# Cost-effective and self-regulating digital Noticeboard systems

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*Abstract*— **Traditional noticeboards in schools and colleges amount to heavy wastage of paper. Misunderstanding between parties involved is common. In this paper, we interface multiple Computer Science concepts and study a cost-effective way of solving the problem through smart noticeboards. We use a Raspberry-Pi single board computer with a perpetually running python script which uses the tkinter library to handle images. The notice board module pings the server every 30 seconds to check the offset of local data and the database on server for necessary updates. The update is followed by auto download of new images from google drive.**

**The system is powered by a nodeJS backend to achieve good performance. We introduce a number of new concepts in this domain to digitize noticeboards to full-effect at a pretty economical price.**

**In this paper we have also given a solution, cloud enabled smart display boards for automating the pro-active disclosure as part of smart village concept proposed by Department of Rural Development Ministry of Rural Development Government of India.**

*Index Terms*—**nodeJS, python, Raspberry-Pi, Smart Noticeboards**

## I. INTRODUCTION

The problems with putting up paper notices on noticeboards are many in number: heavy wastage of paper, limitation in number of notices that can be put up at a time, recording and reuse of notices is rendered impossible, etc. Our study visualizes a smart screen hung *outside* every class—a smart system that regularly updates itself from a server, and effectively displays class-specific notices. The project is an IoT project in its true essence, as described below.

### *A. Internet of Things – Services and Components used*

**Google Drive API:** Our cloud system makes use of the *Google Drive API* for image storage, and its basic functions like upload(), download(), view(), to establish communication between the drive and the cloud.

**Google Speech to Text API:** The Text to Speech API has been used to improve the user-friendliness of the noticeboards.

**Amazon Web Services:** A Virtual Machine hosted on the *Amazon Web Services* supports the backend functionalities of the noticeboard. A PostgreSQL is used to store the data.

**Raspberry-Pi:** The Raspberry-Pi computers are cheap and useful in understanding and demonstrating projects, and we have prototyped a Smart-Noticeboard based on one of these systems.

### *B. Existing Systems*

A digitally augmented notice board based on the Pin & Play system is discussed [4]. Here physical notice board is augmented with digital capabilities to provide additional functionality, used with interactive pins with controllable lights. It can be used to signal to the user information about the state of documents posted on the board [4]. The major strength of DNB is its usability with large electronic screen for display of information on numerous strategic points on university campus [3]. Another author proposed, a photo type laboratory model wireless notice board system with GSM modem connected to it, which displays the desired message of the user through an SMS in a most populated or crowded places [6].

Most existing systems use a GSM modem, and combine it effectively with a basic LCD display. GSM modem with a SIM card is interfaced to the ports of the microcontroller with the help of AT commands. These systems make use of simpler micro-controllers like 8051, Atmel AT89C52, ATMEGA32 etc. A mobile phone is usually made use of in the client side to upload notices [1][2][10].

A smart notice board by which one can update the notice to be displayed from any part of the world in no time and it is advantageous during emergencies when we want to display alert messages or changed schedule in a fast

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manner. The user presses different numbers which correspond to different dial tones, which are then coded and sent from user mobile phone to display on the system wirelessly and accordingly the stored message for a code is displayed on LCD [5].

A system which will enable people to wirelessly transmit notices on a notice board using Zigbee is discussed; system provides an efficient way of displaying messages on Notice Board using Wireless Technology [9]. In one of the papers, authors proposed using existing power lines to send the data to a specific node or to broadcast to various power line nodes [7].

Commercial smart-boards (used in the classrooms) and smart TVs haven't been able to replace conventional paper-driven ones. The main reason is the lack of an efficient UI, a convenient interface, affordable and the flexible technology stack.

### *C. Scope and Motivation*

In traditional method the notifications are displayed on the wooden noticeboard by writing the content on the paper which consumes space, prone to tampering and require manual labour to put and remove on time. Some important notices need to be displayed without any delay. So there is a need for having smart digital notice board.

An attractive User Interface that allows real-time control of notices, on each section's noticeboard of a class, say, is the need of the hour. Our motivation is to provide our own university, initially, with a robust system that helps in instant communication of vital notices. We intend to take this technology to many government-run schools and colleges across India, in the countryside, and help with a clearer, simpler way of communicating notices. The proposed system can also be used for pro-active disclosure.

The proposed system, addresses the cost factor (initial investment and recurring maintenance cost) by adopting the combination of private cloud (payment model) AWS and a public cloud (free model) Google Drive. Cost-effective and self-regulating notice boards are designed using commonly available RasberryPie boards and normal commercially available computer monitors, at the cost as low as for 7500/-.

## II. METHODOLOGY

### *A. Architecture*

We have made use of the AWS cloud services to demonstrate the project. On the client side, we run a python script on the Raspberry-Pi computer that looks up for notice updates in the database. The updates, along with fileID's of every notice, is fetched. Consequently, the image is downloaded and displayed on the respective noticeboards for the specified duration of time.

### *B. Client-Side (Raspberry-Pi)*

We now describe the logic of working for our Raspberry-Pi system. The Raspberry-Pi computer runs a native Python script based on the *'tkinter'* library for image display. The script continuously fetches relevant data from it's tuple update, in the MySQL database. The files, stored in Google Drive, are identified by specific fileIDs. The Python Script downloads the relevant images, and continuously begins to display on the go. The flowchart shown below, Figure 1.0 is our methodology on the Display side of the noticeboards.

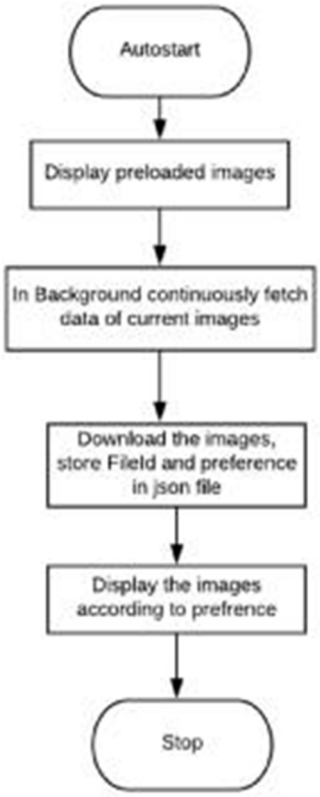


**Fig 1.0 Flow Chart for client-side, Raspberry-Pi**

### *C. Server-Client interaction*

A website to interface every noticeboard with the client is an essentiality. The website should be safe and secure, and should provide all necessary tools for control of the noticeboard. A typical case of communicating notices to various section of a single class in a university is the example we have chosen to solve. Every section has its own Section_ID in the relation, and fileID's of the uploaded images stack up as tuples. A search module to choose/ modify/ delete a file, by name, is essential.

An administration, in our case, the Head of Department is given access to all sections. Lecturers of a particular section are given accounts that can access noticeboards of that particular section only. The Head of Department wields the power the override notices of any of his lecturers, and can send any notices at any point in time.

From a technological standpoint, speed and accuracy are ensured by use of efficient choices of languages and

services. A React powered framework with nodeJS support has been used in out prototype.

The flowchart, Figure 1.1 below contrives our methodology in a concise manner.

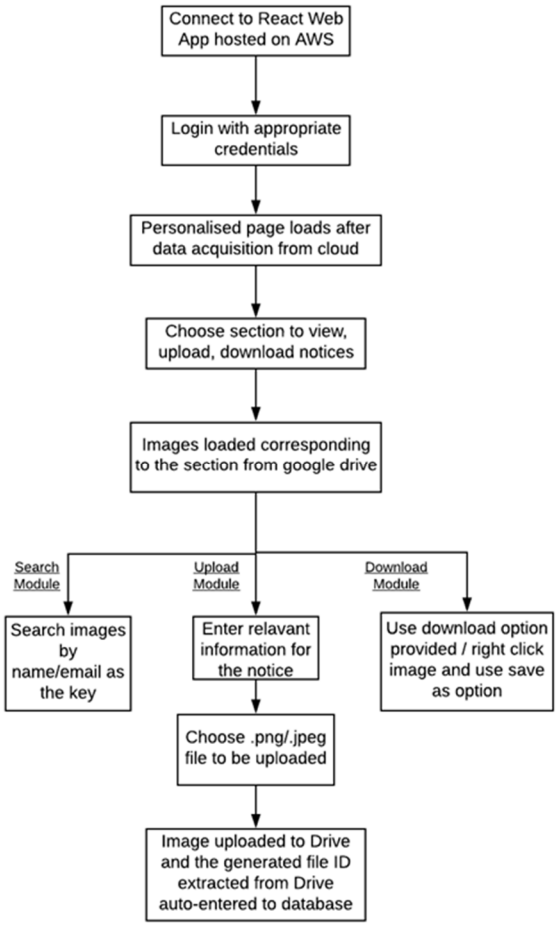


**Fig 1.1 Flow Chart for Server-Client Interaction**

### *D. Other intelligent systems*

The Raspberry-Pi based display system of our prototype integrates another essentiality.

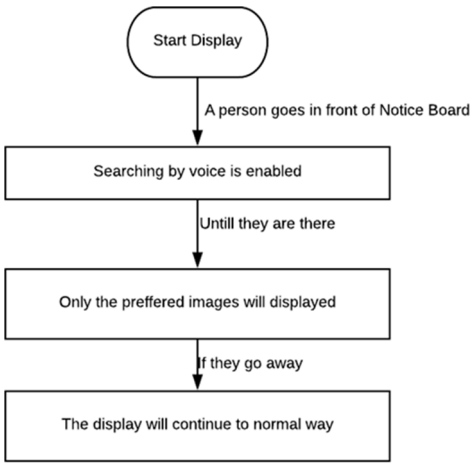


**Fig 1.2 Flow chart for Speech to text functionality**

A user-specific notice generation system. As soon as the user goes and stands in front of the noticeboard, a running OpenCV Python Script (camera is enabled) alerts the display script to await an audio input. The user is alerted, and the audio is taken as input. The *'Google Speech-To-Text API'* is used to process the audio into text. Suppose the student says a particular lecturer's name, only that lecturer's notices to that section of the class are displayed (our chosen example of study) as shown in the Figure 1.2.

### *E. Justification for the opted Methodology*

NodeJS outperforms php in most, if not all service requests [19]. This has compelled us to decide nodeJS to be the perfect means for backend. The Raspberry-Pi systems are robust and can run multiple scripts at a time – which is essential in smart noticeboards. This is in contrary to Arduino [20] and other microcontroller motherboards that only run a single script. So, we have committed to using the Raspberry-Pi Computers to develop noticeboards. The choice of language at the Client-end (on the Raspberry-Pi) is a matter of taste and comfort – and hence Python was chosen.

## III. IMPLEMENTATION

### *A. Technology Stack*

Our system uses an efficient tool stack that has been carefully chosen for full-on delivery and minimal delay. The system has been thoroughly tested for robustness and timely delivery.

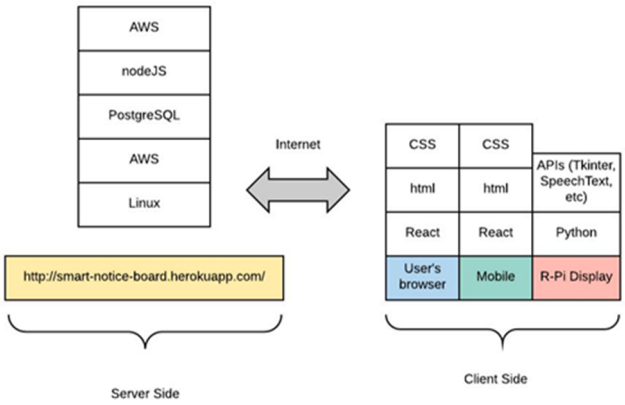


Fig 2.0 Tool Stack for our smart noticeboards

The server-side is hosted as a VM on the AWS cloud. It is swiftly backed by a nodeJS [15] framework that runs on a linux based Virtual Machine. On the Client-side, React [16] has been used. React helps in native display of mobile based CSS sheets too, which is why, React has been our choice for the deed. The Raspberry-Pi system for display make use of various APIs that mainly are Python based.

### *B. Raspberry-Pi based Display*

The noticeboard is an LCD display effected with a Raspberry-Pi computer. A python script runs on this computer and constantly pings the server for instructions to update or delete the notices it currently holds in its local memory. The python script displays the college logo or a default image in case no image is uploaded to the noticeboard.

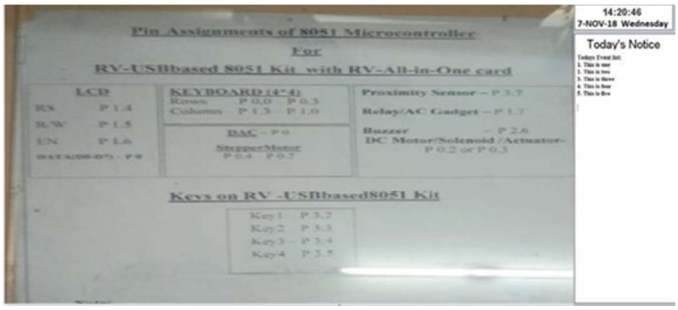


**Fig 2.1 Functional noticeboard with display on**

The display system comes with a toolbar with the recent sent of notices to the right for efficient communication. A date, time field has also been used. It is important to understand that a notice deletes itself from the local memory as soon as the pre-set time for display in a particular section expires.

### *C. Website hosted on AWS*

The React-powered website is at the crux of our implementation. The site is a user-friendly portal for maintenance of every section's notices by a user. An admin login (Head of Department) screenshots of the websites are shown.


**Fig 2.2 Homepage for noticeboard management**

Post login, we go to the dashboard to control every noticeboard particular to sections. A secure mail-ID based registration has also been implemented for security and validation.


**Fig 2.3 Dashboard page of a lecturer**

On logging in, all sections of a particular class, 5, in this case, appear. Choosing any of the classes, say 5A, redirects to the page shown below.


**Fig 2.4 List of images of a lecturer's upload**

The dashboard for section 5A (here) contains two images. Similarly, sections on the page dedicated to previous images and upcoming images are provided.

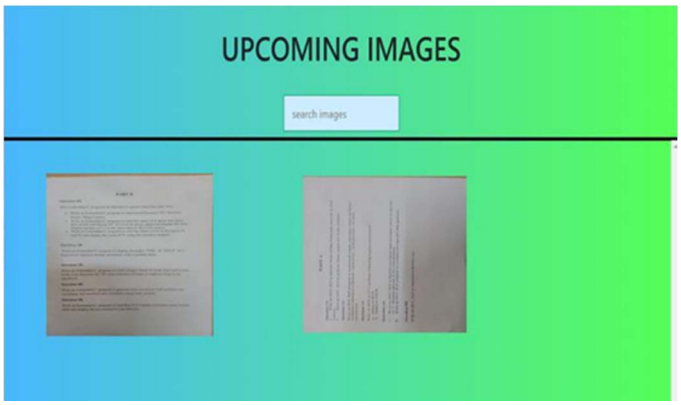


**Fig 2.5 Upcoming images of a lecturer**

The portal has provided us with a good feedback from our lecturers and professors, and has been put to use in the college.

### *D. Relational Schema for data handling*

Every file (a jpg, png (any image)) is pushed into the Google Drive, and fileID is generated.

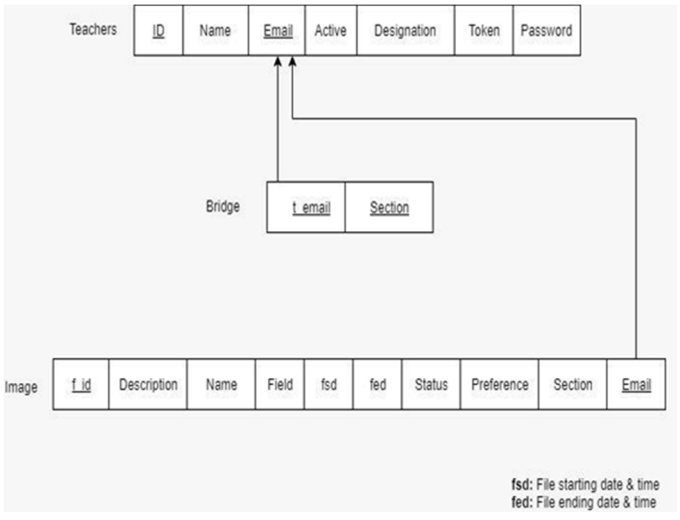


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**Fig 2.5 Relational Schema for backend data storage**

The *Image* relation has f_id, Description, Name, Field, fsd, fed, Status, Preference, Section, and Techer mail, as its attributes. The Status attribute indicates if an image is currently being displayed on the noticeboard or not. The *Bridge* relation keeps track of the classes a lecture teaches. The *Teachers* relation keeps track of every teacher that has access to the noticeboard. The relations are clearly in 3NF (third normal form) and hence data redundancy is avoided – efficient data storage is thereby a given.

### *E. Speech to Text feature in the Raspberry-Pi display*

Google Speech-To-Text API at the display has been used to receive audio input from a student, and search the local SD card for notices based on the keyword of choice. A simple String-matching Python code is run natively to achieve this. A search bar pops out on the screen indicating the student to speak his keyword of choice for further selective search of the notices in the system.


**Fig 2.6 Speech to text functionality in action**

### *F. The Raspberry-Pi display – in flesh and blood – Hardware Implementation*

Here, in our college, we have a working prototype of our smart noticeboards. One of the noticeboards in front of the Head of Department's cabin is shown. The LCD display monitor is connected to a Raspbian-OS, and thus run-time efficient retrieval and display of notices is made possible.


**Fig 2.7 An LCD display of the noticeboard system at RV**

The noticeboard system is thus self-regulating and thus robust.

## IV. APPLICATION OF DIGITAL NOTICE BOARDS FOR PRO-ACTIVE DISCLOSURE

In this paper we have given a solution, cloud enabled smart notice board for automating the pro-active disclosure as part of smart village concept proposed by Ministry of Rural Development, Government of India. Proactive disclosure means sharing of information on a person's or institution's own initiative, without having been asked to do so. The Gram Panchayat is a public institution and has to function in transparent, accountable and responsive manner. This means that all the important information related to functioning of Gram Panchayats must be shared with the villagers.

In the proposed system there will be multiple normal computer monitors which will host different category of information. Uses raspberry pi as embedded computer, which are attached with each of the monitors so that we can display the information received from authorized sources and can be directed to the respective monitor. The system is cloud enabled so that the notices/information can be uploaded from anywhere and anytime. These notices can be downloaded and displayed on the notice board.

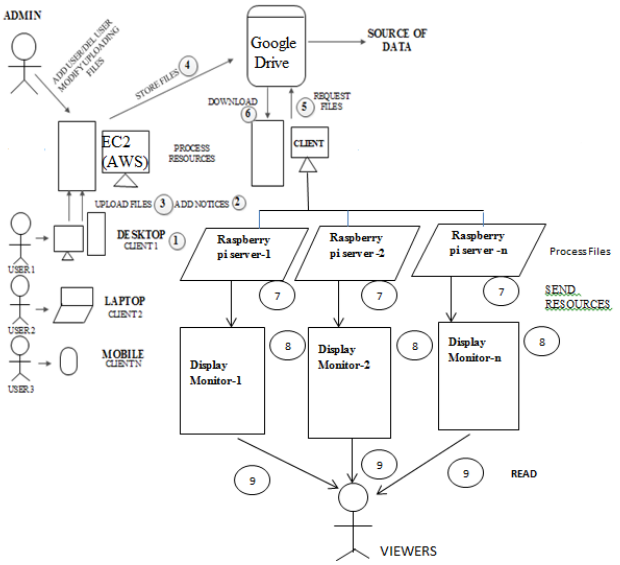


**Fig 2.8 Architecture of Pro-Active Disclosure Display System**

The system is designed such that the authorized panchayat admin can send short notifications to the registered panchayat members. The higher officials will have access to the noticeboards installed in different villages in their administration cluster, providing the centralized monitoring. Fig <2.8> shows the architecture of the proposed system and the steps of interactions between the different components of the system.

## V. CONCLUSION

### *A. Unit-Testing*

The system was effectively tested in our college, and showed commendable results. The system did not get heated in the unit-testing process. Lecturers and Head of the Department have been given admin accounts to control the noticeboards of the classes they lecture.

It is cost effective and proves useful for all the identified stakeholders. The information is made visible to the public thus attaining the pro-active disclosure goal of Sansad Adarsh Gram Yojana proposed by Department of Rural Development, Ministry of Rural Development Government of India, which is one of the important objectives of grampanchayat in a smart village concept.

### *B. Future Work / Add-On possibilities*

A noticeboard can be more than just a noticeboard. Our in-house OpenCV script already recognizes people, and displays a search-box for search by speech. It is in our area of interest to extrapolate this feature to assess emotional changes in students when they read through particular set of notices. A shrug at the sight of an exam-timetable, a joyous smile when a holiday circular is released, or a complex mix of emotions when a company announces a recruitment test – everything can be then understood and modelled. Our *'add-on'* is to use the noticeboard to develop a sentiment-analyzing dataset that can be used later on to study emotions of students and establish a pattern for further research.

## VI. ACKNOWLEDGEMENT

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