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Research Article

Business Support System using Hybrid Classification Algorithm

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Abstract

Cataloguing and patterns extraction from customer data is very important for business support and decision making. Timely recognition of newly emerging trends is needed in business process. Changing market trends need to be taken into consideration for predicting which products have more demand. This paper is about integrating two different algorithms, one is clustering algorithm, which is K-means and other is to find most frequent pattern i.e MFP which will help the back end of a company i.e production and inventory management unit to understand what product is selling more and which has a slow selling rate. In this way company can increase their profit by stocking the market with only those products that people buy.

Keywords: *K-Means, Most Frequent Pattern (MFP), Data mining.*

1. Introduction

Data is very important for every organization and business. Data that was measured in gigabytes and is now being measured in terabytes, and will soon approach the peta byte range. In order to achieve our goals, we need to fully exploit this data by extracting all the useful information from it.

Unfortunately, the size and complexity of the data is such that it is impractical to manually analyse, explore, and understand the data. As a result, important information is often unnoticed, and the prospective benefits of increased computational and data gathering capabilities are only partially realized.

Sale data classification has different market trends. Some clusters or segments of sale may be growing, while others are declining. The information produced is very useful for business decision making.
Decision can take place on the basis classification of Dead-Stock (DS), Slow- Moving(SM) and Fast-Moving (FM) of the sale. Segment by segment sales forecasting can produce very useful information.

The forecasting can be short, mid and long term. Long term forecasting may not produce precise predictions.

However, it is very useful in understanding market trends. It is easy to turn cash into stock, but the challenge is to turn stock into cash (www.roselladb.com). Effective inventory management enables an organization to meet or exceed customer's expectations of product availability while maximizing net profits and minimizing costs. Only through data mining techniques, it is feasible to extract useful pattern and association from the stock data. Data mining techniques like clustering and associations can be used to find meaningful patterns for future predictions.

Clustering is used to generate groups of interrelated patterns, while association provides a way to get generalized rules of dependent variables. Patterns from a huge stock data on the basis of these rules can be obtained. The behaviour in terms of sales transaction is significant. The general term used for such type of analysis is called Market Basket Analysis. Typically there are various items placed in a market for selling, in which some of the product will have a fast selling rate, some will have a slow selling rate and some will be dead stock i.e. rarely selling items.

We consider a scenario of super store or supermarket in distributed environment, or internet based data processing environment. Decision making in business sector is considered as one of the crucial tasks. There is study for data mining for inventory item selection with cross selling considerations which is used for maximal-profit selling items. But our problem is finding out the selling power of the products in the market. (Vivek Ware and Bharathi H. N, 2014).

This is a useful approach to distinguish the selling frequency of items on the basis of the known attributes, e.g. we can examine that a "black coat of imperial company in winter season has high trade", and here are a few qualities related to this example, i.e. colour, type, company, season, and location.

Similarly we can predict that certain products of certain properties have what type of sale trends in different locations. Thus on the basis of this scenario

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we can predict the reason of dead-stock, slow moving and fast moving items. Data mining techniques are best suited for the analysis of such type of classification, useful patterns extraction and predictions.

2. Data Mining

Data mining techniques provide people with new power to research and manipulate the existing large amount of data. Data mining process recognizes interesting information from the hidden data which can either be used for future prediction and/or for intelligently summarizing the details of the data. There are so many achievements of applying data mining techniques to various areas such as marketing, medical, financial and manufacturing. (Jiawan Han and Micheline Kamber, 2004).

In this paper, a proposed data mining application in the manufacturing domain is explained. The application demonstrate the capability of data mining techniques in providing important analysis such as launch analysis and slow turning analysis. Such analysis help in providing manufacturing market with base for more accurate prediction of future market demand.

Data mining technology is one of the strong pillars in customer relationship management (CRM) and plays a vital role in business expansion.

By knowing customer behavior based on previous records, growing profits from cross-selling and other business strategies can be achieved. The behavior in terms of sales transactions is considered significant. Data mining on such transactions is called market basket analysis.

We consider the scenario of a manufacturing firm or a supermarket. Typically there are a lot of variations in the items offered, and the volume of transactions can be very large. For instance, Hedberg (1995) reports that the American supermarket chain Wal-Mart keeps about 20 million sales transactions per day. This enormous volume of data requires sophisticated methods in the analysis.

Effective Decision making in the business sector is considered one of the critical tasks in data mining.

3. Proposed Method

Our proposed approach is a two phased model. Firstly we make use of Flat Files and Online Transaction Processing to obtain customer data and then we combine it into Data Sets. Once we have the combined the data sets we apply the K-Means algorithm to divide the data sets into clusters. These clusters are formed on the basis of the attributes of a particular product.

After forming these clusters we need to classify the products as slow moving (SM), fast moving (FM) and dead stock (DS). Slow moving stock is considered to be a category of those products which have a slow selling rate. Fast moving stock is the category of products which have the highest sale or the highest demand amongst consumers. Dead stock is the category of products that is completely dormant.

After the products have been categorized into slow moving, fast moving and dead stock we apply the Most Frequent Pattern Algorithm to extract frequent patterns. Once the patterns have been extracted we store it into Knowledge Discovery Database.

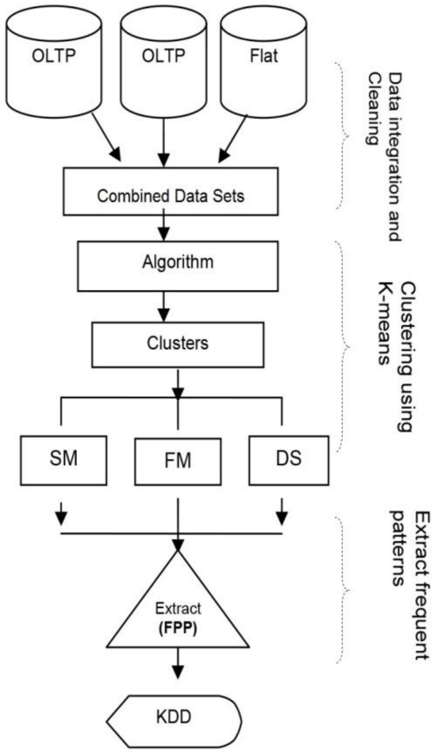


Fig.1 Block Diagram of Proposed Method

4. K-MEANS

Clustering is the process of splitting an assemblage of data points into a lesser number of clusters. For instance, the items in a supermarket are clustered in categories (butter, cheese and milk are grouped in dairy products). In our case, number of products of particular attribute sold will be partitioned in three clusters i.e slow moving, fast moving and dead stock. In general, we have n data points xi, i=1...n that have to be partitioned in k clusters. The goal is to assign a cluster to each data point. K-means [5] is a clustering method that aims to find the positions μi, i=1...k of the clusters that minimize the distance from the data points to the cluster.

K-means clustering solves

$$\arg\min \sum_{i=1}^{k} \sum_{x \in c_i} d(x, \mu_i) = \arg\min \sum_{i=1}^{k} \sum_{x \in c_i} \|x - \mu_i\|^2$$

Where ci is the set of points that belong to cluster i. The K-means clustering uses the square of the Euclidean distance d(x,μ_i)=||x-μ_i ||^2.

This problem is not trivial (in fact it is NP-hard), so the K-means algorithm only hopes to find the global minimum, possibly getting stuck in a different solution. K-means algorithm is used to solve the k-means clustering problem and works as follows,

First, decide the number of clusters k. Then:

1. Initialize the center of the clusters.
2. Attribute the closest cluster to each data point.
3. Set the position of each cluster to the mean of all data points belonging to that cluster.
4. Repeat steps 2-3 until convergence.

5. Most Frequent Pattern

Association rule learning is a popular and well researched method for discovering interesting relations between variables in large databases. It is suggested to identify strong rules discovered in databases using different measures of interestingness. It is widely used in various areas such as risk management, telecomm, market analysis, inventory control, and stock data. In data mining, association rules are useful for analyzing and predicting customer behavior. They play an important part in shopping basket data analysis, product clustering, and catalog design and store layout. For strong association among the patterns Apriori algorithm is highly recommended. In this work a new algorithm MFP, which more efficiently generates strong associations and frequent patterns in the clusters is used.

For this reason a property matrix comprising calculated values of analogous properties of each product has been used as shown in Figure 2.

Let's have a set X of N items in a dataset having set Y of attributes. This algorithm counts maximum of each attribute values for each item in the dataset.

MFP Algorithm: *Let we have set X of N items in a Dataset having set Y of attributes. This algorithm counts maximum of each attribute values y_{ij} for each item in the dataset.*

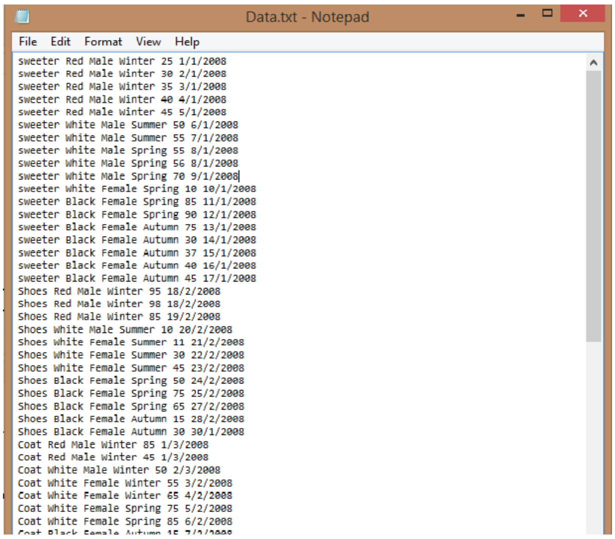
Input: Datasets (DS) Output: Matrix
Frequent Property Pattern (FPP):

```
FPP        (DS)
Begin
                    for each item Xi in DS
                        a. for each attribute
                            i.   count occurrences
                                 for Xi
                                 C=Count (Xi)
                            ii.  Find attribute name
                                 of C
                                 Mi=Attribute (Ci)
                        next [End of inner loop]
                        b.  Find Most Frequent Pattern
                            i.  MFP=Combine(Mi)
                    next [End of outer loop]
    End
```

Fig.2 Proposed Algorithm for Frequents Pattern Extraction

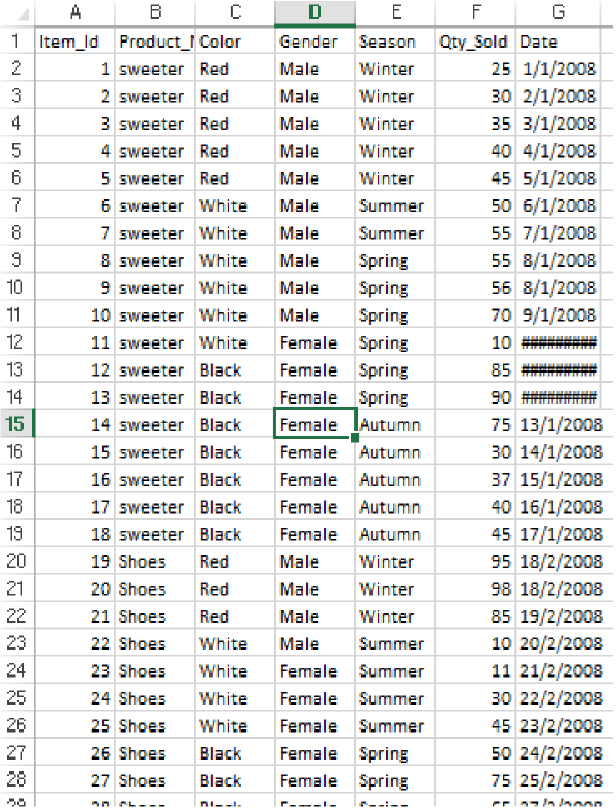
6. Experiment and Result

To implement our concept we made a demo data set as shown in fig.3. The processing is done on this data set and all the spaces between the parameters are removed and stored in the database, which is a processed data (fig.4)



```
sweeter Red Male Winter 25 1/1/2008
sweeter Red Male Winter 30 2/1/2008
sweeter Red Male Winter 35 3/1/2008
sweeter Red Male Winter 40 4/1/2008
sweeter Red Male Winter 45 5/1/2008
sweeter White Male Summer 50 6/1/2008
sweeter White Male Summer 55 7/1/2008
sweeter White Male Spring 55 8/1/2008
sweeter White Male Spring 56 8/1/2008
sweeter White Male Spring 70 9/1/2008
sweeter White Female Spring 10 10/1/2008
sweeter Black Female Spring 85 11/1/2008
sweeter Black Female Spring 90 12/1/2008
sweeter Black Female Autumn 75 13/1/2008
sweeter Black Female Autumn 30 14/1/2008
sweeter Black Female Autumn 37 15/1/2008
sweeter Black Female Autumn 40 16/1/2008
sweeter Black Female Autumn 45 17/1/2008
Shoes Red Male Winter 95 18/2/2008
Shoes Red Male Winter 98 18/2/2008
Shoes Red Male Winter 85 19/2/2008
Shoes White Male Summer 10 20/2/2008
Shoes White Female Summer 11 21/2/2008
Shoes White Female Summer 30 22/2/2008
Shoes White Female Summer 45 23/2/2008
Shoes Black Female Spring 50 24/2/2008
Shoes Black Female Spring 75 25/2/2008
Shoes Black Female Spring 65 27/2/2008
Shoes Black Female Autumn 15 28/2/2008
Shoes Black Female Autumn 30 30/1/2008
Coat Red Male Winter 85 1/3/2008
Coat Red Male Winter 45 1/3/2008
Coat White Male Winter 50 2/3/2008
Coat White Female Winter 55 3/2/2008
Coat White Female Winter 65 4/2/2008
Coat White Female Spring 75 5/2/2008
Coat White Female Spring 85 6/2/2008
Coat Black Female Autumn 15 7/2/2008
```

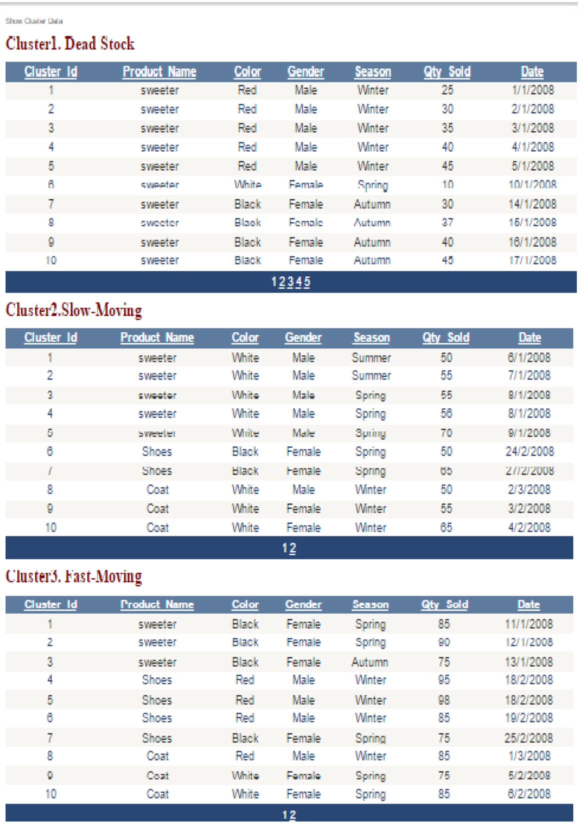
Fig 3 Data Set



	A	B	C	D	E	F	G
1	Item_Id	Product_I	Color	Gender	Season	Qty_Sold	Date
2	1	sweeter	Red	Male	Winter	25	1/1/2008
3	2	sweeter	Red	Male	Winter	30	2/1/2008
4	3	sweeter	Red	Male	Winter	35	3/1/2008
5	4	sweeter	Red	Male	Winter	40	4/1/2008
6	5	sweeter	Red	Male	Winter	45	5/1/2008
7	6	sweeter	White	Male	Summer	50	6/1/2008
8	7	sweeter	White	Male	Summer	55	7/1/2008
9	8	sweeter	White	Male	Spring	55	8/1/2008
10	9	sweeter	White	Male	Spring	56	8/1/2008
11	10	sweeter	White	Male	Spring	70	9/1/2008
12	11	sweeter	White	Female	Spring	10	#########
13	12	sweeter	Black	Female	Spring	85	#########
14	13	sweeter	Black	Female	Spring	90	#########
15	14	sweeter	Black	Female	Autumn	75	13/1/2008
16	15	sweeter	Black	Female	Autumn	30	14/1/2008
17	16	sweeter	Black	Female	Autumn	37	15/1/2008
18	17	sweeter	Black	Female	Autumn	40	16/1/2008
19	18	sweeter	Black	Female	Autumn	45	17/1/2008
20	19	Shoes	Red	Male	Winter	95	18/2/2008
21	20	Shoes	Red	Male	Winter	98	18/2/2008
22	21	Shoes	Red	Male	Winter	85	19/2/2008
23	22	Shoes	White	Male	Summer	10	20/2/2008
24	23	Shoes	White	Female	Summer	11	21/2/2008
25	24	Shoes	White	Female	Summer	30	22/2/2008
26	25	Shoes	White	Female	Summer	45	23/2/2008
27	26	Shoes	Black	Female	Spring	50	24/2/2008
28	27	Shoes	Black	Female	Spring	75	25/2/2008
29	28	Shoes	Black	Female	Spring	65	27/2/2008

Fig.4 Processed Data

Once we have the processed data, K-means clustering is done on the data and the data gets partitioned into three clusters, FM, SM and DS clusters as follows.



Show Cluster Data

Cluster1. Dead Stock

Cluster Id	Product Name	Color	Gender	Season	Qty Sold	Date
1	sweeter	Red	Male	Winter	25	1/1/2008
2	sweeter	Red	Male	Winter	30	2/1/2008
3	sweeter	Red	Male	Winter	35	3/1/2008
4	sweeter	Red	Male	Winter	40	4/1/2008
5	sweeter	Red	Male	Winter	45	5/1/2008
6	sweeter	White	Female	Spring	10	10/1/2008
7	sweeter	Black	Female	Autumn	30	14/1/2008
8	sweeter	Black	Female	Autumn	37	15/1/2008
9	sweeter	Black	Female	Autumn	40	16/1/2008
10	sweeter	Black	Female	Autumn	45	17/1/2008

1 2 3 4 5

Cluster2.Slow-Moving

Cluster Id	Product Name	Color	Gender	Season	Qty Sold	Date
1	sweeter	White	Male	Summer	50	6/1/2008
2	sweeter	White	Male	Summer	55	7/1/2008
3	sweeter	White	Male	Spring	55	8/1/2008
4	sweeter	White	Male	Spring	56	8/1/2008
5	sweeter	White	Male	Spring	70	9/1/2008
6	Shoes	Black	Female	Spring	50	24/2/2008
7	Shoes	Black	Female	Spring	65	27/2/2008
8	Coat	White	Male	Winter	50	2/3/2008
9	Coat	White	Female	Winter	55	3/2/2008
10	Coat	White	Female	Winter	65	4/2/2008

1 2

Cluster3. Fast-Moving

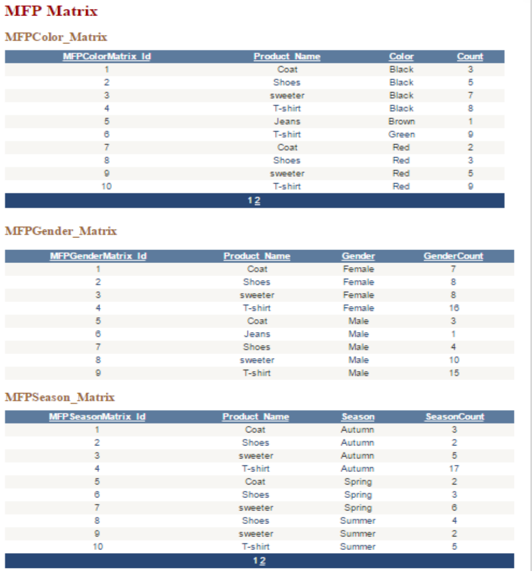
Cluster Id	Product Name	Color	Gender	Season	Qty Sold	Date
1	sweeter	Black	Female	Spring	85	11/1/2008
2	sweeter	Black	Female	Spring	90	12/1/2008
3	sweeter	Black	Female	Autumn	75	13/1/2008
4	Shoes	Red	Male	Winter	95	18/2/2008
5	Shoes	Red	Male	Winter	98	18/2/2008
6	Shoes	Red	Male	Winter	85	19/2/2008
7	Shoes	Black	Female	Spring	75	25/2/2008
8	Coat	Red	Male	Winter	85	1/3/2008
9	Coat	White	Female	Spring	75	5/2/2008
10	Coat	White	Female	Spring	85	6/2/2008

1 2

Fig.5 Clusters

The second phase of the proposed algorithm i.e MFP, is used to generate a MFP matrix for a more comprehensive classification of the products based on its three parameters, which are color, gender and season.

Fig.6 shows the MFP matrix. From that matrix we can say that product T-shirt of color green and red has highest number of quantity sold. Product T-shirt of gender female has highest number of sold quantity which is 16. And product T-shirt is sold maximum in Autumn with count value 17.



MFP Matrix

MFPColor_Matrix

MFPColorMatrix Id	Product Name	Color	Count
1	Coat	Black	3
2	Shoes	Black	5
3	sweeter	Black	7
4	T-shirt	Black	8
5	Jeans	Brown	1
6	T-shirt	Green	9
7	Coat	Red	2
8	Shoes	Red	3
9	sweeter	Red	5
10	T-shirt	Red	9

1 2

MFPGender_Matrix

MFPGenderMatrix Id	Product Name	Gender	GenderCount
1	Coat	Female	7
2	Shoes	Female	8
3	sweeter	Female	8
4	T-shirt	Female	16
5	Coat	Male	3
6	Jeans	Male	1
7	Shoes	Male	4
8	sweeter	Male	10
9	T-shirt	Male	15

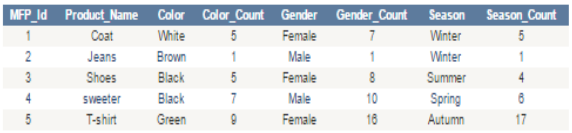
MFPSeason_Matrix

MFPSeasonMatrix Id	Product Name	Season	SeasonCount
1	Coat	Autumn	3
2	Shoes	Autumn	2
3	sweeter	Autumn	5
4	T-shirt	Autumn	17
5	Coat	Spring	2
6	Shoes	Spring	3
7	sweeter	Spring	6
8	Shoes	Summer	4
9	sweeter	Summer	2
10	T-shirt	Summer	5

1 2

Fig.6MFP Matrix

Finally, we combine all the individual matrixes and display it based on the products. Which product has the highest selling rate is given with the help of this final forecasting result shown in Fig 7. Each product is taken into consideration and based on its parameters which has maximum count in its corresponding matrix from Fig 6. is fetched and displayed in the final result. For example, Shoes of color black, gender female and season summer has highest count with respect to all the parameters of shoes. So in this way we can understand the pattern of the products being sold and forecast which products should be restocked in the market.



MFP_Id	Product_Name	Color	Color_Count	Gender	Gender_Count	Season	Season_Count
1	Coat	White	5	Female	7	Winter	5
2	Jeans	Brown	1	Male	1	Winter	1
3	Shoes	Black	5	Female	8	Summer	4
4	sweeter	Black	7	Male	10	Spring	6
5	T-shirt	Green	9	Female	16	Autumn	17

Fig.7 Forecasting Result

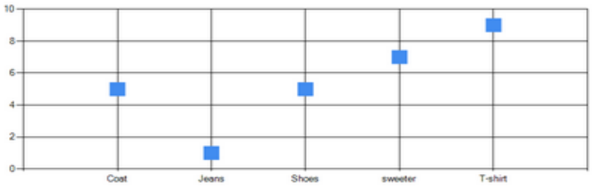


Fig.8 Graphical Representation

7. Future Work

The proposed hybrid classification algorithm will prove its mettle in managing the inventory and to provide a necessary support to the business. After analyzing the customer purchase data of the market, we can move to analyzing the sentiments of the customer in the future. This sentiment analysis will be done by getting the customer reviews and web posts from the internet about the products sold online. This will help in understanding the consumers effectively.

Conclusion

In this paper, we have addressed the problem of managing the inventory and stock data. We have proposed the hybrid classification algorithm to narrow down the huge amount of data into more manageable set of data by identifying frequent patterns in the sales of the products. The K-means and MFP algorithm together are going to prove efficient in managing the data and increase the productivity of the company.

Acknowledgement

We would like to thank our project guide Professor Sonal Maskeen for her enormous co-operation and guidance. All the inputs given by her have found a place in the project. The technical guidance provided by her was more than useful. We are also grateful to our head of the department, Professor Mahendra Patil who has guided us. Lastly we would not be able to conduct this research without the infrastructure and facilities provided by Atharva College of Engineering.

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