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Cloud based disassembly of electric vehicle battery

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Abstract

The electric vehicle is developing faster than any other mode of transport in the world. Various studies focused on vehicle recycling and its impact on the environment is already done. Some studies focused on estimating one or two stages of vehicle recycling with certain percentage of material recovered. In order to reduce the impact to the environment and public health resulting from the increased use of batteries, there is a need to have a good and cost effective recycling infrastructure. The concept of using cloud-based technology in recycling by automation is attempted. In this research paper, cloud based recycling process of E-vehicle batteries done with the help of robotic cell. The adaptability of robotic dismantling of electric vehicle batteries in small-scale industries through cloud network provides improved material recovery result in recycling.

Keywords: Electric vehicle; Robotic arm; Battery pack; Cloud Technology

1. Introduction

The automotive business has been indicating progressive changes, putting resources into the fusion of technologies in vehicles, and in addition enabling drivers to focus on smart vehicles with embedding artificial intelligence for day-by-day utilization. Any run of the typical vehicle is viewed as PC on-wheels since it comes outfitted with an intense on board PC, extensive limit storage device, delicate radio handsets, impact sensors, and a GPS gadget.

Nomenclature

EV Electric Vehicle

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Because of alarming pollution levels in environments, there is a need to move car industry towards electric vehicle. Electric Vehicles (EVs) give new chances to diminish fuel utilization and fumes emanation. EVs need to draw and store energy from an electrical framework to supply propulsive energy for the vehicle. Subsequently, it is essential to know the accessibility of the EVs batteries for charging and releasing [1]. In the meantime, Cloud computing has exhibited quick paced progressions that have enabled it to help growth in manufacturing sector. The flexibility that Cloud has presented for the on-request arrangement of assets and services over the Internet has enabled it to be perceived as a public utility [2]. Prime objective is to make a highly reliable and continually accessible correspondence interface for a system of manufacturing process by taking advantage of the little satellite lower cost, as for regular manufacturing technique [3]. A number of small satellites have been launched with increasing functionalities, in the last few years. Likewise, numerous autonomous vehicles and vehicle equipment have been built, with decreasing costs and form-factor payloads [3]. A prototype model for recycling of electric vehicle battery pack has been developed. The proposed recycling system is based on robotic infrastructure along with sensors, useful for monitoring the weight; dimension, material used, and amount of material recover from recycling. To avoid the risky situation sensors are installed to monitor the operation. The proposed technology significantly avoids the accident in operation [4]. Various autonomous vehicles and vehicle equipment have been working, with diminishing expenses and form factor payloads [3]. A model for recycling of electric vehicle battery pack has been produced. This recycling framework depends upon type of battery, which is selected for recycling. Selection of recycling method also depends the physical parameters of battery. Every one of the information is stored in a computer attach with recycling setup [3]. There are some significant impediments of recycling process for electric vehicle batteries. The fundamental disadvantage in utilizing robot in disassembling of the battery pack is physical show of robotic arm. In this, human is needed to effectively position the robot and educate the area of every fastener this will take more time to completing the task. Then physical demonstration is likewise valuable for instructing the robot for appropriate battery joint design [5]. Several robotic battery-dismantling centre is currently available, but they are not generic. For little and medium scale battery recycling ventures, design and arrangement is exceptionally troublesome. By thinking about this reality, there is a need of generic layout for reusing of the battery. This sort of the basic design is useful for growth the quantity of automated battery recycling canter [6]. The primary target of the robot base recycling process is planned to diminish the aggregate cost of the reusing and increment the material recuperation rate. In this two primary methodologies are used. one of them is conventional layout for recycling of batteries and other is a virtual layout for recycling of batteries. An outline of conventional layout is extremely useful in creating a virtual layout for recycling of batteries [7].

2. Advantage of cloud computing in manufacturing

In recent years, wonderful headways have been made in Cloud Computing and systems administration. Cloud computing exhibited an amazing movement in the worldwide information technology industry. Cloud computing is characterized as a model for empowering all inclusive, basic, on-request, organize access to a common pool of configurable processing apparatuses, for example network, capacity, servers, administrations and applications. Which can have quick arrangement and discharged with slightest administration exertion and cooperation by specialist co-op. Cloud computing has presented few better trademark for conveyance of figuring arrangement in contrast with the old neighbourhood framework. Cloud computing gives an open door for on request computational assets, stockpiling and IT benefit. It has number of registering assets accessible to clients. The user has a chance to rent service and resources according to their need at that time. Cloud computing will give flexible choice for users to take new resources when they have repetitive need. This component is useful for little size manufacturing organizations where venture sum is restricted. Cloud computing additionally gives chance to any client to lease their computing assets after completion of their work for getting additional advantage of their utilized assets. This temporary lease helps in budgeting for another new user. With all advantages, that introduces flexibility for small battery recycling business, they will migrate towards, IT services and cloud computing.

2.1. Cloud based software services

A Cloud service provider gives various kinds of software's for manufacturing of various sizes and material of battery packs. The specialist organization is keeping up, permitting application and make software accessible for clients as an administrator on request. Filling in as a membership based services, software can be connected for a

timeframe this is functioning as an option for purchasing new software, which is of very high cost.

2.2. Data centres

Noteworthy work of the data centre is to keep up and advancing the computational assets. A large portion of the current works in this class of utilizations manages a compelling utilization of manufacturing programming. There are diverse manufacturing programming for various sizes and material of the batteries. Along these lines, determination of a specific kind of battery manufacturing programming is important. Along these lines, the product gives diagnostic outcomes concerning the accessibility of computational assets, which enhance the material utilisation rate and reduce the cost of manufacturing. Manufacturing focuses works by spanning the correspondence between user and data centre through Internet to access information at manufacturing centres.

2.3. Cloud robotics technology

Cloud robotics technology is made on the concept of to use opportunity of cheap computing power and large number of data storage capacity of cloud computing and availability of internet to fulfil need of current demand. Cloud robots technology not required any complex and personal information to perform a task. The robot can access program, which is not stored within. That thing increases his functionality and capability as well as reducing the cost, size, complexity and reduce working time. Cloud robotics are still in its primary state, so we cannot expect that all robots should be handled by a cloud based computer system but this will be a standard feature. For almost all robots. In future capabilities of cloud computing cold be improve by improving in several fields like artificial intelligence, pattern recognition and natural language processing [7].

2.4. Point cloud modelling

This process use data generated from point cloud modelling as well as simulation of objet to optimize their coordinates in the cell. Some algorithm can be used for a better solution of particular problems. In the simulated annealing algorithm, our aim is try to solve problem with minimum displacement of the robot. More than 50% reduction in the net joint movement of the robot has been achieved by the use of cloud computing and point cloud modelling [6]. Notwithstanding, this has seen less augmentation in the movement, separation of the robotic arm.

3. Electric vehicle battery recycling infrastructure

Electric vehicle batteries demonstrates the present and in addition future difficulties for dismantling, recycling, reuse and demonstrates the need of change in their life cycle. While manufacturing batteries, our thinking about recycling process, which relies upon dismantling to enhance measure of yield material recuperated, limit material misfortune and natural consequences at the end of life. In this way, battery design decides future effect on various life cycle stages [8]. There is some responsibility of manufacturing companies to make a waste management structure. By considering waste management system, they use this knowledge for electric vehicle batteries and electric appliances. Recent development in virtual disassembly tool unable to share knowledge between manufacturer companies and waste management companies [8]. As technology and design of electric vehicles are continuously developing, but there is no similarity and common standard is achieved in design of batteries. So, we can see many variations in design of electric vehicle batteries. The most normal explanation behind that is auto producer roll out just a little improvement in design of custom product to make it electric driven. This implies the battery is intended to fit in an officially existing auto body. Hence, the plan of electric vehicle batteries contrasts from auto model to auto display.

4. Present disassembly process

The genuine dismantling procedure is completed to create reusing ideas and directions for recycling material and organizations to produce inventive measures for re-fabricating (reusing singular parts in another structure) and eco-friendly design. Directions for dismantling of batteries on location, security data and process arrangements were recorded appropriately. Genuine dismantling strategies can be classified on how they are done either mechanized or

manual ways. A computerized dismantling is certifiably not a genuine dismantling, which is completed altogether by robots and workforce [8]. Because of the distinctive sort of battery frameworks and diverse arrangements and structures, mechanized dismantling is regularly impractical. Difficulties incorporate the institutionalization of sizes, associations, labelling and marking of individual parts in whole frameworks. There are some fundamental mechanism that is required for the dismantling of a battery framework. These are:

• Evacuation of the cover, i.e. Opening of the battery framework.
• Removal of electrical associations between the battery modules and electronic segments.
• Removal of the mechanical associations between the framework parts (modules, hardware) and the battery base.
• Expulsion of the electronic parts.
• Expulsion of the battery modules.
• Dismantling of the battery modules and expulsion of the battery cells.

4.1. Virtual disassembly

In comparison to actual life dismantling process, there is no compelling reason to ceaseless watch dismantling process. There is likewise less human inclusion is this procedure. Prior to the procedure begin user have all data in regards to battery segments, weights, numbers, materials, dismantling rules of the generation procedure and exactly made illustration demonstrating insights about the assembling of different parts ought to be available [9]. Souser can use this information's for providing guidance to automatic machines.

4.2. Hybrid human and robot disassembly

In the robot-helped, dismantle of the EV batteries there is a thought of workstation. Human and robot both can access battery pack in the dismantling process. A typical workspace is shared between a robot and human for reducing system complexity and time spend between frequent transports of goods between workstations. Besides, the human and robot likewise expects access to their own particular dismantling devices. Human can use the various apparatus including pincers, screwdrivers, a mallet and cutting instruments. Similarly robot can use various kinds of attachments like wrench bits for its unscrewing workspace. The human completes more perplexing errands, for example, prying separated parts joined with snap fits or paste and hauling out or cutting links, at that time robot detaches all screws and fasteners. The position of the screws and fasteners can be either feed physically in robot program or identified by means of a sensor and camera. Robotic arm for these workstations ought to be lightweight to diminish the hazard related to impacts. Then again, the robot ought to have an adequate load limit and have the capacity to make up for the powers and torques created from taking care of an electric screwdriver and extricating screws.

5. Electric vehicle and complexity in recycling

With the increase in count of electric vehicles in upcoming years, is resulting in difficulty in recycling of batteries and handling environmental issues. Currently, governments are not focusing on making policies and issue notification for recycling and waste management after recycling. This will cause unsafe city environment. The rise in the battery use in the future, led city environment to unsafe scenarios and unsustainable conditions [2].

6. Lack of component information to facilitate recycling

The involution of material mixing as an anode and enhancement in inner design of battery makes the complex structure of the battery. To make high performance and reduce in weight make use of more electronic component and hazardous chemicals to be used in battery pack, this will cause an increase in complexity. It is evident that these elements and chemicals present in battery pack would cause difficulty in recycling. At the present recycling and recovery of material in present battery, pack is very lesser in amount, if users want to increase the amount of recovery that will result in high cost. Therefore, the lesser accessibility to the information for product design and material composition causes difficulty in recycling [10].

7. Proposed architecture interface design

The proposed recycling framework depends on cloud computing foundation alongside sensors helpful for checking the weight, measurement, material utilized and measure of material recovery from recycling. Every one of the information is exchanged to the cloud server utilizing internet enable device as shown in fig-1 and fig-2. All the recycling station is equipped with internet and server for continuous working. To keep away from the hazardous circumstance sensors is introduced to screen the activity. The proposed innovation essentially stays away from the accident in task. In proposed recycling engineering interface configuration is sent with basic segments associated with cloud computing. The remote sensor organize is utilized to screen the parameters. A protocol is utilized to exchange the information from sensors. User can utilize financially accessible gateways for coordinating sensors. The facilitator hub will gather every one of the information from sensors through a gateway and keeps up line list. The line list dispatches the information as indicated by the need. This innovation utilizes the priority-based calculation for dispatching the information from a line. To maintain a strategic distance from the breakdown condition different sensors are introduced to screen the robotic arm status. The proposed innovation fundamentally increment material recuperation rate and lessen waste material come out from recycling and essentially stays away from the accident in task.

7.1. Battery pack screw detection by camera

This perspective is applied for detection of battery type it will include size of battery and construction of battery. The camera also detects what kind of screws is used in battery construction. That will send data to the main server, the main server will able to select a corresponding program stored in a library (cloud) as shown in fig-1. From a cloud, corresponding guidance is given to a robotic arm for dismantling of a particular type of battery. Our thinking is that this can be improved by:

•Using a higher resolution camera with sensors.
•Using images in the disassembly process to give instruction to robotic

7.2. Proposed bit changing process

By bit selection, process robotic arm can select any tool for a common socket wrench. This will not cause any change in robot structure. Robotic arm can directly select and change a bit from various bits present in main slot. In robotic arm have a notch that is wider on upper side and narrow at down side. This will help to easily separate bit form toolbox. The motion of a robot is controlled by an external computer that will take all tasks as finite automation. Robotic arm speed is monitored within the specific states. The main flaw into previous arrangement is taking robotic arm to work position is by a human to removed screw by using sensors and camera in this arrangement.

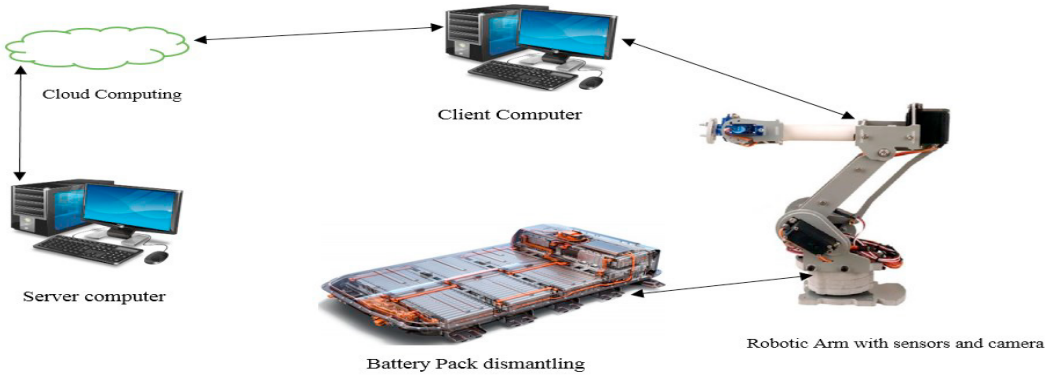

Fig-1 Proposed setup for cloud based disassembly of electric vehicle battery

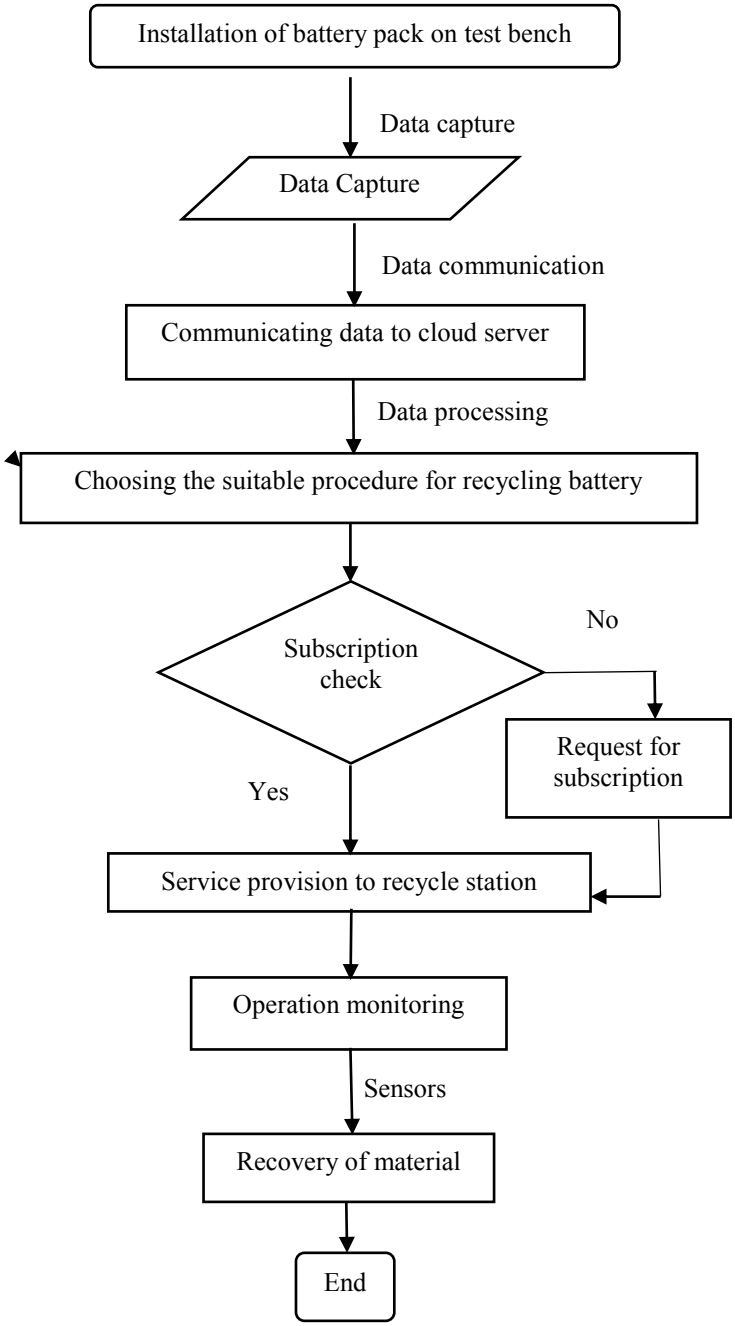

Fig-2 Proposed flowchart for cloud based disassembly of electric vehicle battery

7.3. **Fuzzy logic prediction and working**

Electric vehicle battery boost information is exchanged with cloud servers through the internet and other programming empowered gadget. The sensors used to track the battery type and size of batteries utilized as a part of

a vehicle. Every one of the information's are stored in the incorporated server, which is kept up in the cloud. Every permit recycling plant proprietor can get to the cloud utilizing web-based interface as shown in Fig-2. From the online interface, the client can recover all the continuous information. The internet has empowered gadget used to exchange the information to the server. The sensors are included to screen the vital parameter of the automated robotic arm. Cloud computing, sensor based battery pack dismantling service offers the environmentally friendly and lower cost service. Cloud based dismantling with the robotic arm will save worker from hazardous chemicals and as well as a condition of explosion during dismantling of batteries. From the analysis, user can find it will reduce costs and as well as time to dismantle a battery pack.

8. Conclusion

The reality of creating a fully cloud based electric vehicle battery pack dismantling (recycling and reuse) canters required considerable initial investment. User can get profit only from large-scale battery recycling. This process is of low working cost in comparison to the conventional battery recycling method. A battery is a costly part present in an electric vehicle so by getting the maximum recovery from the used battery pack. User can reduce the cost of a new battery by using the old battery material. Battery pack disassembly is a dangerous process because of the toxic chemical present inside it. Sometimes due to high temperature, the battery pack may explode that may cause serious injuries. So cloud-based disassembly is best suitable medium to use new and efficient technology in various places at the same time in a cost effective way.

9. Future work

In this paper, authors try to give a safe and economical ways of dismantling of electric vehicle batteries. There is a lack of data from various automotive designers and battery manufactures, comparative study between current method and cloud based disassembly of batteries yet to be done.

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