

Vegetable Cutting Machine

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Abstract: A Vegetable cutting machine was designed and constructed. It is automated to reduce the effort of human and it works with the help of electric DC motor. (Rotation motion & Crank lever mechanism). The vegetable is kept on the cutter bed made of stainless-steel sheet to drum which carries blade made of stainless steel. The chute is constructed of stainless steel. It accepts the chopped vegetable and release it out with the aid of gravitational force and also is used for higher scale vegetable cutting application. It has an innovative emergency switch for the safety while system is under automated.

Keywords: Chute, Crank-lever mechanism, DC motor, Emergency switch.

1. Introduction

In olden days, knives are used for vegetable cutting, it requires more time. In addition, skill was required for chopping vegetables finely. There is chance of getting injuries while cutting the vegetables due to negligence or recklessness. Typically, it is very tough for physically disabled people. In present days, life styles of the people are changed. In most of the families, both of the couple are working in the companies. Therefore, they do not have time for cooking so they are depending on the hotels near the working and living areas. It is one of the reasons for increase in the number of medium and small sized hotels in India. In the larger hotels, they can afford highly advanced latest equipment for cutting vegetables in short time. However, small and medium hotel owners cannot afford such advanced equipment for vegetable cutting. Therefore, they take more time for vegetable cutting. Cutting vegetables becomes difficult for handicapped, and they have to depend on others.

2. Literature Survey

A. Strawberry cutting machine

Stavros Vougioukas et al. (2018) A mechanized device for expelling the tops (calyx) of strawberries as they move along a transport line having a plurality of inward - molded opened rollers which work to situate the calyx of every strawberry for being cut. Pictures are caught and prepared for finding the calyx of each strawberry and deciding an ideal cutting plane. Because of the picture handling a control framework incites a sharp edge in a slicing contraption to go through the produce thing and into one of the spaces in a roller, or rollers, to isolate the calyx from the body of the strawberry.

B. Waste removal machine

Antonio Turatti. (2017) creating gadget to make a separate waste bit of organic products sticking to passing on unit by vacuum, passing on unit being orchestrated downstream setting and moving unit and a cutting unit for cutting organic products in correspondence of third goal zone, for example, to evacuate said particular waste segment of said organic products.

C. Leaf cutting machine

Vaibhav K et al. (2018) This venture is planned to examine the structure leaf cutting machine. This machine can be utilized for the horticultural reason and it very well may be additionally utilized in the nourishment ventures. Leaf cutting machine deals with transport line and shaper game plan. Onions are sustained through encouraging transport line into the machine. India is world's second biggest Onion gathered. Be that as it may, yet Farmers forms onion by hand work after collect to evacuate the leaves and roots. This activity is alluded to as garnish which is tedious and They Can't manage the cost of New Techniques Because of the expense of Appraisal Our Motive is to supply them with viable and proficient strategy for gathering to decrease human exertion without harming the onion, Efforts to date have all been toward enormous and costly hardware and none of these has up 'til now been culminated in order to arrive at the market. A Prototype targets cutting leaf of onion utilizing transport line and cutters to cut onions which can be gathered in plate for additional handling or bundling.

D. Paneer cutting machine

Avinash V et al. (2017) this examination paper manages issues of manual paneer cutting in industry. The assembling procedure is currently persistently in process. In the wake of assembling, the paneer pieces ought to be cut in the necessary sizes and get pressed. In Ardash Soya Products, this work is going physically. As the manual impedance is included, the cutting and pressing activity making issue. Additionally, it is tedious. In addition, when the pieces get cut, it ought to be of the necessary weight. For that the principle intention is to focus on paneer cutting and bundling. Along these lines, the point of the venture is to give cutting framework and recommend bundling unit the financial downturn is among the most exceedingly terrible foe to the entirety of humanity. The insecure economy execution additionally making enterprises breakdown particularly the low and medium went firm. This would a lot of effect the augmentation of nourishment costs and

all food supplies that accessible in the market. The vast majority of the nourishment processor accessible in the market is imported and exorbitant just as extra labor and time utilization brought about by manual handling.

E. Vegetable bundling machine

Yan Bao. (2017) the volume is anything but difficult to upgrade the electric control arrangement of machine conveying bundle of dishes and minimal effort. The heap of vegetable machine should meet the sensor to distinguish and control, so as to meet the control necessities, restricting power can be balanced by the catch to accomplish, lashing rate likewise can be balanced, by the keys to set, sensors and mechanical line association, helpful activity can be straight forwardly associated with the fitting, the 220V force supply can be associated with a force source. if, can work, by the transmission signal sensor.

F. Potato cutting machine

Htay Win et al. (2019) This examination exhibits the plan and execution investigation of potato cutting machine (shaft structure and rectangular cutting sharp edge). The fundamental reasons for this examination are to build the potato cutting machine and does execution test. And afterward, the static auxiliary examination of the pole is finished by utilizing ANSYS 14.5 programming. At that point, the hypothetical and explanatory consequences of von-Misses stresses and compelling strain are thought about. In this examination, shaft width is determined by utilizing ASME code condition. Mellow steel shaft is chosen for configuration to acquire high quality. The length of shaft is 600mm and the determined distance across of turning shaft is 20mm. Single-push profound furrow metal balls 6804 and 6904 are chosen. The pressure investigation for shaft is led utilizing ANSYS14.5 by numerical methodology and furthermore the von-Misses stresses and powerful strain are determined hypothetically. From the correlation, hypothetical and numerical proportionate von-Misses stresses and successful strains are almost the equivalent. By watching the investigation results, the pressure esteems got are not exactly the yield quality 247MPa of gentle steel. In this way, the plan is sheltered under working condition. The presentation of the machine is tried and the productivity of the machine is 85% with limit 3.8 kg/min.

G. Potato cutting machine

Aung Ko Latt et. al. (2019) In the creation procedure for potato chips fabricating industry, the idea of potato chips shaper is used for the satisfaction of the advanced procedure. The generation of potato is more in the rustic territory of Myanmar. The little enterprises depend on such kind of exercises which requires a few aptitudes for expanded pace of cutting of chips with the base exertion. The electrically worked gadget is intended to cut the crude potatoes into slight cuts of thickness 3 mm around, reasonable for fricasseeing and heating as potato chips. From the examination, the limit of system is 4.3 kg of

potato every moment. Locally and effectively accessible materials like cast iron, mellow steel and tempered steel are utilized for the development of potato cutting machine. This machine permits in its straightforwardness of structure and unassuming expense with the capacity to produce dainty uniform cuts of the potatoes for the chip's maker with the assistance of electric force framework.

H. Cucumber seed separator

Larasati Ribut Prihatin et al. (2018) Balitsa (Vegetable Crops Research Institute) is an examination focus that has numerous exercises, one of them is about plant incubation facilities. One of the plants that have been incubation facility is cucumber. Incubation facility process or seeds have been isolated with manual procedure utilizing human force. At the point when yields increment, the amount of intensity required naturally. In 2017, a cucumber seed separator was made. The machine performs two phases, cutting the two finishes and isolating the seeds. In the cutting procedure position of the sharp edge and cucumber didn't move, so it made numerous cucumbers were squandered. Due to that reason, in this examination we plan a device that cut the two parts of the bargains by altering its length to lessen the amount of burned through cucumber with progressively proficient time. Consequence of this examination shows that with utilizing this device, the exactness cut the two parts of the bargains is 99,875 % pattern precision. With this instrument can decrease the measure of cucumber that is squandered. Due the consequence of this investigation, for cutting the two parts of the bargains the planned apparatuses need longer amount of times than utilizing human force. Time that required are not completely effective, yet can be diminish human force that required for cutting and isolating cucumber seeds. This instrument can diminish the amount of squandered cucumber until 25.31733%.

I. Lemon cutting machine

Gunjal A. Vet et al. (2016) Computerization was the anger of the building scene. The examination on the current Lemon cutting machine audits the accompanying downsides, for example, high speculation cost, the defilement, extra labor and time utilization brought about by manual preparing. The arrangement includes a container course of action and the weight square is incited by a pneumatic chamber, and has a responding movement along the vertical length of packaging, while the cutting lattice stays fixed. The air supply to the chamber is constrained by a solenoid impelled DCV, which is constrained by a Timing circuit. The passage of Lemon into the lattice mechanical assembly is controlled utilizing a pneumatic chamber alongside a Double bar instrument. The essential goals, whereupon, the present work is based are giving an option in contrast to the current mechanized framework for the most part, focusing on the underlying speculation factor, and to control a local item utilizing pneumatics, in this way taking out the related challenges of manual vegetable cutting. The Lemon is carried by means of slanted cylinder. A plate is set at the base

of the mechanical assembly to gather the Lemon pieces in the wake of handling. Variable weight setting for cutting diverse Lemon is completed by the Timing circuit. The unpredictability engaged with such a framework is the sort of Lemon it can process. The framework is invaluable in the way that current robotization is high in cost, and the force utilization is high. The proposed work is profited by pneumatic force, which is bottomless.

J. Mechanical vegetable cutting machine

Matsumoto. (2013) A vegetable cutting mechanical assembly which incorporates a pivot driving unit, a cutting unit, and a bolstering unit having a vegetable irregular nourishing gadget the encouraging unit is furnished with a drive roller and a determined roller which are introduced across side dividers on a level plane reaching out from the cutting unit, a transport line which is introduced between the two rollers, and a holding roller which is arranged over the transport line on the back side thereof with a freedom to the transport line being held; and a single direction grip is mounted to the drive roller to such an extent that, with shaking turning thereof, the drive roller is discontinuously revolution driven, in this manner the vegetables put on the transport line being irregularly sustained, and at the hour of cutting activity, bolstering of the vegetables can be halted.

K. Leaf cutting machine (root vegetable)

Cedomir Repac et al. (2016) The creation identifies with a gadget for cutting leafy foods, specifically onions, having a shaper part that has a majority of sharp edges and having a partner component against which the shaper part is squeezed for slicing the material to be cut, wherein the partner component has a punch which presses the material to be sliced through the shaper part, or the edges thereof. For accepting the cut material, a holder is releasable arranged on the shaper part, on its side remote from the partner component, in the district of the sharp edges.

L. Root vegetable cutting machine

Catherine Lewis (2012) The creation identifies with a cutting gadget for foods grown from the ground, ideally onions, and incorporates a cutting part having crossing blade sharp edges or equal blade edges framing a matrix, and a counter cushion, against which the cutting part can be pushed in the process cutting the onion at issue. The counter cushion onion and proposed to enter the openings or depressions of the blade edge network when the cutting part is in a totally down-tilted situation over the cutting-board. Ion is established by a cutting-board having a midway found cutting part and which by means of a joint looking like a pivot is Swinging associated with the slicing board to permit the blade sharp edge matrix to complete a Swinging development toward the path down towards the front line and one onion in position consequently. Inside the zone significantly coinciding with the zone of the blade sharp edge lattice the cutting-board shows a majority of projections

supporting.

M. Pneumatic vegetable cutter

Robert A. Arnold (2015) A reacting to cutting instrument remembers a shank for mounting for a pneumatic sledge, a sharp edge holder gets together associated with the shank and an edge braced in the edge holder get together. The sharp edge holder gathering incorporates a base part and a retainer part which are clasped together. A cutting-edge beneficiary is shaped between the base and retainer U.S. Patent Documents individuals. The base part incorporates a break and the retainer part incorporates a shoulder which is gotten in the base part break for projection by a fixed finish of the cutting edge. A technique for expelling adhesively-connected ornamentation from a vehicle body board incorporates the means of furnishing an edge holder get together with base and retainer individuals, giving an edge a proximate end and a distal having a honed distal forefront, clipping the base Waller stein. Furthermore, retainer individuals together with the cutting-edge proximate end. There between, giving the retainer part a shoulder adjoining the sharp edge proximate end against the shoulder, responding the edge holder get together and propelling the edge front line through glue between the ornamentation and the vehicle body board.

N. Vertical vegetable cutting machine

William C et al. (2014) A vertically broadening base of rectangular cross segment with an upwardly opening compartment in that is adjustably gotten inside the comparatively designed downwardly opening assembly of an overlying lodging. The upper finish of the base removable mounts a shaper plate. The top board of the lodging removable mounts a palm-held force unit. The force unit, through a focal opening in the top board, mounts components which secure a vegetable for pivot by the force unit as the lodging is moved downwardly over the base for commitment of the vegetable logically with the shaper plate. The parts dismantle and store in settled connection to one another.

O. Prismatic vegetable cutter

Charles. R et al. (2011) the present innovation includes a handle having at least one coring get together broadening apparently and away from one finish of the handle. The coring gathering is a constant ring of flimsy, treated steel having a cross-segment of a known geometric shape, a hover in the least complex structure. The ring is joined to, or is an augmentation of, a slim crisscross band divide which is joined to the handle.

P. Fruit cutting machine

Avigdor Orr et al. (2008) An improved method of slicing fresh fruits and vegetables utilizing a high-pressure fluid jet that minimizes bruising throughout the cut pieces and tissue damage in the vicinity of the cut surface.

Q. Vegetable slicier

Arnold G. Schaumberg. (2014) A helpful and reasonable

contraption for cutting, dicing and cutting staples, for example, leafy foods, particularly those having shifting densities all through their volume, involving a level base part having a majority of upstanding peg individuals to help an article to be cut and a pivot able cutting edge upheld by the base part and conveying a majority of cutting blades every one of which has a twofold edged blade surface for slicing through the article. A separable dicing casing can be slide ably embedded contiguous the blade outline gathering for the dicing of an article.

3. Conclusion

This vegetable cutter appears to be ergonomically effective, less prone to muscular stress. Thus, this work acts as an alternative to the existing automatic vegetable cutter, in terms of automation the vegetable enters into the cutting apparatus. The time consumed is less when compared to manual cutting. It provides the desired output and the variety of the shapes is done by use of different cutting grid. It is noticed that automation will help to cut the vegetable with perfect shape.

References

- [1] S. Ganyani and Tawanda Mushiri, Design of an Automated Vegetable Cutter and Slicer (2019).
- [2] Kamlesh Pradhan, Amar Dandale, AkshayDhenge, RiteshBanpurkar, Review Paper on Semi-Automatic Chips Machine (2013).
- [3] Subrata Talapatra, Md. Shakil, Pritom Kumar Mondal, Md. Saiful Islam, Implementation of Product Design Tools for the Development of an Automated Vegetable Chopper (2017).
- [4] Kumar, R. S., Alexis, J., & Thangarasu, V. S. (2017). Optimization of high-speed CNC end milling process of BSL 168 Aluminium composite for aeronautical applications. *Transactions of the Canadian Society for Mechanical Engineering*, 41(4), 609-625.
- [5] Kumar, S. R., Alexis, J. S., & Thangarasu, V. S. (2017). Experimental Investigation of Influential Parameters in High Speed Machining of AMS 4205. *Asian Journal of Research in Social Sciences and Humanities*, 7(2), 508-523.
- [6] Ganeshkumar, S., Thirunavukkarasu, V., Sureshkumar, R., Venkatesh, S., & Ramakrishnan, T. Investigation of Wear Behaviour of Silicon Carbide Tool Inserts and Titanium Nitride Coated Tool Inserts in Machining of EN8 Steel.
- [7] Kumar, S., Alexis, J., & Thangarasu, V. S. (2016). Prediction of machining parameters for A91060 in end milling. *Advances in Natural and Applied Sciences*, 10(6 SE), 157-164.
- [8] Kumar, R. S., Thangarasu, V. S., & Alexis, S. J. (2016). Adaptive control systems in CNC machining processes--a review. *Advances in Natural and Applied Sciences*, 10(6 SE), 120-130.
- [9] Kumar, S., Alexis, J., & Dhanabala Krishnan K.P (2015). Application of GA & ANN for the Optimization Of Cutting Parameters for end milling operation- a comparison. *International Journal of Applied Engineering Research*, 10(20), 18092-18107.
- [10] Manual Slicer and Dicer Apparatus for fruits and vegetables (2014) Arnold G. Schaumberg
- [11] Method for slicing fruits and vegetables (2008) Avigdor Orr, Highland Park; John O. Spingler, Plainsboro, both of N.J.
- [12] Charles. R. Device and method for Coring and Cutting of fruits and vegetables (2011).
- [13] William C. Dobson; David C. Belongia, Vegetable Cutting Device (2014).
- [14] Ramakrishnan, T., & Pavayee Subramani, S. (2018). Investigation of Physico-Mechanical and Moisture Absorption Characteristics of Raw and Alkali Treated New Agave Angustifolia Marginata (AAM) Fiber. *Materials Science*, 24(1), 53-58.
- [15] Ramakrishnan, T., & Sampath, P. S. (2017). Dry Sliding Wear Characteristics of New Short Agave Angustifolia Marginata (AAM) Fiber-Reinforced Polymer Matrix Composite Material. *Journal of Biobased Materials and Bioenergy*, 11(5), 391-399.
- [16] Jeyakumar, R., Sampath, P. S., Ramamoorthi, R., & Ramakrishnan, T. (2017). Structural, morphological and mechanical behavior of glass fiber reinforced epoxy nanoclay composites. *The International Journal of Advanced Manufacturing Technology*, 93(1-4), 527-535.
- [17] Ramakrishnan, T., & Sampath, P. S. (2017). Experimental investigation of mechanical properties of untreated new Agave Angustifolia Marginata fiber reinforced epoxy polymer matrix composite material. *Journal of Advances in Chemistry*, 13(4), 6120-6126.
- [18] Ramamoorthi, R., Jeyakumar, R., & Ramakrishnan, T. (2017). Effect of Nanoparticles on the Improvement of Mechanical Properties of Epoxy Based Fiber – Reinforced Composites - A Review. *International Journal for Science and Advance Research in Technology*, 3(11), 1251- 1256.
- [19] Ramakrishnan, T., Sampath, P. S., & Ramamoorthi, R. (2016). Investigation of Mechanical Properties and Morphological Study of the Alkali Treated Agave Angustifolia Marginata Fiber Reinforced Epoxy Polymer Composites. *Asian Journal of Research in Social Sciences and Humanities*, 6(9), 461-472.
- [20] Ramakrishnan, T & Sampath, P.S. (2016). Thermo gravimetric Analysis (TGA) and the Effect of Moisture Absorption on the Mechanical Properties of New Agave Angustifolia Marginata 3 Fiber (AAMF) Reinforced Epoxy Polymer Composite Material. *International Journal of Printing, Packaging & Allied Sciences*, 4(5), 3245-3256.
- [21] Ramakrishnan, T., Sathish, K., Sampath, P. S., & Anand Kumar, S. (2016). Experimental investigation and optimization of surface roughness of AISI 52100 alloy steel material by using Taguchi method. *Advances in Natural and Applied Sciences*, 10(6 SE), 130-138.
- [22] Sathish, K., Ramakrishnan, T., & Sathish Kumar, S. (2016). Optimization of turning parameters to improve surface finish of 16 Mn Cr 5 material. *Advances in Natural and Applied Sciences*, 10(6 SE), 151-157.
- [23] S. Karthik Raja S. Balasubramani, S. Venkatesh, T. Ramakrishnan (2015). Effect of Cryogenic Tempering on Steel. *International Journal of Mechanical and Civil Engineering*, 2 (6), 98-113.
- [24] Reciprocating cutting tool and method (2015) Robert A. Arnold Cutting device for fruits and vegetables, preferably onion (2012).
- [25] Catherine Lewis, Device for cutting fruits vegetables, in particular onions (2016).
- [26] Cedimir Repac, Branko Culig. Vegetable Cutting Apparatus, (2013).
- [27] Gunjal A. V, Shinde K. L, Sonawane R.V, Dike A. P, Gujrathi T. V, Bhane A.B., Automatic Pneumatic Operated Lemon Cutting Machine (2016).
- [28] Venkatesh, S., & Sakthivel, M. (2017). 'Numerical Investigation and Optimization for Performance Analysis in Venturi Inlet Cyclone Separator', *Desalination and Water treatment*, Vol. 90, No. 9, pp. 168-179.
- [29] Venkatesh, S., Sakthivel, M., Sudhagar, S., & Ajith Arul Daniel, S. (2018). 'Modification of the cyclone separator geometry for improving the performance using Taguchi and CFD approach', *Particulate Science and Technology*.
- [30] Venkatesh, S., Bruno Clement, I., Avinasilingam, M., & Arulkumar, E. (2017). "Design of Experiment Technique for Improving the Performance of Stirling Engine", *International Research Journal of Engineering and Technology*, Vol. 4, No. 5, pp. 62-65.
- [31] Venkatesh, S., Balasubramani, S., Venkatramanan, S., &Gokulraj, L. "Standardization of hpx spool for lead time reduction of string test", *Journal of Mechanical and Civil Engineering*. 2, No. 6, pp. 62-79.
- [32] Kousalya Devi, S., Venkatesh, S., &Chandrasekaran. P. (2015). "Performance Improvement of Venturi Wet Scrubber," *Journal of Mechanical and Civil Engineering*, Vol. 2, No. 4, pp. 1-9.
- [33] Arunkumar, P., Dhachinamoorthi, P., Saravanakumar, K., &Venkatesh, S. (2014). "Analysis and Investigation of Centrifugal Pump Impellers Using CFD," *Engineering Science and Technology: An International Journal*, Vol. 4, No. 4, pp. 112-117.
- [34] Dhanabalakrishnan, K.P., Abuthakir, J., Subramanian, R., Venkatesh, S. (2015). "Evaluation of Tensile Properties of Particulate Reinforced Al-Metal Matrix Composites," *Engineering Science and Technology: An International Journal*, Vol. 5, No. 1, pp. 173-175.
- [35] Design of Automatic Cutting Cucumber System on Seed Sperator Machine (2018).
- [36] Larasati Ribut Prihatin, Porman Pangaribuan, Ramdhan Nugraha, Yusi Duwi Satriyo Design and Construction of Potato Slicing Machine. (2019).

- [37] Aung Ko Latt, Aunti Min Thaw, Design and Performance Analysis of Potato Slicing Machine (Shaft Design and Rectangular Cutting Blade) (2019).
- [38] Htay win, Myint thein, Mg Chan Myae Aung, Design of Electric Control System for Automation Vegetable Bundling Machine, (2017).
- [39] Yan Bao, CAD Modelling and analysis of Different Size Paneer Cutting Machine, (2017).
- [40] Avinash V. Gaikwad, Pravin S. Ghawade. F. Justin Dhiraviam, V. Naveenprabhu, M. Santhosh, "Study the Effects of Solar Assisted Vapour Compression Air Conditioning System for Winter Applications", International Journal for Scientific Research & Development, Vol 4(11), (2017), pp. 505-508.
- [41] Vaibhav K. Kale, Deepak A. Kawade, Tushar D. Shinde, Pavan S Vhanamane, Keshav Pagar, Onion Leaf Cutting Machine. (2018).
- [42] V. NaveenPrabhu, K. SaravanaKumar, T. Suresh and M. Suresh," Experimental investigation on tube-in-tube heat exchanger using nanofluids", Advances in Natural and Applied Sciences, Vol. 10(7), (2016), pp. 272-278.
- [43] V. Naveenprabhu, D. Mugeshkumaar, K. B. Pravin, V. Ranjith, S. Sanjay Arthanari Swamy," A Review of Evaporative Cooling of Finned and Non-Finned Heat Exchanger on Condenser", International Journal for Scientific Research & Development, Vol 6(2), (2018), pp. 459-461.
- [44] V. Naveenprabhu, F. Justin Dhiraviam, A. Vimal, K. Kumarrathinam," Design of Common Header Line for Reduction of Process Time in Pump Testing", International Research Journal of Engineering and Technology, Vol. 4(1), (2017), pp. 969-975.
- [45] Antonio Turatti, Automatic Machine for Cleaning up and Cutting fruit, Particularly Strawberries or Radishes (2017).
- [46] Stavros Vougioukas, Davis, David Slaughter, Davis, Dennis Sadowski, Davis, Long He, Richland, Adrien Durand, Petite Ville, Davis, Automated Strawberry Orienting and Capping Machine (2018).
- [47] B. Santhosh Kumar, et.al," Effect of Load on Joint Efficiency and Hardness in Friction Stir Welding of AA6061 & AA6063 Aluminium Alloys.", International Journal for Scientific Research & Development, Vol 6(2), (2018), pp. 2669-2771.
- [48] Ganesh Kumar, S & Thirunavukkarasu, V 2016, Investigation of Tool Wear and Optimization of Process Parameters in Turning of EN8 and EN 36 Steels, Asian Journal of Research in Social Sciences and Humanities . vol. 6, no.11, pp. 237 – 243.
- [49] Kumar, S. D., Kumar, S. S., & Kumar, K. A. (2018). Investigation of Forced Frequency in a Commercial Vehicle Suspension System. Mechanics and Mechanical Engineering, 22(4), 967-974
- [50] Balasubramani, S., & Balaji, N. (2016). Investigations of vision inspection method for surface defects in image processing techniques-a review. Advances in Natural and Applied Sciences, 10(6 SE), 115-120.
- [51] Balasubramani, S., Dhanabalakrishnan K.P., Balaji, N. (2015) Optimization of Machining parameters in Aluminium HMMC using Response Surface Methodology. International journal of applied engineering research, 10(20), 19736-19739.
- [52] Subramaniam, B., Natarajan, B., Kaliyaperumal, B., & Chelladurai, S. J. S. (2018). Investigation on mechanical properties of aluminium 7075-boron carbide-coconut shell fly ash reinforced hybrid metal matrix composites. China Foundry, 15(6), 449-456.
- [53] Sureshbabu, Y., & AshokaVarthanan, P. Study the emission characteristics of catalytic coated piston and combustion chamber of a four-stroke spark ignition (SI) engine. Journal of Chemical and Pharmaceutical Sciences.
- [54] Sureshbabu, Y., & AshokaVarthanan, P. (2018) Study the emission characteristics of catalytic coated piston and combustion chamber of a four-stroke spark ignition (SI) engine. International Journal for Scientific Research & Development, 6(02), 1981-1983.