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Quantitative Molecular Imaging in Cancer Diagnosis, Detection, and Treatment

By, Adya Rateria (BE/10712/2014), Biotechnology

Guide: **Kenneth M. Tichauer, PhD**

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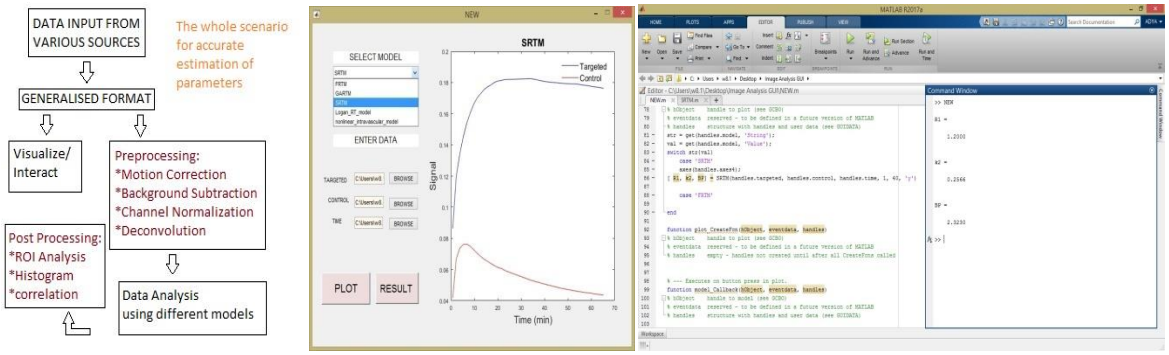
Quantitative Molecular Imaging(QMI) has played a pivotal role in the field of cancer research and treatment. By targeting desired biomolecules and using fluorescent markers, QMI allows for more exact analysis of the absence or overexpression of certain growth factors, namely Epidermal Growth Factor Receptors (EGFR).The most widely used molecular imaging method involves injecting a single imaging agent. Then after waiting a period of time the tissue is imaged. Although fluorescence patterns are visible, there are issues with the imaging that arise due to physiology tendencies of tissues as well as natural non-specific uptake of the imaging agent in non-cancerous tissue. This approach has its limitations however. In contrast to single agent imaging, introducing two imaging agents (one control and one targeted) has been experimentally calculated to provide more a more accurate image and identification of cancerous tissue. This method is especially useful in determining small cancer cells. As imaging methods are becoming increasingly more complex due to new techniques and findings, applying them to real-world applications such as cancer research needs be simplified for a number of reasons. Our software and metric calculations would provide researchers a tool to effectively and productively use fluorescence imaging. It essential is a toolbox for researchers studying quantitative molecular imaging in specific to targeted and paired imaging agents. This toolbox software will simplify long calculations and corrections so researchers can focus on the most important task at hand: finding solutions.

My team's goal was to utilize MATLAB to develop a software package that processes user-input molecular imaging data to obtain quantities of interest. This software will be interactive with the user and guide the user through a graphic user interface (GUI) that is applicable to a various number of imaging devices. The software will primarily allow users to input data, choose pre-processing data correction, analyze data through various calculative methods, view post-processing images through metrics, and finally allow users for easy interaction and visualization with images. Considering the benefits of paired agent imaging, it was decided that an open source software package can be written to automate data analysis of images. This could lead to wider spread use of the method and encourage further development of the software



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CONTROLLING BIOFILMS FOR MEDICAL AND ENVIRONMENTAL APPLICATION

-SHWETA SHREE (BE/10714/14)- BIOTECHNOLOGY

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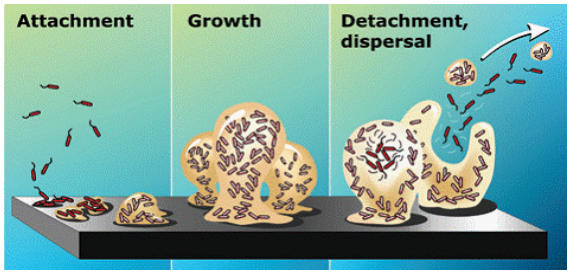
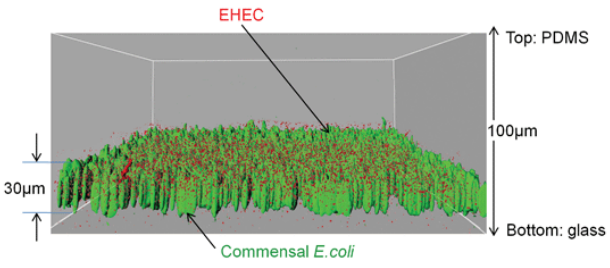
Enterohemorrhagic Escherichia coli O157:H7 (EHEC) is a world-wide human food-borne pathogen which causes mild to severe diarrhoea, hemorrhagic colitis, and hemolytic uremic syndrome. The ability of this pathogen to persist in the environment contributes to its dissemination to a wide range of foods and food processing surfaces. The formation and persistence of surface-attached microbial communities, known as biofilms, are responsible for 75% of human microbial infections (National Institutes of Health). Biofilm formation is a dynamic and complex process and includes initial attachment of cells to the substratum, physiological changes within the organism, multiplication of the cells to form microcolonies, and eventually maturation of the biofilm. The research was basically based upon engineering of beneficial microbes for controlling deleterious biofilms and treatment of persistent infectious diseases. Biofilms, known for its resiliency, have come forth as an attractive target for addressing persistent infectious diseases and biofouling problems.

Escherichia coli strain Nissle 1917 (EcN) is a probiotic bacteria and is non pathogenic. It is one of the widely used remedial bacterial strains. Previously, based on our earlier results EcN cells are found to inhibit the EHEC biofilm formation. Transformation or modification in the EcN genome can be done easily. Mutation of these EcN WT cells leads to the increase in the dual biofilm which means maybe the gene responsible for the inhibition has been deleted due to mutation and thus cannot inhibit EHEC dual biofilms. Further screening and sequencing will confirm the gene sequence which is accountable for the EHEC-EcN dual biofilm inhibition. Earlier studies have focused on studying genetic factors that control EHEC biofilm formation on a global scale, although studies of this type have been performed with other bacterial pathogens. Our results reinforced the fact that dual biofilm formation is a complex process involving a large number of genes and genetic pathway. In summary, interactions between specieswithin a mixed biofilm are influenced by several factors, including production of antibacterial agents, metabolic requirements, and environmental conditions. Any change in one or more of these factors can dramatically impact the structure and dynamics of the biofilm community. Studies of mixed biofilms are beginning to unravel the complexity of interspecies interactions and their impact in clinical and environmental settings.

We studied interactions of multi-species biofilms and tried to engineer beneficial microbes to control deleterious biofilms. We applied protein/genome engineering and synthetic biology tools for engineering beneficial microbes for use as a drug delivery vehicle and a drug synthesis factory. This may provide insights into novel strategies for controlling biofilm-associated problems in medical, environmental and food-related areas.





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Leadership in Energy andEnvironmental Design (LEED)

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As quoted in an ASCE journal (Robichaud, 2010), "we define green building as a philosophy and associated project and construction management practices that seek to:

• 1- Minimize impacts on environment, natural resources and non renewable energy resources to promote sustainability of the environment.

• 2- Enhance the health, wellbeing and productivity of the whole environment and community.

• 3- Cultivate economic development and financial returns for developers and whole community.

• 4- Apply life cycle approaches to community planning and development."

Leadership in Energy and Environmental Design (LEED) is a mostly used green building rating system in the world. It is a globally recognized symbol of sustainability achievement. According to the U.S Green Building Council (USGBC), the benefit of LEED is that it works for all buildings at all phases of development. LEED certified buildings are resource efficient in which they use less water and energy and reduce greenhouse gas emissions. In the long term, LEED buildings save money. According to a research conducted on sustainable development, any necessary change in an upfront cost of about 2% on sustainable development, results on an average savings of 20% of total construction cost (Azhar, 2011). Hence sustainable buildings are economically viable.

In the United States of America, LEED is a program that provides third-party certification of sustainable buildings and is the most utilized method of certifying a building's environmental performance. They address to all types of buildings such as residential, commercial, healthcare, retails, schools, and also every phase of building lifecycle such as planning, construction, operation and maintenance. Development of LEED began in 1993 which was supported by the initiative of USGBC. The first version of LEED v1.0 was developed in 1998, LEED v2.2 in 2008 and the third edition of LEED 2009 (previously named LEED v3) in 2009. LEED v4 was released in 2013 and is being used widespreadly in all the parts of U.S.A. LEED is generally applicable in U.S industry because it is compatible with U.S codes, rules and regulations. Other countries have different types of certification.

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IMPLEMENTATION OF BIM FOR STRUCTURAL DESIGN AUTHORING AND COST PLANNING

By-Nitin Agrawal (BE/10550/14)
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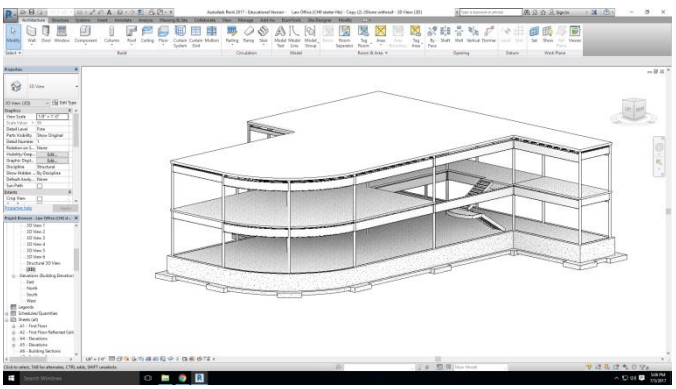
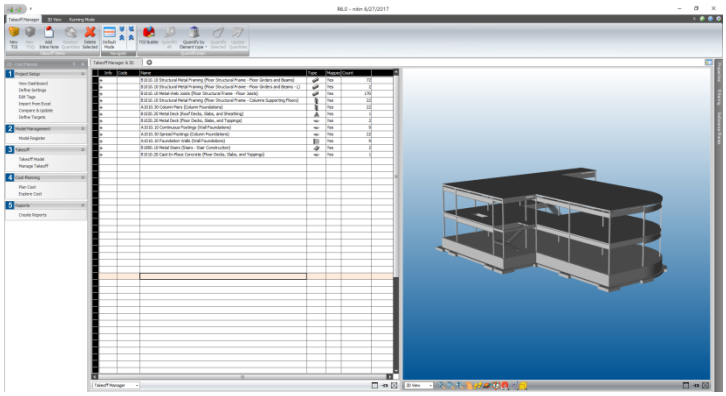
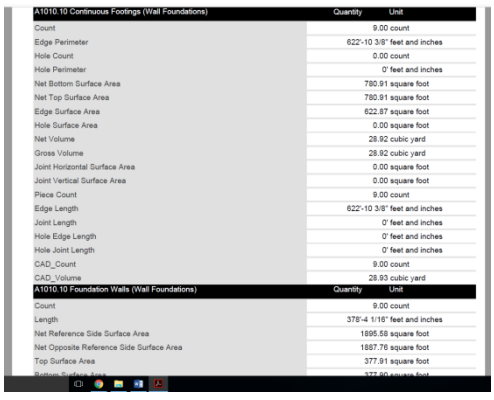
Building Information Modelling (BIM) is a process, which has changed the way infrastructure projects are initiated, carried out and maintained throughout their lifecycle. According to National BIM Standard-United States, BIM is a digital representation of physical and functional characteristics of a facility. It serves as a shared knowledge resource for information and forms a basis for decisions during its life cycle. In this experiential research I designed a structural 3D model in Autodesk Revit for visualization and generated reports (Quantity Takeoff Report and Cost Plan Report) in Vico Software. In the process of research I learned about what is BIM and also the 3D software Autodesk Revit as well as the 5D software Vico Office.This knowledge is very crucial as it is the future of the Construction industry.

Apart from our report that was submitted at the end of the programme, we had to give presentation in an expo held for summer research students like ourselves. We presented our posters in the Armour R&D Expo.

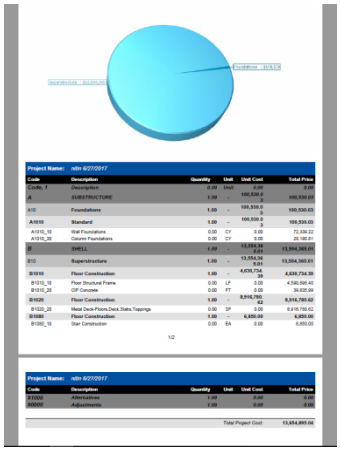
My research workflow was as follows:







A1010.10 Continuous Footings (Wall Foundations)	Quantity	Unit
Count	9.00	count
Edge Perimeter	622'-10 3/8"	feet and inches
Hole Count	0.00	count
Hole Perimeter	0'	feet and inches
Net Bottom Surface Area	780.91	square foot
Net Top Surface Area	780.91	square foot
Edge Surface Area	622.87	square foot
Hole Surface Area	0.00	square foot
Net Volume	28.92	cubic yard
Gross Volume	28.92	cubic yard
Joint Horizontal Surface Area	0.00	square foot
Joint Vertical Surface Area	0.00	square foot
Piece Count	9.00	count
Edge Length	622'-10 3/8"	feet and inches
Joint Length	0'	feet and inches
Hole Edge Length	0'	feet and inches
Hole Joint Length	0'	feet and inches
CAD_Count	9.00	count
CAD_Volume	28.93	cubic yard
A1010.10 Foundation Walls (Wall Foundations)	**Quantity**	**Unit**
Count	9.00	count
Length	378'-4 1/16"	feet and inches
Net Reference Side Surface Area	1895.58	square foot
Net Opposite Reference Side Surface Area	1887.76	square foot
Top Surface Area	377.91	square foot



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Effective Calculation of Volumes of Earthwork Using a UAV Unmanned Aerial Vehicles for Construction Projects

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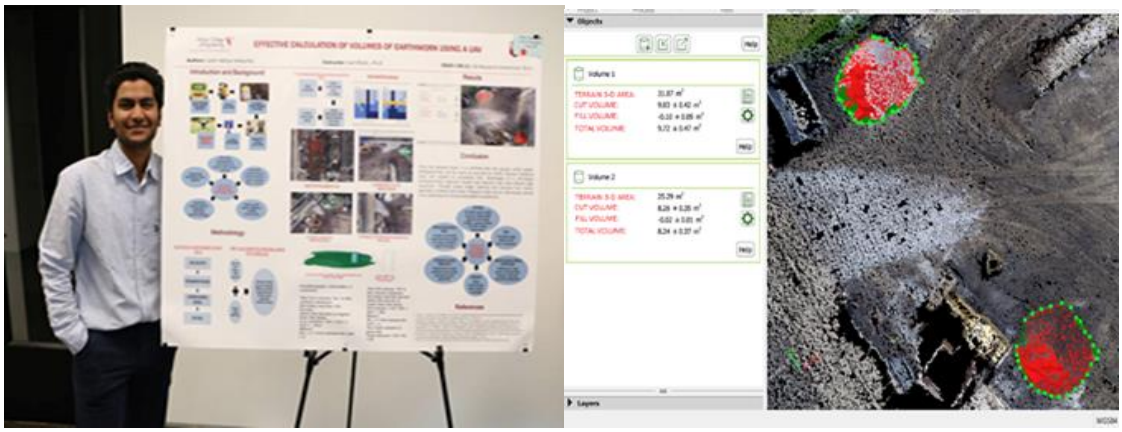
Abstract:A major share of surveyors and construction engineers in the construction sector have scrutinized various engineering measurement technologies for efficient calculation of distances, areas and volumes in a construction site. With the use of certain surveying instruments such as EDM, total station, laser scanner and robotic total station, preceding research efforts achieved appreciable progress in measuring and mapping technology. Systematic and meticulous computations of volumes of earthwork using a UAV can overcome challenges associated with accuracy, data acquisition time, accounting and inventory adjustments, reporting to banks and capital expenditures in an AEC firm. To test the reliability and robustness of earthwork measurement using UAVs, aerial images of Morton Park, a site under construction in Illinois Institute of Technology, Chicago were acquired and post processed using Pix4DMapper, a photogrammetric software to create a densified point cloud, a triangular mesh and an orthomosaic. During this process, concepts of structure-from-motion approach and dense image matching techniques were utilized for point cloud generation. A 3-D densified point cloud of the site was effectively exploited to compute volumes of two earthwork stockpiles on the site. Based on test results, earthwork volume measurement using a UAV showed significant improvement in precision compared to conventional surveying methods.



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Fast object detection using Deep Neural Networks
Pedestrian Detection using Faster R-CNN

By, Venkata Swaroop Matte (BE/10053/14)

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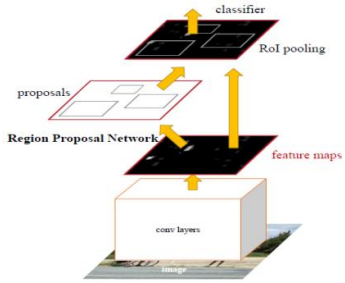
Pedestrian detection is a key problem in computer vision, with several applications that have the potential to positively impact quality of life. One of the most popular applications is for self-driving cars. One of the major challenges for a robotic car is pedestrian detection. In recent years, the number of approaches to detecting pedestrians in monocular images has grown steadily. However, multiple data sets and widely varying evaluation protocols are used for this task. We have used Faster R-CNN dedicatedly for the task of pedestrian detection in order to achieve the needed processing speed for real time detection. In Faster R-CNN it consists of a Region Proposal Network to generate proposals and Fast R-CNN detector to classify the object.

We have used the already existing code of Faster R-CNN by By Shaoqing Ren, Kaiming He, Ross Girshick and Jian Sun, which was done using the Caffe Framework and Matlab and trained using ZF net. We have used the Caltech pedestrian dataset for training and testing part of this project. Our model will be trained using the training sets of the Caltech dataset after converting them from seq files to images and also converting the annotations for those images from their vbb format to xml format to match the pattern like the Pascal VOC dataset in order to easily train the pedestrian detection model. We have made all the appropriate changes like changing the dataset, changed the number of classes and dimensions of the input images in the matlab scripts and also made changes in the prototxt files to train the dataset. For the testing part, we have used the pre-trained model of Faster R-CNN trained with ZF net and used the test images of Caltech pedestrian dataset which constitute of 4024 images and performed evaluation of the model. We also had to make few significant changes to the pre-trained model in order to use the Caltech dataset. We changed the model so that it can be trained with only a single class, 'Person'.

The Faster R-CNN model for pedestrian detection using the Caltech dataset turned out to be effective. It has achieved a processing speed of 32.25 fps and the average execution time is 0.031secs. The precision and the processing speed in the results can be improved by modifying the architecture of the Faster R-CNN model in a better way. We have achieved a low miss rate when compared with the other non-CNN based models.



a) Faster-RCNN network b) Initial image c) Final image

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Fast Object Detection Using Deep Neural Networks

Pedestrian Detection using Single Shot Multi-Box Detector

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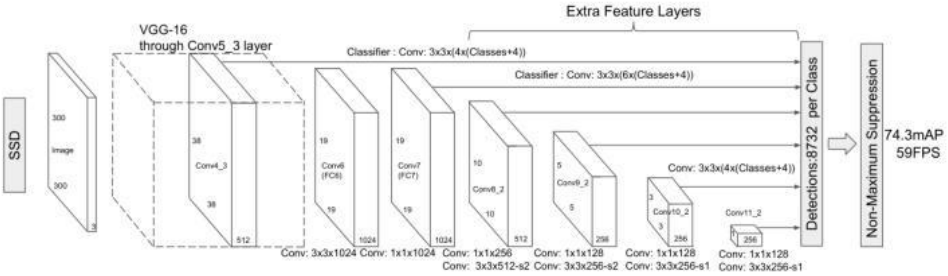
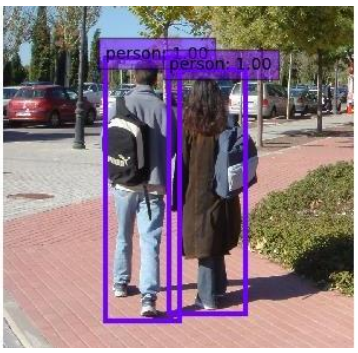
Over the past years, quantum leaps have been noticed in everyday technology. Speech Recognition, Object Detection and other artificial intelligence applications are gaining popularity with time. There has been a threefold rise in the use of speech recognition over past two years. They work much better now and are far more convincing. Billions of images are being uploaded every minute on social media and this rate will keep on increasing in coming years. Availability of so much data has revealed all forms of human form. Thus, accuracy of pedestrian detection has been improved over the years. Now the parameter which needs enhancement is speed.

Most of the current state of the art object detectors take an input image and generates object proposals. Second step includes resampling of pixels for each bounding box. Which then passes the proposals to a high-quality classifier. This type of approach is computationally too intensive and too slow for real time applications like self-driving cars. Single shot multi-box detector is the answer to this problem. With extra feature convolutional layers, it doesn't need to resample the image. It can work for images with different scales. Its Accuracy is comparable to the other state of the art detectors however, its speed is enhanced. Hence speed vs accuracy tradeoff is improved. The objective of this study is to implement fast and efficient pedestrian detector using single shot multi-box approach. Training and testing is built on caffe framework.

We managed to achieve multi-box loss of less than one and miss rate of 41.39 % which is much less as compared to rest of state of the art detectors. Caffe was run on a machine with 12 GB Nvidia GTX 1080 Ti GPU.



Single Shot Multi-Box Detector



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The Adaptive Cycle Engine

Simulation of 6 stroke gasoline engine

Guide: Francisco Ruiz*(Associate Professor)*
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Manikandan Suresh(BE/10318/2014)

Utkarsh Gupta(BE/10145/2014)

We propose to study a new class of internal-combustion engine's working cycles bearing an intrinsically higher thermal efficiency and achieve lower carbon emissions than those in use today.

Bounded by the 2nd law of thermodynamics, the conventional gas guzzlers yield a low efficiency of 40%, given the combustion temperature, there is still a lot of room for improvement when compared with the Carnot cycle limit yielding 88.9% (1-300K/2700K). This boost can be acquired by unveiling concepts like heat regeneration, alternative fuels and many more but we dropped down to the basics and are trying to implement a new working cycle altogether.

'Adaptive': This term is coined owing to the flexible nature and variable number of the strokes involved in a particular cycle.

Keys to the adaptive cycle are:

1. Decoupling compression and expansion strokes within each cylinder.

2. Multiple expansion or compression strokes in a cycle.

3. Electronically controlled valves.

4. Knock reduction owing to ignition after Top Dead Centre (TDC).

5. Acts as 'hybrid' of sorts by storing energy as compressed air instead of a battery.

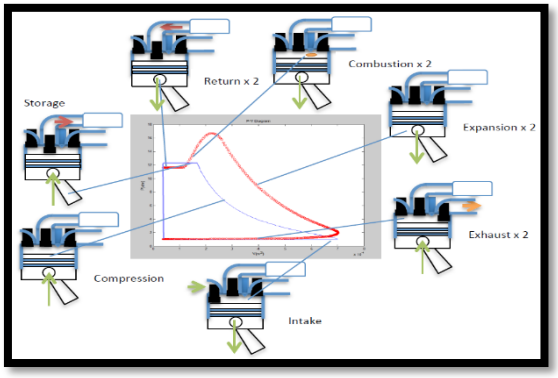

Figure 1 General concept with a six-stroke

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SIMULATION:

- Performed simulations on the 6 stroke gasoline based engines on the GT-POWER engine simulation software

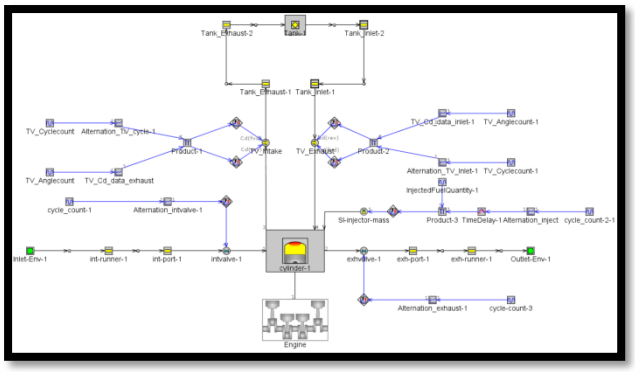

Figure 2: GT POWER simulation model

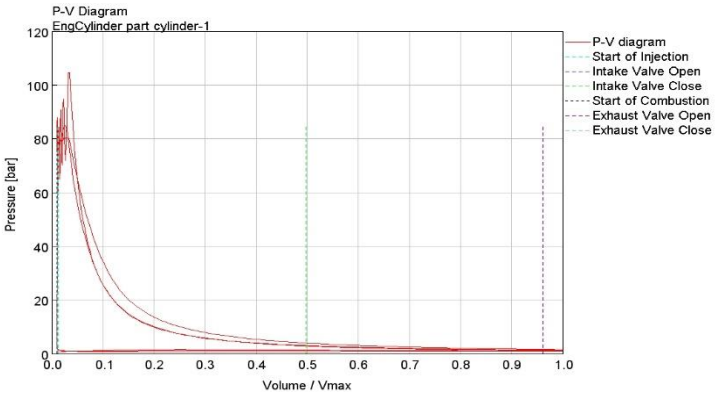

Figure 3: P-V diagram of 6 stroke gasoline engine

CONCLUSION:

The results indicated that despite having a lesser indicated mean effective pressure than the conventional four stroke cycle, the overall work is considerably greater owing to an additional expansion stroke with the same amount of gasoline injected per cycle. Specifically, different simulations were conducted to calculate this number and results show that work is around 30-35% greater. Following the same procedure indicated thermal efficiency of the engine maintains the same relation.

FUTURE PROSPECTS:

If the coordinated experiments and simulations are successful, we will have achieved an internal combustion engine capable of:

- Doubling the fuel economy of current vehicles
- Reducing engine size by two-thirds for a given power output.
- There is also the possibility of reducing emissions, especially of NOx, below what is achievable with four-stroke engines
- Being able to use fuels of low octane rating without causing knock.
- Production costs and expected reliability are far better than current offerings, including hybrid and electric power plants.

This will be the first practical engine with a high-speed computer-controlled valve apparatus, which can be applied also to conventional four-stroke engines in order to increase their power and reduce emissions and fuel consumption.

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Stochastic Modeling of Project Schedule and Expected NPV

-Guided by Dr Prasad S Kodukula, Phone- +1 (312) 543-6539, prasad@kodukula.com

Asawari Singh (BE/10717/14) Neeharika Valluri (BE/10732/14)

Project investment decisions are often based on estimates of project schedule, cost, and net present value (NPV),among other factors. The estimation models typically apply a deterministic approach using a single set of input values. Such estimates likely are over- optimistic and unrealistic, because:

1) Input values have uncertainty.
2) Schedule and cost risks are often ignored.
3) A fixed path is assumed for the project outcome, although management has the flexibility to make decisions contingent upon how the project unfolds.

To overcome these limitations, PMHawks-2016 developed HawkEye, a software tool that offers a "hawk's view" of project risks and uncertainty using a stochastic approach.
Our team, PMHawks-2017, added two major functions to this tool: Project schedule risk analysis and decision tree analysis.
HawkEye uses Visual Basic for Applications (VBA) on Microsoft's Excel platform. It employs Latin Hypercube sampling method for Monte Carlo simulations to generate stochastic values of the inputs and output to the estimation model.
For stochastic schedule analysis, we linked HawkEye to Microsoft Project, which provides the schedule estimates.
We created the capability for HawkEye to draw decision trees and calculate expected NPVs (ENPVs) at various decision nodes stochastically.
Project schedule estimates based on stochastic models that account for both uncertainty and risk are more realistic.
HawkEye is an effective tool for simulations. It generates probability density function (PDF) and cumulative distribution function (CDF) graphs for the inputs and outputs of various models. It also performs sensitivity analysis to determine which inputs have the highest impact on the output and calculates "correlation coefficients," "critical indexes," and "crucial indexes" for project schedule.
Decision trees account for probability of project success and contingent decisions and offer better insights into a project's outcome. This will help executives in making better project selection decisions.