deep learning toolkit built on CUDA, providing Jetson with onboard inference and the ability to apply reasoning in the field. Included is NVIDIA's cuDNN library, adopted by multiple

deep learning frameworks including Caffe. This quality makes Jetson stand apart from many processors like intel's i7 series. This encourages us to develop an AI platform for the DMR on which with all above mentioned qualities is able to perform extremely well.

Sensors could be used, anomaly could be detected by any computing platform like the arduino, raspberry pi etc. But Jetson has proved to be much much more efficient compared to both of them. Jetson is a compact supercomputer which can definitely bring in a change in many portable electronic gadgets that we use but before that we use it for the specific tedious tasks like in our case – **Disaster Management.**

We can incorporate AI in the DMR in the following ways –

- Help in finding the lost articles by memorizing the location and predicting its most probable shifted location. It learns from our daily habits associated with that object.
- Reporting to the user, detailed inspection of energy consumption, how to improve it that is - which gadgets take up the most energy, which are wasting energy, detect any fault in the device with the help of its energy patterns.
- We are connecting a modem to the DMR, it is expected to make emergency calls to the proper group of people and convey the right message.
- Through sensing detect the presence of pests, spider webs, dust and thus suggest cleaning solutions for the place.

Conclusion

Jetson is a mini supercomputer with enormous computing powers. We have decided in this report to use it as a Disaster Management Robot – DMR. It is a bot that is area specific that is for example you can place it residential areas. There it works for all phases as we defined in the report whether disaster or no disaster, it has work to do. It has an ability to connect through WiFi to devices around it and notify them for any results it gets –from pest warning to disaster warning. Through Bluetooth it continuously sends the camera data or any other data that it has collected. Its computational powers are used to incorporate AI in DMR where

in learns from the regular actions and situations then report and analyse if anything abnormal is found out.