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Experimental Study on behavior of SAGWCR (Suction Adhesive Glass wall Climbing Robot) using k means anomaly method in Edge Computing using IIOT network

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Abstract

There is an emerging need in detecting an adaptive suction adhesive mechanism for wall climbing robot with optimal power utilization and with high reliability in its effective performance at high attitude. The general issue arises only when it is practically applied on the field with certain weight and payload, the suction mechanism sometimes may fail depending upon the payload and friction on the surface of the wall. Generally suction adhesive will be good for smooth surface and not advisable for rough surface. In this paper a novel approach is made to implement an intelligent suction adhesive mechanism based on Industrial Internet of Thinks concept. An attempt is made on experimental study for the performance analysis of this suction adhesive over the glass surface. The k means anomaly method in edge computing is used further to identify the abnormalities or the time at which the system starts to get deviate/fail. The result of this study will make us to think further on implementing a reactive mechanism to overcome the deviation or failure. The reactive mechanism may be considered as a compensator which is introduced to avoid the slippage of the SAGWCR.

1.Introduction

Edge impulse is an online platform which helps developers to learn iot concepts providing intelligent device solutions with embedded machine learning. The efficient use of sensor data is possible now with deep machine learning. This edge impulse platform provides more efficient, rapid and scalable processing data directly at sensor interface. It consumes less power as it is need only during sending the data. This software can also detect complex events that rule based system cannot easily detect.[1].A detailed analysis framework was given by Hugh Boyes [2] on the Industrial IoT.The review report by Multan Sign Bati[5] gives the idea about the modules involved in building IIOT

2.Procedure:

The 300 gram weighing SAGWCR consists of suction adhesive mechanism (150 gram) and samsung J2 pro mobile phone tiedup together as shown in fig 2.1 and 2.2. The accelerometer sensor inside the phone is used to read the position of the suction adhesive bot with respect to X,Y,Z axis.

Fig 2.1 The mobile tied up with suction adhesive mechanism

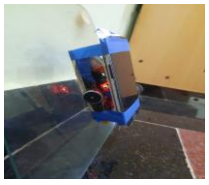

Fig 2.2 The suction adhesive mechanism on a glass wall carrying the mobile

This mobile is connected to edge impulse software through which IoT network is established .An user account is created in Edge impulse software with specific login id and password, after login the project id will be created. The entire flow of experiments is as shown in the below chart Fig2.3.

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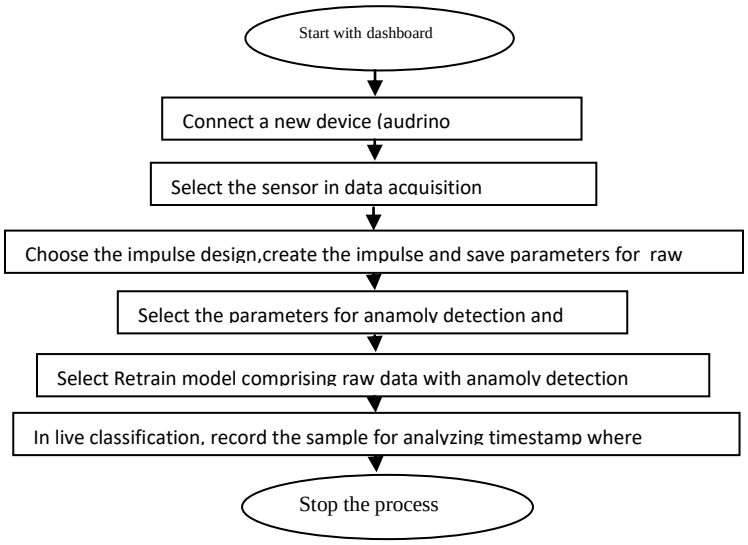

Fig 2.3.Flow chart showing the entire process of experiment

3.Standard Reading:

The mobile is tied upon the suction adhesive wall climbing robot and the entire mechanism is placed on the vertical glass wall. As shown in fig 3.1 and 3.2 ,the mobile is connected to the cloud using Edge imulse platform. The sample reading is taken by manually holding the bot on vertical glass wall , this accelerometer output is considered to be the standard which has to be taken as reference as shown in fig 3.3. This reference output /standard output will help to identify the anomaly during the actual trials.

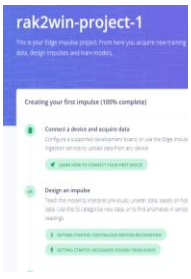

Fig 3.1 - creation of project in the name rak2win

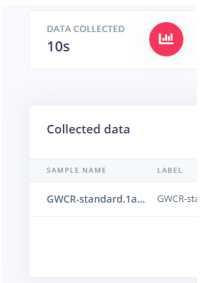

Fig3.2-Data collection for the reference standard signal

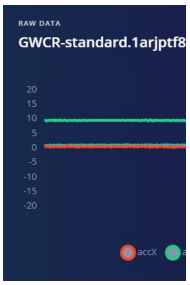

Fig3.3-Accelerometer output of standard

4.Creating impulse

After trapping the standard signal parameters now we need to create an impulse with k means anamoly detection , the fig4.1 shows the screen shot of impulse creation.

Fig 4.1 Creating an impulse in Edge platform

5.Analyzing the Raw data

The parameters of raw data is trapped from standard signal, the generate feature option is used to view the parameters in x axis, y axis and z axis as shown in fig 5.2and 5.3.

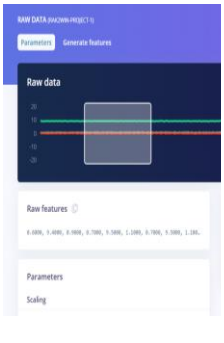

Fig 5.1 – identifying the raw features from standard

Fig5.2- shows the feature explorer

Fig5.3 -shows the feature explorer

6.Anomaly detection setting & Retrain model:

Now the settings is made for detection of anomaly after generating the features from raw data. As shown in figure 6.2 the retrain is done for the raw data for anomaly detection.

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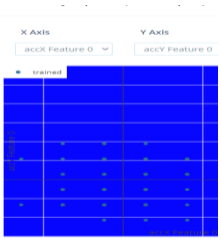

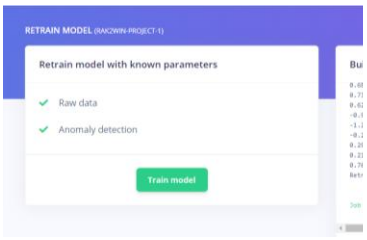

Fig 6.1 – anomaly detection setting

Fig 6.2- Retrain of raw data and anomaly detection

7.Live Classification:

Now different trails are made to access the suction adhesive capacity of the glass wall climbing robot mechanism. At each trial the raw data of the accelerometer output is trapped and anomaly with respect to standard reference output is explored with respect to X,Y,Z axis. And finally the timestamp for each trial where the anomaly starts occurring is noted .Here four trials are done experimentally with different timestamp.The fig 7.1 shows the live classification panel

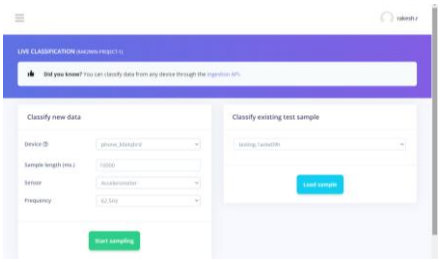

Fig 7.1 – live classification in Edge platform

8.Testing trial -1 to 4

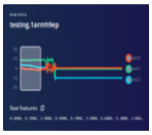

Fig 8.1 – Raw data of trial 1

Fig 8.2- feature explorer for trial 1

Fig8.3-shows the timestamp for trail 1 Time stamp-2240 sec

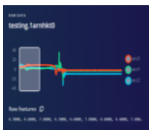

Fig 8.4 – Raw data of trial 2

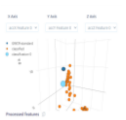

Fig8.5- feature explorer for trial 2

Fig8.6-shows the timestamp for trail 2 Timestamp-2960

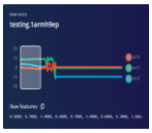

Fig 8.7 – Raw data of trial 3

Fig8.8- feature explorer for trial 2

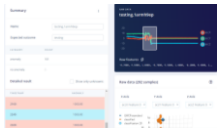

Fig8.9-shows the timestamp for trail 3-Timestamp-2560

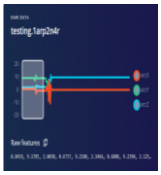

Fig 9.1 – Raw data of trial 4

Fig9.2- feature explorer for trial 4

Fig9.3-shows the timestamp for trail 4 Timestamp-2080

Conclusion:

A series of 10 trials are made(of which 4 are shown as sample fig 8.1 to9.3) from which timestamp at which anomaly occurs ranges between 2080 seconds to 2960 seconds. It clearly says an attention towards suction adhesive mechanism is required for this bot at time range between 2 seconds to 3 seconds in general ,where a designer can think of introducing a standby to balance or improve the suction force much more at this timestamp. This kind of illustration can be arrived by machine learning using internet of things network on wall climbing robot in general.

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